



Canada Foundation for Innovation  
Fondation canadienne pour l'innovation

# 2008 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 August 22, 2008, the CFI has committed almost \$4.4 billion in support of 5,751 projects at 130 research institutions in 64 municipalities across Canada.

**The CFI has committed more than \$4.4 billion in support of more than 5,700 projects.**

## Purpose

By June 30 of each year, institutions funded by the CFI are required to submit Project Progress Reports 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 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;
- optimal use of research infrastructure.

**Aggregation of project data informs planning and policy.**

## Methodology and Sample

Project reports are required to be submitted for every project for five years following the finalization of the award. As of July 22, 2008, the CFI had received 2,844 of the 3,063 required reports for the 2007-08 reporting period, a submission rate of 93%.

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, there are

**The submission rate for the 2008 Project Reports is 93%.**

limitations that 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.

## Highlights

### Research infrastructure leads to social and economic benefits

For projects funded since 2003, the availability of the infrastructure led to the:

- creation of 2,708 public/private sector jobs;
- generation of 848 intellectual property rights;
- development of 657 new or improved products, processes or services;
- development of 588 new or improved public policies or programs;
- creation of 113 new CFI-linked spin-off companies.

**Research infrastructure led to the creation of 2,708 public/private sector jobs.**

### Fuelling brain gain

In the past year:

- 32% of project leaders reported that the availability of CFI-funded infrastructure was an important factor in their decision to join the institution;
- 73% of project leaders reported that the availability of infrastructure was an important factor in the decision of researchers to stay at an institution;
- almost 15,831 internal researchers (including the researcher, other principal researchers, and other faculty at the institution) advanced their research by using CFI-supported infrastructure;
- Overall, 2,130 new researchers were recruited. Of this number, approximately half (44%) were recruited internationally.

**More than 15,000 internal researchers advanced their research.**

## Meeting Canada's need for knowledge workers

- In the past year, 14,665 post-doctoral fellows and graduate students were attracted to the institutions, partly due to the availability of the infrastructure;
- For projects funded since 2003, a total of 35,175 post-doctoral fellows and graduate students have used the infrastructure as a key resource in their research project. Of this group, 54% have stayed at the institution as trainees, 10% have joined another Canadian academic institution, college or research hospital, and 8% have joined the Canadian private sector;
- For projects funded since 2003, a total of 9,868 technical personnel have been trained on the use and maintenance of the research infrastructure. Of this group, 67% have stayed at the institution, 11% have joined another Canadian academic institution, college or research hospital, and 10% have joined the Canadian private sector.

**More than 35,000 students have used the research infrastructure as a key resource in their research project.**

## Enhancing Canada's international reputation

- In the past year, 15,675 visiting researchers from around the world made use of state-of-the-art infrastructure at Canadian universities, colleges, and research hospitals. The CFI funding of unique and innovative research has earned researchers and institutions international attention and recognition.

**More than 15,000 visiting researchers made use of CFI-funded infrastructure.**

## Fostering collaboration

For projects funded since 2003:

- 54% of the project leaders report that the infrastructure has contributed to fostering international collaboration in a significant/critical manner, while 41% reported that the infrastructure fostered local or regional collaboration;
- 6,879 internal/external research collaborations have occurred. More specifically:
  - 1,541 with an institution outside Canada;
  - 1,086 with the private sector within Canada;
  - 1,868 with an institution within Canada;
  - 2,384 within the institution.

**More than 6,000 internal and external research collaborations have occurred.**

## Conclusion

The results of this analysis indicate that the infrastructure funded by the CFI is increasing research capacity and having a profound effect on the research environment in Canada. Benefits of CFI investments, however, go beyond increased research capacity. Institutions continue to report that CFI-funded infrastructure not only supports the development of new products, processes, and services but it generates improvements to public policy, health, science, engineering, and the environment.

The CFI's objectives, practices, and results demonstrate its commitment to the principles outlined in the Government of Canada's S&T Strategy, *Mobilizing Science and Technology to Canada's Advantage*. Through the provision of state-of-the-art infrastructure, the CFI will continue to play a major role in helping Canada's research community transform its ideas into innovations.

**The CFI's objectives, practices and results demonstrate its commitment to the principles and priorities outlined in the Government of Canada's S&T strategy.**

## 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<sup>1</sup>. The institutions then leverage 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<sup>2</sup>, including:

- 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 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 August 22, 2008, the CFI has committed more than \$4.4 billion in support of 5,751 projects at 130 research institutions in 64 municipalities across Canada.

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<sup>1</sup> Research infrastructure includes state-of-the-art equipment, buildings, laboratories, and databases required to conduct research.

<sup>2</sup> Funding Agreement between the Canada Foundation for Innovation and Her Majesty in Right of Canada. March 31, 2003, p. 1

## **2.0 Purpose and Scope**

### ***2.1 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 more overall objectives of the CFI and its programs. The aggregation and analysis of Project Progress Report (PPR) data serve to provide data that informs issues of relevance for planning and policy by examining societal and economic benefits to Canada; levels of attraction and retention 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 as well as informing future program evaluations and other special studies.

### ***2.2 Scope of this analysis***

PPRs address key areas related to infrastructure and personnel, as well as the research activities enabled by the infrastructure and more overall benefits to Canada. Institutions are asked to provide both quantitative and qualitative data describing activities and outcomes more than the past year. There are also instances where data is requested from the beginning of the projects funded since 2003. It should be noted that the report presents the aggregate results of project funding for the identified sample and does not attempt to develop national or international comparisons of results.

The focus of the 2008 Report on Results is on projects funded for the 2007-08 fiscal year (April 1, 2007 to March 31, 2008). This represents a total of 2,844 of the 3,063 required reports for the 2007-08 reporting period, a remarkable submission rate of 93%.

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

<b>Table 1 Overview of CFI funds reporting in 2008 sample</b>						
<b>Fund</b>	<b>Number of projects reporting by year</b>					
	<b>2003-04</b>	<b>2004-05</b>	<b>2005-06</b>	<b>2006-07</b>	<b>2007-08</b>	<b>TOTAL</b>
New Opportunities	368	349	320	134	12	<b>1,183</b>
CRC Infrastructure	227	239	200	126	39	<b>831</b>
Leaders' Opportunity*	-	-	-	164	395	<b>559</b>
Innovation Fund	55	61	52	11	2	<b>181</b>
CFI Career Awards	7	9	6	1		<b>23</b>
Leading Edge Fund	-	-	-	-	22	<b>22</b>
New Initiatives Fund	-	-	-	-	22	<b>22</b>
Research Hospital Fund	-	-	1	7	1	<b>9</b>
International Access	3	3	0	0	0	<b>6</b>
Research Development Fund	3	-	-	-	-	<b>3</b>
Exceptional Opportunities	0	1	0	0	1	<b>2</b>
International Joint Ventures Fund	2	-	-	-	-	<b>2</b>
National Platforms	-	-	-	-	1	<b>1</b>
<b>TOTAL</b>	<b>665</b>	<b>662</b>	<b>579</b>	<b>443</b>	<b>495</b>	<b>2,844</b>

\* 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 may also be obtained from the CFI Policy and Program Guide at [www.innovation.ca](http://www.innovation.ca)

## 3.0 Methodology

### 3.1 *Data collection procedures*

By June 30 of each year, institutions are required to submit a PPR for each funded project. PPRs are to be submitted for every 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 1 of each year. Individual PPRs are prepared by project leaders and reviewed, assembled and submitted by their host institutions. A copy of the 2008 Project Report Form is available on our website [www.innovation.ca](http://www.innovation.ca).

The PPR is a self-completed electronic survey with quantitative and qualitative sections. Open-text boxes invite respondents to elaborate or further explain their answers, which constitute valuable sources of in-depth information.

### 3.2 *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 CFI's progress towards achieving the objectives set out for the organization. However, there are several considerations to take into account when interpreting the data.

#### **Self-reporting**

Project reports are prepared by project leaders and compiled by their host institutions. Although a copy of the progress report is printed and filed for information and reference, given the sheer volume, program officers are not tasked with the responsibility to review individual reports since they are not intended for individual monitoring of specific projects. There is, however, little to no incentive for institutions to provide false or misleading data, due to the fact that the reports have no bearing on potential future funding at this time. Rather, inaccuracies may occur due to a lack of administrative capacity to fill out forms comprehensively and track all numbers, especially for large, complex projects.

#### **Size and complexity of projects**

There is a great variety in terms of the size and complexity of research infrastructure projects which affects 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, purchase, and develop, whereas large complex awards such as those provided under the New Initiatives Fund may take several years to become fully operational. In summary,

the scope and sophistication of projects affect the speed of implementation, and generation of outputs and outcomes.

### **Diversity of research projects**

There is a diversity of scientific disciplines and sectors covered by the projects. CFI-funded projects span all disciplines and the full range of higher education institutions, including universities, colleges, research hospitals and non-profit research organizations. In addition, some projects are considered to be fundamental R&D while others are applied.

### **Timing of project funding and reporting**

The CFI's database for progress reports submitted for the 2007-08 fiscal year contains information on projects that commenced any time between April 1, 2002 and March 31, 2008. As a result, projects vary in terms of their relative maturity and, therefore, in some of the results achieved.

### **Double counting**

There is a possibility of double counting in some of the responses. For example, in questions related to attraction and retention, researchers and trainees may regard more than one infrastructure project as a significant incentive to join institutions and/or pursue research careers. This would result in overestimations of results. Alternatively, data that is difficult to track or obtain with certainty could be omitted, resulting in underestimations.

### **Attribution**

Finally, there is a dilemma of attribution. The research infrastructure investment made by the CFI is only one contribution to a larger endeavour. There are also the co-funders of the infrastructure, non-infrastructure support of research and training, and many other contributing factors that affect the ability to precisely attribute impacts.

Despite these limitations, progress reports constitute an important and unique source of Canadian R&D information, and the response rate of 93% is remarkable for such a large sample. It is also worth reiterating that this database includes projects that span all disciplines and represents the full range of higher education institutions.

### 3.3 Data sample

By the cut-off date of July 22, 2008, a total of 2,844 of the 3,063 required reports had been received, representing a submission rate of almost 93%. Table 2 shows the number of reports submitted for the year April 2007 to March 2008, and the corresponding response rate.

