Usage of CFI-funded infrastructure

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This report presents the findings of an in-depth study examining the level of use of CFI-funded infrastructure including factors influencing various usage profiles. The project relied on Project Progress Reports submitted to the CFI and interviews with a sample of researchers and research administrators.

Key findings

Overall CFI-funded infrastructure is being fully used

- Approximately 75% of infrastructure was reported as fully utilized in any given fiscal year.
- Almost half of the CFI-funded infrastructure is being fully utilized across five consecutive years.
- Chronic underutilization and oversubscription are reported in less than 3% of projects and have unique causes.

Researchers are conscientious stewards of the infrastructure

- Researchers make efforts to maximize the use of the infrastructure to accommodate users.
- They also recognize the need for periodic maintenance to ensure that the infrastructure remains operational as long as possible.
- There is no evidence to suggest that researchers prefer to secure the latest or newest models of equipment; rather they seek to ensure that infrastructure best meets their research needs.

Levels of infrastructure use can vary from one year to the next, but this is generally not a cause for concern

- Periods of their underutilization or oversubscription are generally temporary. Underutilization typically occurs in early reporting years and oversubscription in later years.
- Underutilization seldom occurs later in a project lifecycle, and when it does, it is typically due to maintenance needs.
- Both researchers and research administrators indicated that the benefit of additional users outweighed concerns related to wait times or accidental breakage or damages to the equipment caused by this oversubscription.

Introduction

Since its creation in 1997, the CFI has committed more than $6.6 billion in support of 9,111 projects at 145 research institutions in 70 municipalities across Canada. Of that, $5.1 billion has been allocated towards research infrastructure with the remaining $1.4 billion towards the operations and maintenance (O & M) costs of that infrastructure[1]. Together, the research infrastructure and associated O & M funding enable researchers to carry out leading-edge research that contributes to the nation's capacity to innovate, compete and prosper in a knowledge-based global economy.

In order to maximize the return on this investment it is essential that the CFI-funded infrastructure is well used by researchers and research teams throughout its useful life. This in-depth study examined both the level of use of CFI-funded infrastructure as well as factors influencing various usage profiles. The project relied on Project Progress Report [2](PPR) data and interviews with a sample of researchers and research administrators.

Project questions and approach

Preliminary review of PPR data led us to pose the following three specific questions:

1. **Is CFI-funded infrastructure being well used?**
2. **Does underutilization or oversubscription impact productivity and the lifespan of the infrastructure?**
3. **Are there best practices for optimizing infrastructure use?**

To answer these questions, we looked at existing administrative data, combined with interviews conducted with a select sample of researchers and research administrators (see appendix for sample profile and interview questions).

Defining infrastructure use

Through the interviews, we learned that in general, researchers define the level of infrastructure use based on a combination of: overall needs of their team; user demand; availability of personnel to operate the infrastructure; and the physical capacity of the infrastructure including the required downtime for maintenance, setup, and reconfiguration. Subtle variations were noted in the application of the definitions based primarily on the type and complexity of the infrastructure and the availability of operational capacity. For example, in cases where no dedicated personnel were required to operate or oversee the operation of the infrastructure, full utilization was frequently reported when it was in use 24 hours a day, seven days a week, 365 days a year (e.g. microscope, computer). Where personnel were required to be on hand, full utilization tended to be reported when it was in use between 80 to 100 % of regular work hours (i.e. 9 a.m. to 5 p.m., Monday to Friday).

Another very important factor to consider is the type and nature of the infrastructure. Some infrastructure is highly specialized or customized and is therefore not necessarily usable by a large population of researchers. Specialized infrastructure is necessary only for certain research programs and requires expertise to be operated. Customized infrastructure is the equipment that has been modified or enhanced for a specific purpose by a research team.

Oversubscription typically implies that demand for the infrastructure outpaces its capacity, necessitating a wait list or prioritization system. Underutilization simply means capacity exceeds

[1] $ 1.4 billion of operation and maintenance cost includes $1.2 billion of Institutional Infrastructure Operating Fund (IOF) and $ 200 million of Major Science Initiatives (MSI) Fund (as of June 2015)

[2] CFI Policy and Program Guide

usage, either because the demand for the infrastructure is below the capacity for its use, or because insufficient resources are available to operate the infrastructure to its maximum capacity. In some cases, however, we found that these two terms – oversubscription and underutilization - were used interchangeably when insufficient resources existed to operate the infrastructure at a desired level. For example, if a dedicated full-time technician was available, the infrastructure could be used during work hours five to seven days a week, but if they were only available part-time, the infrastructure would operate just two to three days a week and a wait list would be generated. This then leads to a classification of oversubscribed. On the other hand, the same infrastructure operating two to three days a week without a waiting list could be regarded as underutilized considering its maximal operational capacity of seven days a week.

1. CFI-funded infrastructure is being fully used

Over the past five fiscal years the majority of project leaders report their infrastructure is being fully utilized

Annual PPR data reported by project leaders (PLs) demonstrates a consistent yearly profile of the usage status of the CFI-funded infrastructure across fiscal years (Figure 1). Approximately 75% of PLs reported that their infrastructure was fully utilized, while about 25% reported that it was either underutilized or oversubscribed. The overall proportion reporting underutilization dropped slightly between 2009-10 and 2010-11. This likely relates to the change in reporting triggers (effective since March 2011) which now require projects to commence reporting once the infrastructure is deemed to be operational.