<b>Table 2 Summary of 2008 Data sample</b>				
<b>Category</b>	<b>No. of funded institutions</b>	<b>No. of funded projects</b>	<b>No. of reports submitted</b>	<b>Response rate (%)</b>
A. Large universities, hospitals, and non-profit	40 (42.6%)	2,533 (83.3%)	2,379 (83.6%)	93.2%
B. Small universities	45 (47.9%)	498 (16.3%)	461 (16.2%)	92.6%
C. Colleges	9 (9.6%)	12 (0.4%)	4 (0.1%)	33.3%
<b>TOTAL</b>	<b>94 (100%)</b>	<b>3,063 (100%)</b>	<b>2,844 (100%)</b>	<b>92.9%</b>

Table 2 reflects how the CFI distinguishes between three broad categories of eligible institutions that may receive funding. Universities are categorized based on whether they receive greater than or less than 1% of total federal funding agency awards. Large universities, hospitals, and non-profit, therefore, receive greater than 1% of total federal funding agency awards.

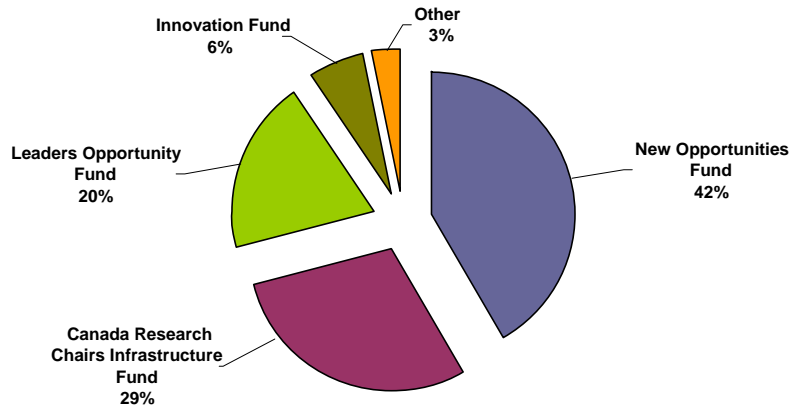
#### 3.3.1 2008 sample profile

##### Composition of 2008 sample by fund and by projects

The 2008 sample consists of data distinguished by 13 fund categories. Projects classified as a New Opportunities Fund award represent more than 42% of the sample. This is followed by the Canada Research Chairs Infrastructure Fund (29%), and the Leaders Opportunity Fund (20%). This information is summarized in Figure 1.<sup>3</sup>

<sup>3</sup> Funds representing less than 1% of the total sample have been included in the 'other' category. They include CFI Career Awards (0.8%), the Leaders Edge Fund (0.7%), the New Initiative Fund (0.7%), the Research Hospital Fund (0.3%), the International Access Fund (0.2%), the Research Development Fund (0.1%), the International Joint Ventures Fund (0.07%), the Exceptional Opportunities Fund (0.07%), and the New Platforms Fund (0.04%).

**Figure 1. Composition of the 2008 sample by fund (n=2,844)**



Further, Table 3 summarizes the dollar value of the 2008 sample. The total of projects in this sample represents a CFI investment of \$1.5 billion. The vast majority of these projects (71% or 2,020 projects) received awards of less than \$200,000. Almost 60 percent (57.9%) of the CFI investment was allocated to 184 projects (6.5% of the projects in the sample) for awards of \$1 million or more.

**Table 3 Sample 2008 - CFI Awarded amounts by range**

Ranges of awarded amounts (\$)	# Projects (%)	CFI \$ Amount (%)
<200K	2,020 (71.0%)	\$229,885,205 (15.4%)
200K-1M	634 (22.3%)	\$198,874,075 (13.4%)
1M-4M	101 (3.6%)	\$232,641,053 (15.6%)
4M-10M	67 (2.4%)	\$407,292,709 (27.4%)
10M-20M	16 (0.6)	\$221,539,592 (14.9%)
>20M	6 (0.2%)	\$198,474,189 (13.3%)
<b>TOTAL</b>	<b>2,844 (100%)</b>	<b>\$1,488,706,823 (100%)</b>

**Projects by sector**

Table 3 shows the 2008 sample segmented by sector. It should be noted that project leaders select 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 target research priority areas.

1. Natural Resources
2. Information and Communications Technology
3. Health and Related Life Science and Technologies
4. Environmental S&T

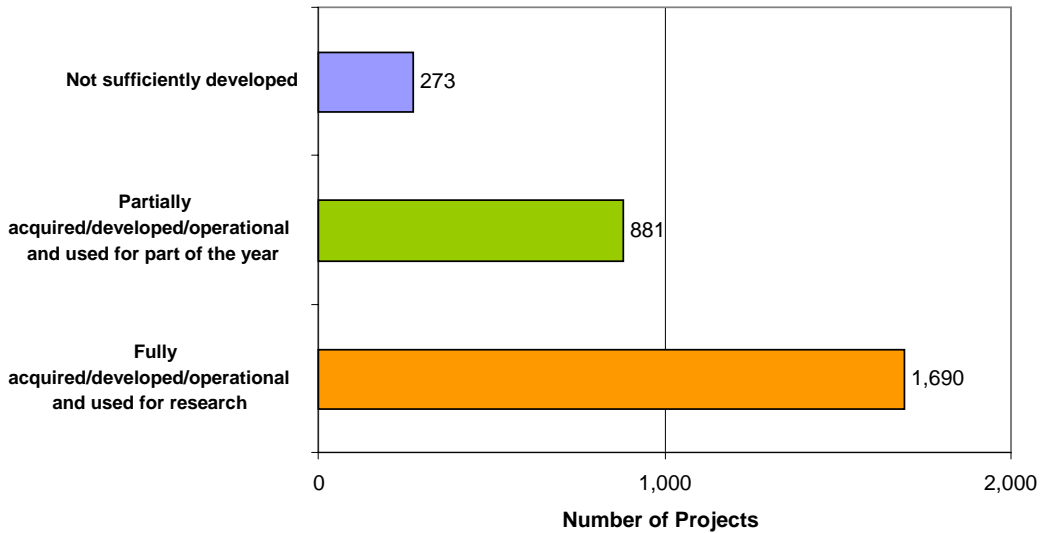
The data provided in Table 3 reveals that CFI project funding is aligned with the government's priority areas.

<b>Table 4 Project by sector, 2008 sample</b>		
<b>Sector</b>	<b>No.</b>	<b>%</b>
Health	1,106	38.9%
Science	626	22.0%
Engineering	600	21.1%
Environment	293	10.3%
Social Sciences	219	7.7%
<b>TOTAL</b>	<b>2,844</b>	<b>100%</b>

**Implementation status and project maturity**

A key consideration with respect to the 2008 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 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 more than 90% of the projects included in the 2008 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=2,844)**



Further to Figure 2, Table 5 shows the number of projects by year included in the 2008 sample and presents their level of operational status as identified by the institution.

**Table 5 Project maturity by fiscal year, for projects funded since 2003  
(2008 n = 2,844)**

Fiscal year	Number of years since award finalization	Number of projects	Fully operational	Partially operational	Not sufficiently developed
April 2007 to March 2008	1	495	52 (10.5%)	259 (52.3%)	184 (37.2%)
April 2006 to March 2007	2	443	170 (38.4%)	231 (52.1%)	42 (9.5%)
April 2005 to March 2006	3	579	376 (64.9%)	182 (31.4%)	21(3.6%)
April 2004 to March 2005	4	662	510 (77.0%)	137 (20.7%)	15 (2.3%)
April 2003 to March 2004	5	665	582 (87.5%)	72 (10.8%)	11 (1.7%)

These data are important to consider because research and innovation projects typically require a certain period of time to demonstrate results. For example, projects less than two years old typically generate fewer, if any, measurable outcomes because they are typically acquiring infrastructure, building or renovating research facilities, etc. To account for this time lag, the following section reports on those projects that were fully or partially operational (n=2,571) and used for research during the past year, unless otherwise noted.

## 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:

- strengthen Canada's capacity for innovation;
- attract and retain highly skilled research personnel in Canada;
- stimulate the training of highly qualified personnel through research;
- promote networking, collaboration, and multidisciplinary among researchers, institutions, and sectors;
- ensure the optimal use of research infrastructure within and among Canadian institutions.

Section 4.0 of this report addresses the key outputs and outcomes of CFI-supported infrastructure by summarizing the information obtained from the institutions in the 2008 PPRs.

### 4.1 *Benefits to Canada*

The CFI defines innovation as a process that begins with the creation of knowledge in research and continues through its applications, for the benefit of Canadian society. While the availability and quality of research infrastructure are an important enabler of innovation, ultimately, it is knowledge transfer that impacts society at large

#### **Key Findings—Benefits to Canada**

- ✓ Institutions continue to report that the research enabled by CFI investments supports the conversion of knowledge and ideas into benefits for commercial use or for the common good.
- ✓ These benefits include the development of new products, processes and services, improvements to public policy, health, science, engineering and the environment.
- ✓ In the last two years, a minimum of 19 new spin-off corporations were independently confirmed as having a CFI link.
- ✓ The CFI funding represents an important contribution to Canada's Knowledge Advantage in areas identified as priorities in Canada's S&T Strategy.

Table 6 presents an overview of how CFI investments in infrastructure have helped to generate social and/or economic benefits for Canada for projects funded since 2003. Benefits may be generated directly by activities of researchers and trainees or indirectly by other users of the research infrastructure.

**Table 6 More overview of benefits to Canada \***

	Number of project leaders responding 'yes'	% 'Yes'	If 'yes', how many?
Private/public sector jobs	326	13%	2,708
Spin-off companies	98	4%	113**
New or improved public policies and programs	588	23%	N/A
New or improved products, processes, or services	657	26%	N/A
Patents	343	13%	1,043
Intellectual property rights	133	5%	848
Licensing agreements	109	4%	236
Other benefits	839	33%	N/A

*n=2,571*  
*\* for projects funded since 2003*  
*\*\*instances confirmed with 2008 survey validation.*  
*N/A denotes that respondents are not asked to quantify their response*

### For projects funded since 2003

#### Private/public sector jobs

326 project leaders reported instances of their CFI-funded infrastructure facilitating the creation of more than 2,700 public/private sector jobs. The types of jobs identified include: analysts, engineers, programmers, facility managers, research associates, and technicians.

#### Patents

A total of 343 project leaders reported that the infrastructure played a role in the ability to obtain 1,043 patents.

#### Intellectual property (IP) rights

133 project leaders reported that the infrastructure played a role in the ability to secure intellectual property rights (IP) in 848 instances. These include: copyrights, disclosures, industrial designs, and patent applications.

### **New or improved products, processes, or services**

A total of 657 project leaders reported instances of CFI-funded infrastructure enabling them to develop new or improved products, processes, or services.

### **Licensing Agreements**

109 project leaders reported that the infrastructure played a role in the ability to secure 306 licensing agreements.

## **4.1.1 2008 Spin-off survey**

Further steps were necessary to validate the instances of spin-offs reported this year. The 2007 exploratory study conducted by the CFI focused on cases of positive reporting included in the 2006 sample. The study confirmed 94 cases of CFI-linked spin-offs created between 2000 and 2006.<sup>4</sup> Because of the timeframe of the sample, some of the 143 instances reported this year could have been already included in the 2006 report. To assess the number of the CFI-linked spin-offs created in the past two years, the responses required further analysis.

### **a) Sample profile**

98 project leaders reported that the infrastructure has permitted the development of 143 spin-off companies. This year's sample includes companies operating in the sectors of health, engineering (all types), sciences, social sciences<sup>5</sup>, environment, and the arts.

### **b) Data collection**

Institutions that reported affirmative cases of creation of spin-offs were asked to complete a short email survey.

The 2008 spin-off survey was sent to 33 institutions. The CFI received responses from 24 (73%) of the institutions representing a total of 88 spin-offs, or 61.5 % of this year's reported 143 spin-offs.

### **c) Data analysis**

The information obtained from the survey was necessary to verify compliance with the definition of spin-offs as advanced by Dr. Denys Cooper<sup>5</sup> in the exploratory study on the link between CFI

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<sup>4</sup> Of the 155 CFI-funded projects reporting positive in 2006 that their research infrastructure was of benefit to spin-off companies, 94 university/hospital spin-off corporations could be independently confirmed as spin-offs. From: *Research Infrastructure and the Economy: An exploratory study on the link between CFI investments and Canadian spin-off company growth*, Barker, M. and Cooper, D. CFI, 2008

<sup>5</sup> Dr. Denys Cooper, Guest Worker at the National Research Council's Industrial Research Assistance Program (NRC/IRAP)  
Definition: For our study, the term "university spin-off company" refers to either a Canadian university or hospital source of the intellectual property (IP). The company has been created to commercialize IP that is owned either by the university/hospital or by the researcher(s) within these

investments and Canadian spin-off company growth. The compiled data obtained from the surveys was validated by internet search and compared to the National Research Council/Industrial Research Assistance Program (NRC/IRAP)/Cooper database.

**c) Incremental number of spin-offs from the 2008 sample**

As a result of the survey and the analysis of the compiled data, with inclusion of projects awarded in the past two years (from April 2006 to March 2008), we were able to confirm that a minimum of 19 new CFI-linked spin-offs are included in the 2008 report and are operational as of September 19, 2008.

Of the total 88 responses received for the 2008 survey, there were 21 instances of spin-offs included in the 2008 sample that had already been captured in previous analysis and in the Cooper database. Twenty-five instances require further confirmation and 23 cases were deemed invalid. In summary:

- 21 instances were already included in the Cooper database and the former project reports
- 19 confirmed cases of new University CFI-linked spin-offs
- 8 likely (not confirmed)
- 17 require further confirmation
- 18 invalid (unable to confirm)
- 5 duplications (instances reported by more than one project leader)

**Other benefits**

The final question of the report form allows project leaders to identify 'other' benefits that result from the infrastructure. Close to 2,000 responses were recorded. The following themes were identified and/or reiterated:

- Advancing knowledge or research;
- Collaboration (both international and regional);
- Increased research capacity;
- Training and employment;
- Attraction and specialized training of HQP;
- Research peer-reviewed publications, conference proceedings and presentations.

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institutions, or the IP is owned by both of these agencies. The critical point is that the relevant researchers who are the source of the IP are employees of, or hold full-time appointments in the institution when the company is formed.

**Other benefits to Canada**  
**From project leader comments**  
**n= 100 Top CFI investments by dollar value**

In reviewing project leader comments, several benefits to Canadians surfaced that are not captured by a more traditional set of indicators. The following attempts to capture the essence of the comments from researchers across Canada on how these benefits are generated.

**Return on investment:** Investments in large basic research projects often take longer to produce concrete benefits than investments in applied science. However, the potential of basic research to generate knowledge and to have an impact on the well-being of Canadians is enormous. Researchers working in basic science rely largely on funding from government sources since their scientific pursuits do not attract enough private investment.

**International visibility:** Some CFI awards have resulted in unique Canadian innovations that have received considerable international visibility and have positioned Canadian researchers among world-class scientific leaders. Research on topics of relevance or common interest gains the attention of media, the research community at large, and the private sector. These high-visibility projects showcase Canada as a world leader in science and technology.<sup>6</sup>

**Evidence-based policy:** Research projects included in this sample span a broad range of disciplines and topics, many of which are in areas of critical importance to Canada. The following examples illustrate direct impacts of research on evidence-based policy:

**Genetics social policy:** CFI infrastructure has facilitated a major research project on genetics and this work is providing novel guidelines for the incorporation of genetic tests in to the healthcare system.

**Modelling of complex social systems:** Researchers are working closely with a range of government organizations to help solve social problems and to shape cultural programs in Canada. For example, modelling healthcare demand, reducing surgical waitlists, modelling the criminal justice system, and studying the epidemiology of HIV.

**Knowledge generation and outreach:** Project leaders cite extensive high-quality publications and internationally recognized peer-reviewed journals as one significant benefit to Canada since they are considered clear indicators of the generation of new knowledge. Publications in leading-edge scientific journals also have an important outreach effect by raising the profile of institutions and their research. The presence of researchers at local, provincial, national and international conferences is considered an important factor in fostering collaborations, sharing knowledge and promoting the country's research image.

**HQP high-quality training:** CFI infrastructure fosters high-level training of uniquely qualified personnel and collaborations, especially in areas of strategic importance to Canada, such as environment and health.

**Informal collaborations:** Major investments in infrastructure provide a rich environment for research and development which in turn may attract industry participation in the academic research environment. Informal communications and networks cannot be quantified but they have an impact in producing benefits to research and to Canada.

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<sup>6</sup> e.g. Project SNOLAB 7179 -Carleton and neuroArm 8766 - Calgary

## 4.2 Strengthening Canada’s capacity for innovation

Strengthening a country’s capacity for innovation is dependant upon numerous factors, including the quality of infrastructure, as well as the availability and access to research funding and highly qualified personnel, who not only to conduct research, but also assist in the operation and maintenance of the infrastructure.

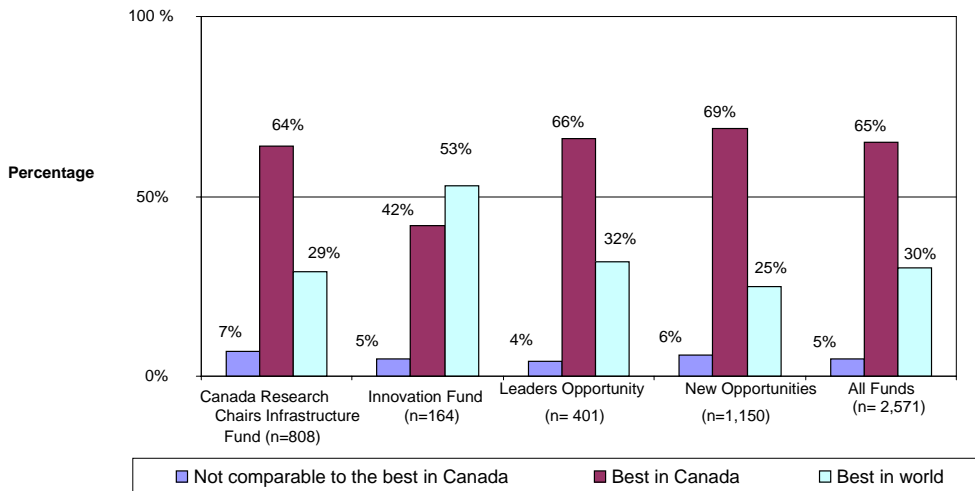
### Key Findings – strengthening Canada’s capacity for innovation

- ✓ Overall, 30% of institutions compare their infrastructure to the best in the world while 65% report that their infrastructure compares to the best in Canada.
- ✓ On average, the useful remaining life across all infrastructure types is 7.5 years for the 2008 sample data. This ranges from a low of three years (computing equipment, software, etc.) to a high of 12 years (for buildings and research facility space).
- ✓ For those projects classified as fully or partially operational and used for research during the past year, approximately 15% of the institutions categorized as large universities, hospitals, and non-profit organizations report that the research enabled by the infrastructure has been leading edge internationally. This is a key finding given that this category represents more than 83% of the projects funded in the 2008 sample.

### 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: The four individual funds shown in Figure 8 account for 97% of PPR responses.

Overall, 65% of project leaders compare their infrastructure to the best in Canada. An examination of the funds independently reveals that:

- *Canada Research Chairs Infrastructure Fund*: 64% of project leaders report that their infrastructure compares to the best in Canada while 29% compares it to the best in the world;
- *Innovation Fund*: 42% of project leaders report that their infrastructure compares to the best in Canada while a 53% compares it to the best in the world;
- *Leaders Opportunity Fund*: 66% of project leaders report that their infrastructure compares to the best in Canada while a 32% compares it to the best in the world.
- *New Opportunities Fund*: 69% of project leaders report that their infrastructure compares to the best in Canada while a 25% compares it to best in the world.

### 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 life of the asset however, is directly dependent on the application. Computer servers, software, and databases have on average the lowest useful life at approximately three years. At the other end of the spectrum, building(s) and research facility space have an average useful life of more than 12 years. Table 7 shows that the average remaining useful life across all types of infrastructure is 7.5 years.

Table 7 Useful remaining life of infrastructure, 2008 sample	
Infrastructure types	Average* years of useful life remaining
Building(s) and research facility space	12.9
Other - specify (see below)	6.6
Non-specialized or standard research equipment	7.5
Highly-specialized research equipment, as appropriate to your field	6.9
Computing workstations, servers, software, databases, etc.	3.8
<b>Average across all infrastructure types</b>	<b>7.5</b>

\* Simple average

In table 7, the category 'other' was in line with the overall average useful life at eight years.

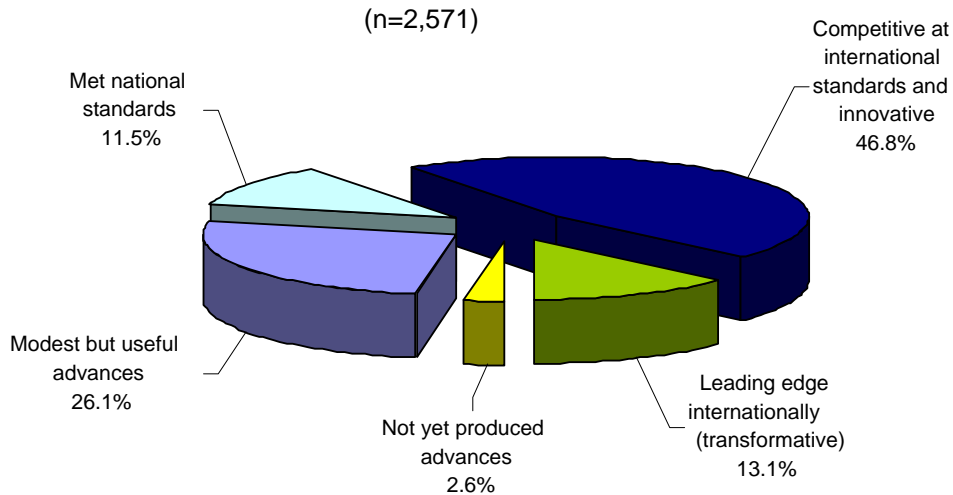
Examples of 'other' types of infrastructure include:

- Audio and video conference equipment;
- Cell lines;
- Data (including databases, archives, data acquisition cards, etc.);
- Research vehicles (including cars, trucks, trailers, and boats);
- Animal care facilities.

**Research enabled by the infrastructure**

For those projects funded since 2003 and classified as fully or partially acquired and used for research during the past year (i.e. n=2,751), 47% of the project leaders indicated that the research enabled by the infrastructure has been innovative and competitive at international standards while 13% of the institutions reported that their research has been transformative and leading edge internationally (Figure 4).

**Figure 4 - Research enabled by the infrastructure**



Overall, for the 2008 reporting period, 59.9% (46.8% + 13.1%) of institutions indicated that the research had met international standards to some degree. Table 8 examines this issue further by analyzing the research enabled by the infrastructure by category of institution.

**Table 8 Research enabled by category of institution, 2008 sample**

Category of institution	Leading edge internationally	Competitive with international standards	Met national standards	Produced modest advances	Not yet produced advances
A. Large universities, hospitals, and non-profit	312 (14.6%)	1,029 (48.0%)	228 (10.6%)	518 (24.2%)	54 (2.5%)
B. Small universities	24 (5.6%)	173 (40.6%)	66(15.5%)	151 (35.4%)	12 (2.8%)
C. Colleges	0(0%)	0(0%)	1(25.0%)	2 (50.0%)	1 (25.0%)

Almost 15% of the large universities, hospitals, and non-profit institutions report that their research has been leading edge internationally and has been transformative, while approximately half (48%) of this same group report that the research has been competitive with international standards. This is a key finding given that large universities, hospitals, and non-profit institutions represent almost 84% of the projects funded in the 2008 sample.

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

In a world where the search for talent is intensifying, it is crucial for Canada to position itself as a destination of choice for the brightest minds in order to remain competitive globally. With the integration of many eastern European countries into the EU and with the increased competition for skilled workers in countries like India and China, potential candidates may no longer look to Canada as a first choice for advancement.<sup>7</sup> Countries like Australia, New Zealand, the United Kingdom and the United States have been engaged for a long time in this battle for talent. With an aging workforce and population growth coming predominantly from immigration, it is important for Canada not only to attract but also to retain highly trained talent. Investments in infrastructure are one incentive institutions have come to rely on to recruit and retain researchers.

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

##### ✓ Researchers

For the current reporting year, 32% of project leaders report that the availability of the infrastructure was an important factor in the decision to join an institution.

- Overall, 2,130 new researchers were recruited in the past year. Of these, 19.3% were recruited from the U.S. and 24.3% were recruited from elsewhere. The top five countries identified include France, U.K., China, Germany, and Brazil.
- Of the 2,130 researchers recruited, 90.3% were recruited from the academic/hospital sector.

##### ✓ Post-Doctoral Fellows (PDF) and Graduate Students (GS)

Overall, 14,665 PDF/GS were attracted to the institutions due to the availability of the infrastructure. Further analysis reveals that CFI projects attracted, on average, 1.5 PDF and 4.6 GS per project.

- Project leaders report that, since the beginning of their projects, more than 35,175 PDF and GS have used the infrastructure as a key resource in their research project. Of this group, 54.4% have stayed at the institution as trainees while an additional 9.6% have joined another Canadian academic institution, college, or research hospital.

##### ✓ Technical Personnel

- Since 2003, a total of 9,868 technical personnel have been trained on the use and maintenance of the infrastructure. Of this group, 66.9% have stayed at the institution while an additional 10.7% have joined another Canadian academic institution, college, or research hospital.

<sup>7</sup> The argument of increased international competition to attract highly qualified personnel is often presented in articles and academic discussions. The statement included in this report can be linked to comments made by Claire M. Morris, President and CEO of the Association of Universities and Colleges of Canada in an article from: [www.aucc.ca/publications/media/2008/oped\\_gazette\\_02\\_25\\_e.html](http://www.aucc.ca/publications/media/2008/oped_gazette_02_25_e.html) and Statistics Canada, *The Daily*, May 24, 2000.

## Qualitative analysis of comments from project leaders on attraction and retention of researchers and highly qualified personnel (HQP) (From a representative sample<sup>8</sup> of 782 comments)

In analyzing the comments of project leaders on the topic of attraction and retention of researchers and HQP, there were a number of recurrent themes identified.

### Attraction

- 1) Increased competition:** Comments emphasized that competition for research talent has significantly increased. The most prevalent competitor cited is the private sector, which is more aggressive in trying to attract highly skilled researchers and HQPs. Competition is also strong among research centres and institutions at a national and international level, all having taken steps to attract researchers and highly qualified personnel.
- 2) Motivation:** Project leaders offer ample evidence of researchers deciding to join an institution based on the availability of CFI-funded equipment and the possibility of working on leading-edge research. The potential of an institution or laboratory to provide infrastructure for high level research seems to have an impact on attracting specialized talent. Some project leaders shared their experiences as immigrant researchers attracted by infrastructure they could not have accessed at their institutions or country of origin. Even when excellence in research is perceived as the result of multiple factors, there is a resounding agreement on the fact that the absence of world-class infrastructure and an adequate research environment would keep researchers from joining an institution.
- 3) Outreach and country image:** Hosting visiting scholars and engaging in international collaborations are mentioned as points of contact for initiating the process of attracting research talent and as effective ways to recruit both researchers and HQPs at the national and international level. The CFI investments in innovative areas of research have received media attention, increased the reputation of an institution and, consequently, attracted successful applications of national and international graduate students.
- 4) Training and education:** Several project leaders emphasized that, regardless of the direct effect on attraction and retention of researchers and HQPs, the CFI funding is absolutely necessary - even vital - for training purposes. CFI-funded infrastructure is reported as invaluable to ensure high quality training and allowing students to acquire expertise using world-class equipment. The benefits to undergraduate students from the infrastructure purchased with CFI funds is not being captured as part of the Project Report Form. Nevertheless, project leaders repeatedly mentioned the benefits of CFI-funded infrastructure in attracting undergraduates. National and international undergraduate students come to an institution attracted, at least in part, by the equipment available. These students often stay until completion of graduate degrees and join researchers in Canadian academia or in the private sector.
- 5) Funding of field research:** The investment of the CFI in non-traditional research is seen as pivotal in attracting qualified students from around the world. The examples provided include projects in areas of ecology or biology where studying species in the wild requires sophisticated equipment. CFI investment has enabled breakthrough research in these unique and innovative areas which has earned lead researchers and their institutions attention and has attracted national and international researchers and graduate students.

The impact of CFI investment on attraction rates is positive yet significantly higher for students than for researchers and scientists. The scope of project leader comments on attraction of HQP varies from “huge impact” to “hard to determine.”

<sup>8</sup> Sample size criteria: Fitz-Gibbon, Taylor and Morris, *Design for Program Evaluation*, Newbury Park, Sage, 1987:163.

## Retention

CFI funding is an important factor in the decision of some international researchers to remain at an institution and a key reason for some researchers to decline offers to join other institutions. As is the case for most analysis of behavioural motivation, it is difficult to ascertain the capacity of CFI infrastructure to affect researchers' decisions to stay. However, from the comments of project leaders, we find the following evidence:

**1) Delayed departure:** Some researchers said they delayed their departures by more than a year for the opportunity to use CFI-funded equipment. This is powerful evidence that the infrastructure impacts retention in areas where research relies heavily on infrastructure.

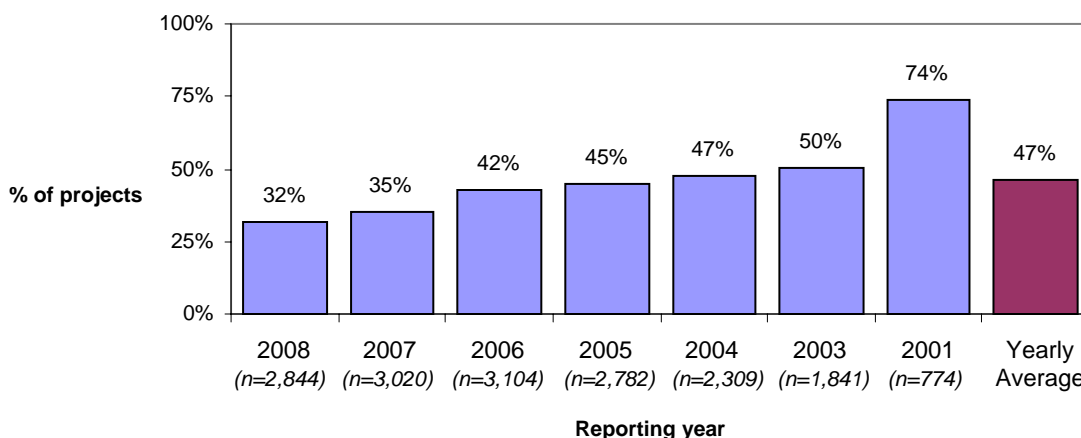
**2) State-of-the-art infrastructure:** At large institutions, CFI funding contributes to retaining researchers and HQP by ensuring that cutting-edge research projects remain operational, facilitating access to advanced infrastructure to produce leading-edge research and accelerating research (enabling researchers to reduce the turnaround time of their experiments). Without the adequate set of conditions in place, project leaders believe that researchers would leave in search of better research environments.

### 4.3.1 Researchers

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

A seven-year analysis of data prepared by KPMG as part of the CFI's overall Performance Evaluation and Audit initiative (OPEA), shows a decline in the percentage of projects reporting the availability of infrastructure as an important factor in the decision of researchers to join an institution. World-class research is Canada's standard and leading-edge infrastructure is no longer desirable but expected. The percentage of project leaders reporting infrastructure as being an important factor in the decision of researchers to join their institution has decreased to 32% from a high of 74% in 2001 (Figure 5). These findings resonate with the narrative of project leaders who report a more active competition to attract researchers and specialized students.

**Figure 5. Availability of infrastructure and researchers' attraction (in the past year)**

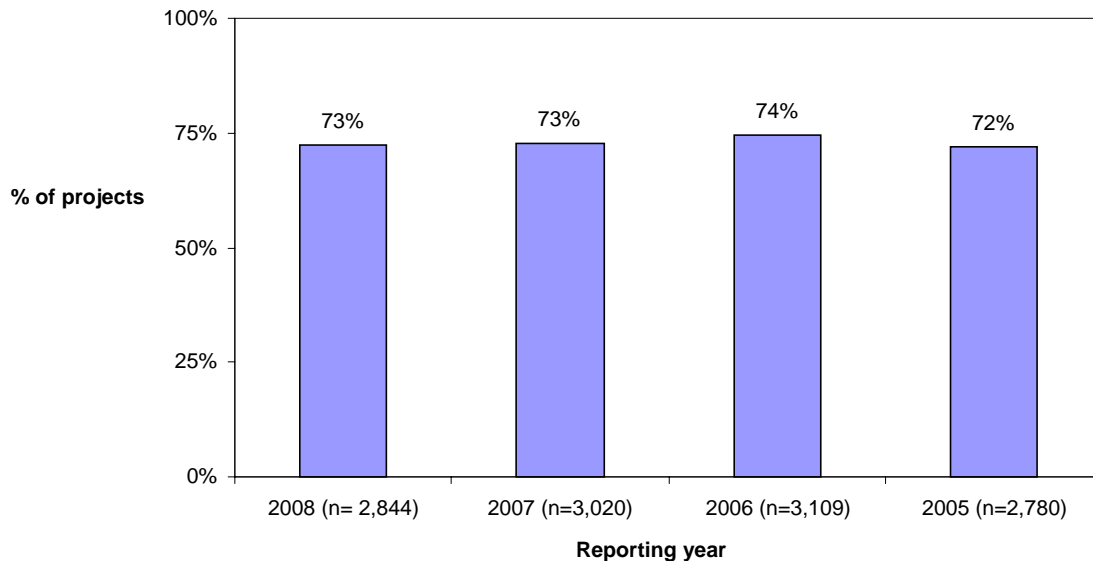


Source: KPMG analysis of Project Progress Report data 2001-2008.

Trying to ascertain the capacity of CFI infrastructure to retain significant numbers of researchers is challenging. However, in Figure 6, which illustrates data for the past four years, the percentage of projects reporting that CFI infrastructure has been an important factor in the decision of the researchers to stay at the institution are high. Since 2005, more than 70% of Project Leaders have reported the availability of the infrastructure as an important factor in the decision of researchers to join and stay.

If compared to the rates reported for attraction (Figure 5), rates in Figure 6 could suggest that CFI investment in infrastructure is a stronger influential factor for retention than for attraction. However, it must be noted that, unlike the one-year scope in Figure 5, the data reflected in Figure 6 shows numbers as reported for the “past four years”.

**Figure 6. Availability of infrastructure and researchers retention (past four years)**



### Country of origin of researchers

#### One-year scope

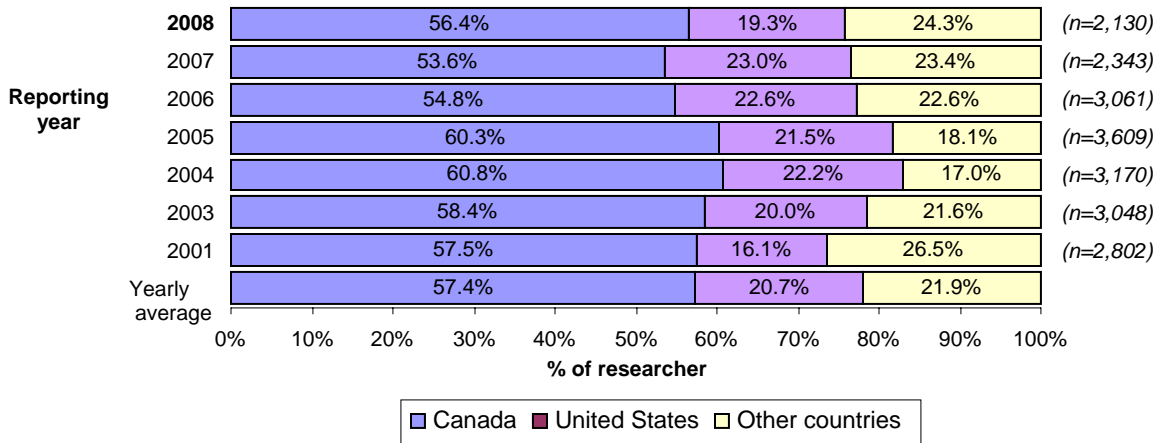
Project leaders reported that the availability of current or future infrastructure was an important factor in the decision of 2,130 new researchers to join the institutions in the past year (2007-08). More than half of these researchers were recruited from Canada.

- 1,201 (56.4%) were recruited from within Canada
- 411 (19.3%) were recruited from the U.S.
- 518 (24.3%) were recruited from elsewhere

Figure 7 shows that these numbers have remained relatively constant for the last seven years.

Of those researchers recruited from elsewhere (excluding Canada and the U.S.), 62 countries of origin were identified. The top five countries identified by project leaders include France (47),<sup>9</sup> United Kingdom (42), China (41), Germany (37) and Brazil (17).

**Figure 7. Origin of researchers recruited from 2001-08**



Source: KPMG analysis of Project Progress Report data 2001-2008.

<sup>9</sup> The number in the parentheses denotes the number of times a country was identified by the institutions.

Table 9 shows the number of researchers recruited during the past year, by fund and by country of origin.

**Table 9 Number of researchers recruited last year, by fund and origin, 2008 sample**

Fund	Number of projects (#)	Number of researchers recruited	Number recruited from Canada	Number recruited from U.S.	Number recruited from other countries
New Opportunities Fund	1,183	669	406	114	149
Canada Research Chairs Infrastructure Fund	831	651	329	123	199
Innovation Fund	181	368	238	62	68
Leaders Opportunity Fund	559	318	165	75	78
CFI Career Awards	23	28	10	9	9
Leading Edge Fund	22	32	19	9	4
New Initiatives Fund	22	22	9	7	6
Research Development Fund	3	0	-	-	-
Research Hospital Fund	9	24	16	6	2
International Access Fund	6	1	-	-	1
International Joint Ventures Fund	2	5	4	-	1
Exceptional Opportunities	2	12	5	6	1
National Platforms	1	-	-	-	-
<b>TOTAL</b>	<b>2,844</b>	<b>2,130</b>	<b>1,201</b>	<b>411</b>	<b>518</b>

#### Five-year scope

Similarly, when reporting on the recruitment of researchers in a five-year retrospect scope (since the beginning of the project), project leaders credited the availability of infrastructure as an important factor in the decision of more than 7,000 researchers to join an institution.

- 4,336 (61.4%) were recruited from within Canada
- 1,424 (20.2%) were recruited from the U.S.
- 1,300 (18.4%) were recruited from elsewhere

These trends have remained relatively constant more than the past five years. The data reveal that the majority of researchers are recruited from within Canada (61.4%). However, Canadian institutions continue to attract international researchers from the U.S. and abroad (38.6%). Of those researchers recruited from elsewhere (excluding Canada and the U.S.), 85 countries of

origin were identified. The top five countries identified by project leaders include Germany (98),<sup>10</sup> France (95) and United Kingdom (95), China (66), Switzerland (35) and Australia (34).

### **Sector of origin of researchers**

Data from the Project Progress Reports show that researchers are recruited from a variety of sources. In the past year, project leaders reported that of the 2,130 researchers recruited, more than 90% were recruited from the academic/hospital sector. Based on prior data, this trend has remained relatively constant for the past four reporting periods. In fact, of the 7,060 researchers recruited since 2003:

- 6,376 (90.3%) were recruited from the academic/hospital sector;
- 387 (5.5%) were recruited from the private sector;
- 297 (4.2%) were recruited from the public/non-profit sectors.

### **4.3.2 Post-doctoral fellows (PDF) and graduate students (GS)**

#### **Number and origin of post-doctoral fellows and graduate students**

For the projects reported in the 2007-08 fiscal year, data indicate that CFI's investments in infrastructure plays an important role in stimulating the training of young Canadians through research. In the past year, 14,665 PDF/GS were attracted to the institutions due to the availability of the infrastructure.

- 3,465 PDF
- 11,200 GS

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<sup>10</sup> The number in parentheses denotes the number of times a country was identified by the institutions.

Table 10 shows that in the past year, the 2,844 funded projects attracted more than 14,000 PDF and GS. (A column with the numbers of attracted researchers is included for comparative purposes).

**Table 10 Attraction of PDF and GS by CFI Fund**

Fund	Number of Projects	Number of Researchers Recruited	Total PDF	Total GS	Total Number PDF and GS Attracted
New Opportunities Fund	1,183	669	858	3,234	4,092
Canada Research Chairs Infrastructure Fund	831	651	975	3,369	4,344
Innovation Fund	181	368	993	2,882	3,875
Leaders Opportunity Fund	559	318	358	1,211	1,569
CFI Career Awards	23	28	49	62	111
Leading Edge Fund	22	32	84	149	233
New Initiatives Fund	22	22	75	79	154
Research Development Fund	3	0	1	9	10
Research Hospital Fund	9	24	46	80	126
International Access Fund	6	1	4	11	15
International Joint Ventures Fund	2	5	12	101	113
Exceptional Opportunities	2	12	10	13	23
National Platforms	1	-	-	-	-
<b>TOTAL</b>	<b>2,844</b>	<b>2,130</b>	<b>3,465</b>	<b>11,200</b>	<b>14,665</b>

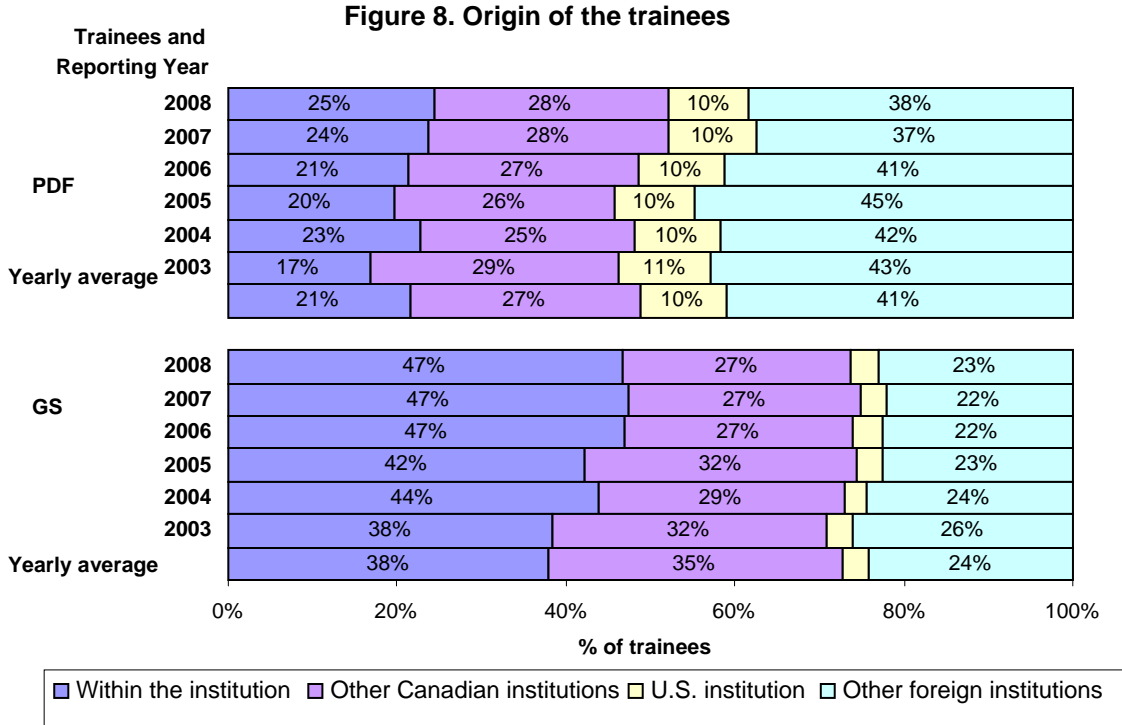
Canadian universities must be able to attract highly skilled PDF and GS to remain competitive internationally. Data show that PDF and GS are attracted from several sources. Of note are the following points (for the past year):

Post-Doctoral Fellows

- 1,804 (52.1%) of PDF are attracted from within or from other Canadian institutions
- 1,331 (38.4%) of PDF are attracted from other foreign institutions
- 330 (9.5%) of PDF are attracted from the U.S.

Graduate Students

- 8,262 (73.8%) of GS are attracted from within or from other Canadian institutions
- 2,581 (23.0%) of GS are attracted from other foreign institutions
- 357 (3.2%) of GS are attracted from the U.S.



Source: KPMG analysis of Project Progress Report data 2001-2008.

From Figure 8 we can see that the trend has remained fairly constant more than the past seven years and despite the unquestionable value of the investment in research infrastructure, we have not seen a significant increase in the number of foreign trainees attracted to Canada. Former immigration regulations limited to one year the work permit of graduate students. These limitations offer a plausible explanation to the slow growth in the numbers of international trainees in the past years as many trained and skilled individuals had to leave the country shortly after completion of their training programs.

Recent regulatory changes allow students from abroad to work up to three years anywhere in Canada following graduation.<sup>11</sup> Additionally, the new permit will not be employer specific and a job offer is no longer mandatory. These amendments set Canada apart from other competing countries since they allow these students to better negotiate post-graduate employment in their

<sup>11</sup> Post Graduation Work-permit program, Citizen and Immigration Canada, www.cic.gc.ca, Media Release Hon. Diane Finley, April 2008.

fields of expertise here in Canada. In the past, many students exited the country when unable to secure employment thus taking their talent back to their home countries, and in effect competing with Canadian workers and firms. These favourable changes to immigration regulations may lead to more innovation and greater potential value by creating successful entrepreneurs or contributing to the Canadian research enterprise.

The Association of Universities and Colleges of Canada (AUCC)<sup>12</sup>, reports that Canadian universities attract students from more than 200 countries. Based on 2004 data, China accounted for 23% of the total, or almost 15,000 students. This was followed by the U.S. (7,000 students), France (5,000 students), and India (2,500 students). Conversely, the top five destinations for Canadians studying more overseas at the post-secondary level includes the U.S., the U.K., Australia, France, and Germany.

### **Career paths of PDF and graduate students**

Many project leaders track the career paths of the students who have worked in their labs. For projects reporting since 2003, project leaders indicated that 35,175 PDF and GS have used the infrastructure as a key resource in their research project. It should also be noted that of these:

- 2,860 (8.1%) have joined the Canadian private business sector;
- 980 (2.8%) have joined the Canadian public sector;
- 230 (0.7%) have joined the Canadian not-for-profit sector.
- 19,139 (54.41%) have stayed at the institution as trainees;
- 3,397 (9.66%) have joined another Canadian academic institution, college, or research hospital;
- 2,949 (8.38%) have moved abroad;
- 4,194 (11.9%) have been classified as “other”;<sup>13</sup>
- 1,426 (4.0%) have stayed at the institution as an employee or contractor;

The availability of state-of-the-art infrastructure has contributed to the attraction, retention and training of numerous PDF and GS, including a large number of international trainees.

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<sup>12</sup> Association of Universities and Colleges of Canada. Trends in Higher Education, Volume 1. Enrolment, 2007

<sup>13</sup> The responses classified as ‘other’ above vary and are too broad to quantify. Responses range from currently seeking employment, to entered a new/different discipline, to not known.

### 4.3.3 Technical personnel

#### Training

Different types of trained technical personnel are also being produced as a result of investments in infrastructure. Since the *beginning of the project*, project leaders reported that 9,868 technical personnel have been trained on the use and maintenance of research infrastructure. Of these:

- 975 (9.9%) have joined the Canadian private business sector;
- 336 (3.4%) have joined the Canadian public sector;
- 70 (0.7%) have joined the Canadian non-profit sector;
- 6,602 (66.9%) have stayed at the institution;
- 1,057 (10.71%) have joined another Canadian academic institution, college, or research hospital;
- 468 (4.7%) have moved abroad;
- 360 (3.7%) have been classified as “other”<sup>14</sup>.

#### Attraction and retention

Increasingly sophisticated research facilities, databases, and equipment require highly qualified individuals for their successful operation. The ability to attract, train, and retain technical personnel is a critical component in the operation and maintenance of research infrastructure. For those projects that were sufficiently developed in 2008, 78% of project leaders report that it was easy or reasonable to attract and retain skilled personnel. This compares to 22% who report that it was difficult or very difficult to attract and retain skilled personnel for operations and maintenance of the infrastructure. Of note is the fact that this finding has been consistent for the past four reporting periods (2004-05 to 2007-08).

## 4.4 *Promoting networking, collaboration, and multidisciplinary among researchers*

Collaboration is one of the characteristic features of modern science and often a critical aspect of scientific research. Although international scientific collaboration is by no means a new phenomenon, the scientific collaborative enterprise has accelerated more than the past years. The increasing complexity of global issues (i.e. pandemics, natural disasters, and the environment) has led to a growing need to collaborate scientifically through highly networked multidisciplinary and multinational teams. Partnerships, networking and collaborations across disciplines are increasingly necessary to advance research and achieve innovative results.

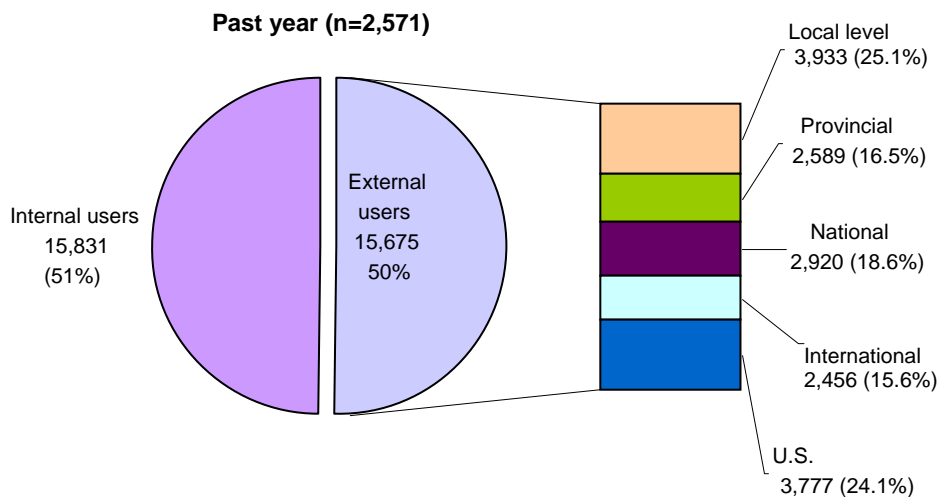
<sup>14</sup> Again, the responses classified as ‘other’ above vary and are too broad to quantify. Responses range from returned to school to maternity leave to retired although they represent a small proportion of the overall number reported.

### Key Findings – networking, collaboration, and multidisciplinary among researchers

- ✓ In the past year alone, more than 31,000 researchers advanced their research by using infrastructure supported by the CFI.
- ✓ 72% of the project leaders indicated that the research benefited from a multidisciplinary approach and that it had been enabled by CFI-supported infrastructure.
- ✓ A high proportion (93%) of researchers collaborates within the institution(s) and approximately 73% collaborate with other institutions in Canada.
- ✓ More than half (54%) of the project leaders report that the infrastructure has contributed to fostering international collaboration in a significant/critical manner while a smaller proportion (41%) reported that the infrastructure fostered local or regional collaboration.
- ✓ For the most recent year, 73% of project leaders indicated that the infrastructure had some influence in fostering local or regional collaboration in the formation of R&D clusters or regional R&D-based initiatives in Canada.

In the past year, project leaders reported that more than 31,000 internal and external researchers advanced their research by using infrastructure supported by the CFI (Figure 9). This number is based on 2,571 projects that were fully or partially operational and used for research during the past year.

**Figure 9. Users of the research infrastructure**



Based on the 15,675 external users of the research infrastructure during the past year, approximately 40% represent international users (i.e. international and U.S.). The highest proportion of reported external users is at the local level with a 25% share (3,933).

Data also reveals that more than 15% of the users can be categorized as international. Of those

users classified as international (i.e. excluding Canada and the U.S.), 99 “other countries” were identified with the top five countries identified by project leaders remaining the same as in the 2007 sample, including France (126)<sup>15</sup>, the U.K.(114), Germany (96), Australia (69), and China (52).

Further examination of the data by users’ origin reveals that the majority (78%) represent the university, college, or hospital sector. This is followed by private sector users (9.5%), public sector users (8%) and, at much lower rates, users from the non-profit sector. These findings are positive as they support the national objective to support productive networks and collaborations among Canadian post-secondary institutions, research hospitals, and the private sector.

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

For the 2008 sample, 15,831 researchers (including primary researchers, other principal researchers, and other faculty) advanced their research during the past year. Table 11 shows the number of researchers advancing their research broken down by fund and category of institution. Table 11 also reveals that the majority (88%) of researchers advancing their research (at the institution) on CFI projects do so at large universities, hospitals, and non-profits.

**Table 11 Number of researchers advancing research by fund and category of institution**

Fund	Large universities, hospitals, and non-profit	# Projects	Small universities	Colleges	TOTAL	TOTAL /Project
New Opportunities Fund	4,239	1,150	816	na	5,055	4.40
Canada Research Chairs	3,739	808	581	6	4,326	5.35
Innovation Fund	3,414	164	630	10	4,054	24.66
Leaders Opportunity Fund	1,333	393	188	na	1,521	3.87
Leading Edge Fund	195	13	81	na	276	21.23
Research Hospital Fund	208	7	na	na	208	29.71
CFI Career awards	159	20	6	na	165	8.25
Exceptional Opportunities	77	2	na	na	77	38.50
New Initiatives Fund	71	8	6	na	77	9.63
International Joint Ventures Fund	52	2	na	na	52	26.00
Research Development Fund	na	3	14	na	14	4.67
International Access Fund	6	1	na	na	6	6.00
<b>TOTAL</b>	<b>13,493</b>	<b>2,571</b>	<b>2,322</b>	<b>16</b>	<b>15,831</b>	<b>6.15</b>

### Multidisciplinary research

Responses show that the availability of the research infrastructure has enhanced opportunities for

<sup>15</sup> Parentheses denote the number of times a country was identified by a project leader.

multidisciplinary research. Overall, for projects funded since 2003, 72% (1,858/2,751) of the project leaders indicated that the research benefited from a multidisciplinary approach that had been enabled by the CFI-supported infrastructure, while only 16% (408/2,751) reported that the research had not, to date, contributed to a multidisciplinary approach (Table 12a).

**Table 12a Projects benefited from a multidisciplinary approach by fund and type of institution, for projects funded since 2003**

	# Projects fully/partially operational	No opportunity (to date)	Yes - but not due to the infrastructure	Yes - Benefited from a multidisciplinary approach
<b>By: TYPE OF FUND</b>				
New Opportunities Fund	1,150	211(18%)	143(12%)	796(70%)
Canada Research Chairs Infrastructure Fund	808	95(12%)	106 (13%)	607(75%)
Innovation Fund	164	15(9%)	9 (5%)	140(85%)
Leaders Opportunity Fund	393	83(21%)	44(11%)	266(68%)
CFI Career Awards	20	2(10%)	2 (10%)	16(80%)
Leading Edge Fund	13	1(8%)	-	12(92%)
Research Development Fund	3	0	0	3(100%)
New Initiatives Fund	8	0	0	8(100%)
Research Hospital Fund	7	0	0	7(100%)
International Access Fund	1	0	0	1(100%)
International Joint Ventures Fund	2	1(50%)	0	1(50%)
Exceptional Opportunities	2	0	1 (50%)	1(50%)
<b>TOTAL</b>	<b>2,571</b>	<b>408 (16%)</b>	<b>305 (12%)</b>	<b>1,858 (72%)</b>
<b>By: Type of institution</b>				
A. Large universities, hospitals, and non-profit	2,141	322(15%)	253(12%)	1,566 (73%)
B. Small universities	426	84(20%)	52 (12%)	290 (68%)
C. Colleges	4	2(50%)	0	2 (50%)
<b>TOTAL</b>	<b>2,571</b>	<b>408 (16%)</b>	<b>305 (12%)</b>	<b>1,858 (72%)</b>

This data can also be examined further by the type of fund and the type of institution (Table 12b). Overall, the infrastructure has been either significant (59%) or critical (30%) to enabling a multidisciplinary approach.

**Table 12b Impact of multidisciplinary approach**

	The research has benefited from a multidisciplinary approach	Role of the infrastructure		
		Minor	Significant	Critical
<b>By: TYPE OF FUND*</b>				
New Opportunities Fund	796	100 (13%)	465 (58%)	231 (29%)
Canada Research Chairs Infrastructure Fund	607	79 (13%)	340 (56%)	188 (31%)
Innovation Fund	140	8 (6%)	63 (45%)	69 (49%)
<b>TOTAL – Three funds</b>	<b>1,543</b>	<b>187 (12%)</b>	<b>868 (56%)</b>	<b>488 (32%)</b>
<b>TOTAL – All funds</b>	<b>1,858</b>	<b>223 (12%)</b>	<b>1,058 (57%)</b>	<b>577 (31%)</b>
<b>By: TYPE OF INSTITUTION</b>				
A. Large universities, hospitals, and non-profit	1,566	182 (12%)	879 (56%)	505(32%)
B. Small universities	290	39 (13%)	179 (62%)	72 (25%)
C. Colleges	2	2 (100%)	0	0
<b>TOTAL</b>	<b>1,858</b>	<b>223 (12%)</b>	<b>1,058 (57%)</b>	<b>577 (31%)</b>

\* The three funds identified above represent more than 91% of the PPR responses.

### Enhanced opportunities for collaborative research

The report data reveals that:

- 93% of researchers collaborate within the institution(s);
- 73% collaborate with other institutions within Canada.

The data also reveals enhanced opportunities for collaboration with other institutions outside of Canada at 60%. Another key finding is that almost one in five (19%) of the institutions have collaborated with non-profit institutions since the beginning of the project. (It should be noted that institutions had the option to choose all that apply.)

**Table 13. Collaborative research arrangements**

	Collaboration within Canada	Collaboration outside Canada	No collaboration to date
Collaboration within institution(s)	93%	NA	7%
Collaboration with (an)other institution(s)	73%	60%	13%
Collaboration with government	36%	8%	62%
Collaboration with the private sector	42%	19%	52%
Collaboration with non-profit organization(s)	19%	7%	78%

Note: project leaders have the option to choose all that apply.

### International collaboration

For the most recent year, 85% of institutions indicated that the infrastructure had some influence in fostering international collaboration in terms of joint research, the mobility of students and technical personnel, and participation in international networks.

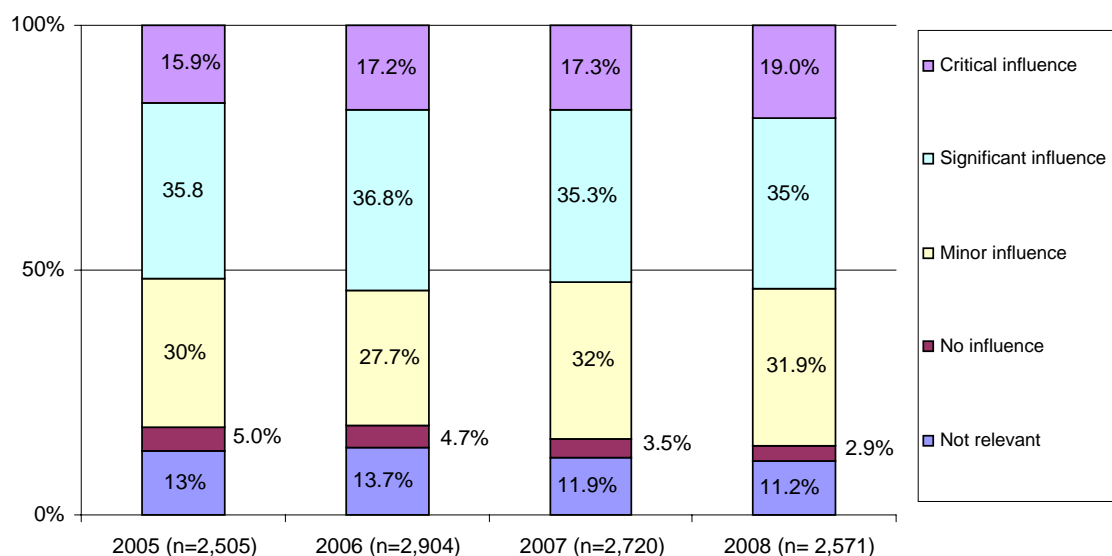
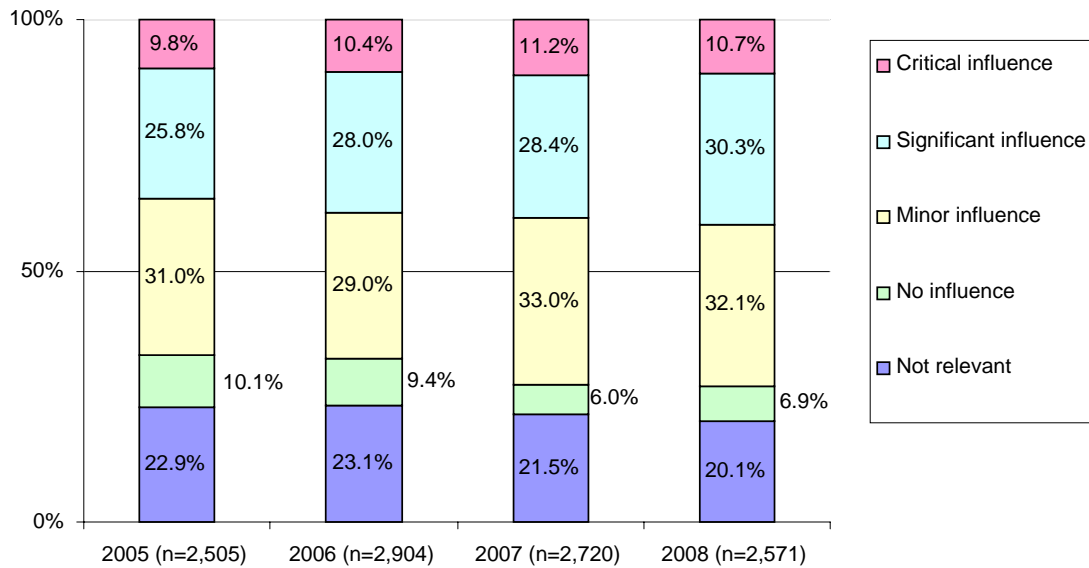
**Figure 10. Influence of the infrastructure fostering international collaboration**

Figure 10 shows the response for the past four reporting periods and reveals a similar trend in previous years. More than half of the institutions report that the infrastructure has contributed to fostering international collaboration in a significant/critical manner.

### Local/Regional Collaboration

International collaboration can be regarded as a key benchmark of success for research projects. However, the ability to successfully collaborate at a local and regional level also creates value through the fostering of R&D clusters or through regional R&D-based initiatives.

**Figure 11. Influence of infrastructure fostering local or regional collaboration**



For the most recent year, 73% of project leaders indicated that the infrastructure had some influence in fostering local and regional collaboration in the formation of R&D clusters or regional R&D-based initiatives in Canada. A similar response is shown for the past three years. The proportion reporting that the infrastructure fostered local or regional collaboration (36% in 2005; 39% in 2006; 40% in 2007; 41% in 2008) remains smaller than the proportion reporting the same for international collaboration. Furthermore, project leaders reporting that the type of collaboration was not relevant because the research has a different target were approximately double for local/regional collaboration as compared to international collaboration (see Figures 10 and 11).

## 4.5 Optimal use of research infrastructure

The CFI promotes the optimal use of research infrastructure within and among Canadian institutions and creates the necessary conditions for sustainable, long-term economic growth.

### Key findings – optimal use of research infrastructure

- √ During the past year, 75% of project leaders reported that the infrastructure was fully utilized, and approximately one in ten reported that it was more than-subscribed.
- √ For those projects that were sufficiently developed in 2008, 80% of project leaders reported that it was easy or reasonably easy to obtain sufficient funds for operations and maintenance but over time, there are some indications that this support may be becoming more difficult to source.
- √ Large/very large projects may require additional funding to support Operations and Maintenance.

### Utilization of infrastructure

Table 14 shows that 11% of project leaders reported that the infrastructure was fully utilized to the point of being more than-subscribed, while an additional 75% reported that the infrastructure was fully utilized.

Table 14 Utilization of the infrastructure		
Fund	Fully utilized & over-subscribed	Fully utilized
Canada Research Chairs Infrastructure Fund (n=808)	99 (12%)	619 (77%)
Innovation Fund (n=164)	23 (14%)	105 (64%)
New Opportunities Fund (n=1,150)	123 (11%)	886 (77%)
<b>All Funds (n=2,571)</b>	<b>279 (11%)</b>	<b>1,936 (75%)</b>

This pattern is similar across funds. However, it is noted that 22% of Innovation Fund project leaders reported that the infrastructure was under-utilized while the proportion for all funds is significantly smaller, at 10%. Project leaders cited incomplete installation of equipment (i.e. still ongoing for some projects), several projects in the implementation/testing phase, and limited operating funds as rationale for this under-utilization. Similar reasons for under-utilization were recorded for all funds.

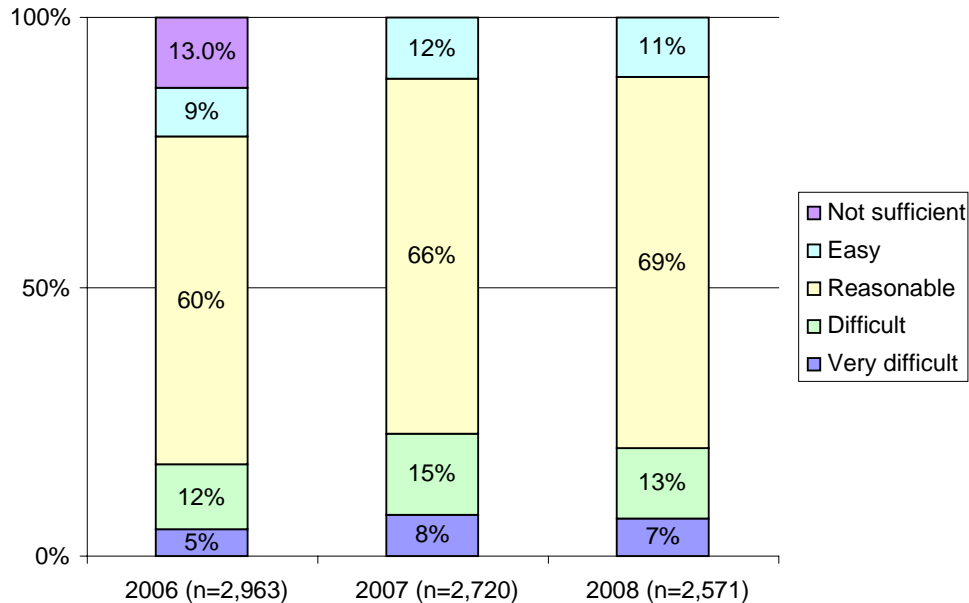
### Funding for operations and maintenance

Obtaining state-of-the-art infrastructure is only one component of a successful research endeavour. Another key factor is the ability to obtain funding for the operation and maintenance of the infrastructure. Funding for operations and maintenance is not only critical for the attraction, training, and retention of highly-skilled personnel, but it is also used to cover other expenses such as supplies, minor upgrades, and maintenance contracts.

For those projects that were sufficiently developed in 2008, 77% of project leaders reported that it

was easy or reasonably easy to obtain sufficient funds for operations and maintenance, while 23% reported that it was difficult or very difficult to obtain funds. This finding has been somewhat consistent for the past three reporting periods (Figure 12).

**Figure 12. Funding for operations and maintenance (In the past year)**



An operations and maintenance costs study recently completed by the CFI<sup>16</sup> produced the following findings:<sup>17</sup>

1. On average, total operations and maintenance costs will amount to 44% of total capital costs more than a five year period or 9% per year.
2. Much of the increase in operations and maintenance costs is related to an increased proportion of operations and maintenance that is to be dedicated to personnel support, amounting to an average of 61% of the total.
3. An increased reliance on the institution for operations and maintenance is anticipated, due in part to a lack of success in securing funding from other sources.
4. For large projects (i.e. capital costs greater than \$4 million), additional Operations and Maintenance support will be required given that the state-of-the-art lifetime generally exceeds six years. Very large projects (i.e. International Joint-Ventures Fund projects) should be considered on a case-by-case basis given the unique requirements of each facility.

<sup>16</sup> Canada Foundation for Innovation, *Operations and Maintenance Costs of CFI-Supported Infrastructure*.

<sup>17</sup> Based on 88 applications to the Leading Edge Fund that were recommended for funding by the CFI's Multidisciplinary Assessment Committees.

## 5.0 Conclusion

The results of this analysis corroborate the findings from previous years indicating that the research enabled by the CFI has a profound effect on the research environment in Canada. Benefits of CFI investments go beyond increased research capacity. Institutions continue to report that the research enabled by CFI investments contribute to the generation of knowledge and its translation into commercial and social benefits. New technologies, products, processes, and services improve the life of Canadians, public policy, health, science, engineering, and the environment.

It is evident from the PPRs that the research enabled by the CFI is supporting the necessary conditions for sustainable, long-term economic growth. A review of the 2008 sample data (April 1, 2003 to March 31, 2008) reveals the following key findings:

### Benefits to Canada

- A wide range of benefits have been realized as a result of CFI investments in research infrastructure.
- Institutions continue to report that the research enabled by CFI investments support the development of new products, processes, and services that support improvements to public policy, health, science, engineering, and the environment.
- The CFI's objectives, practices, and results demonstrate its commitment to the principles outlined in the Government of Canada's S&T strategy.

### Strengthening Canada's Capacity for Innovation

- Overall, 30% of institutions compare their infrastructure to the best in the world while 65% report that their infrastructure compares to the best in Canada.
- On average, the useful remaining life across all infrastructure types is 7.5 years for the 2008 sample data.
- For those projects classified as fully or partially operational and used for research during the past year, approximately 14.6% vs. 15% for 2007 of the institutions categorized as large hospitals, universities, and non-profit organizations report that the research enabled by the infrastructure has been leading edge internationally. This is a key finding given that this category represents more than 83% of the projects funded in the 2008 sample.

### **Attraction, Retention, and Training of Research Personnel**

- **Researchers:**
  - For the current reporting year, 32% of project leaders report that the availability of the infrastructure was an important factor in the decision to join an institution.
  - Overall, 2,130 new researchers were recruited in the past year. Of these, 19.3% were recruited from the U.S. and 24.3% were recruited from elsewhere. The top five countries identified include France, U.K., China, Germany, and Brazil.
  - Of the 2,130 researchers recruited, 90.3% were recruited from the academic/hospital sector.
- **Post-doctoral fellows (PDF) and graduate students (GS):**
  - Overall, 14,665 PDF/GS were attracted to the institutions due to the availability of the infrastructure. Further analysis reveals that CFI-funded projects attracted, on average, 1.5 PDF and 4.6 GS per project.
    - For those projects reporting since 2003, project leaders reported that 35,175 PDF and GS have used the infrastructure as a key resource in their research project. Of this group, 54.4% have stayed at the institution as trainees while an additional 9.6% have joined another Canadian academic institution, college, or research hospital.
- **Technical personnel:**
  - For projects reporting since 2003, project leaders reported that 9,868 technical personnel have been trained on the use and maintenance of the infrastructure. Of this group, 67% have stayed at the institution while an additional 10.7% have joined another Canadian academic institution, college, or research hospital.

### **Networking, collaboration, and multidisciplinary among researchers**

- During the past year, a total of 31,506 researchers advanced their research by using infrastructure supported by the CFI.
- 72% of the project leaders indicated that the research benefited from a multidisciplinary approach and that it had been enabled by the CFI-supported infrastructure.
- A high proportion (93%) of researchers collaborates within the institution(s) and approximately 73% collaborate with other institutions within Canada.
- More than half (53.94% vs. 53% in 2007) of the project leaders reported in 2008 that the infrastructure has contributed to fostering international collaboration in a significant/critical manner while a smaller proportion (41%) reported that the infrastructure fostered local or regional collaboration.
- For the most recent year, 73% of project leaders indicated that the infrastructure had some influence in fostering local or regional collaboration in the formation of R&D clusters or regional R&D-based initiatives in Canada.

**Optimal use of research infrastructure**

- During the past year, 75% of institutions reported that the infrastructure was fully utilized. Of these, 11% reported more than-subscription.
- For those projects that were sufficiently developed in 2008, 77% report that it was easy or reasonably easy to obtain sufficient funds for operations and maintenance, but over time, there have been some indications that this support may be becoming more difficult to obtain.
- Large/very large projects may require additional funding to support operations and maintenance.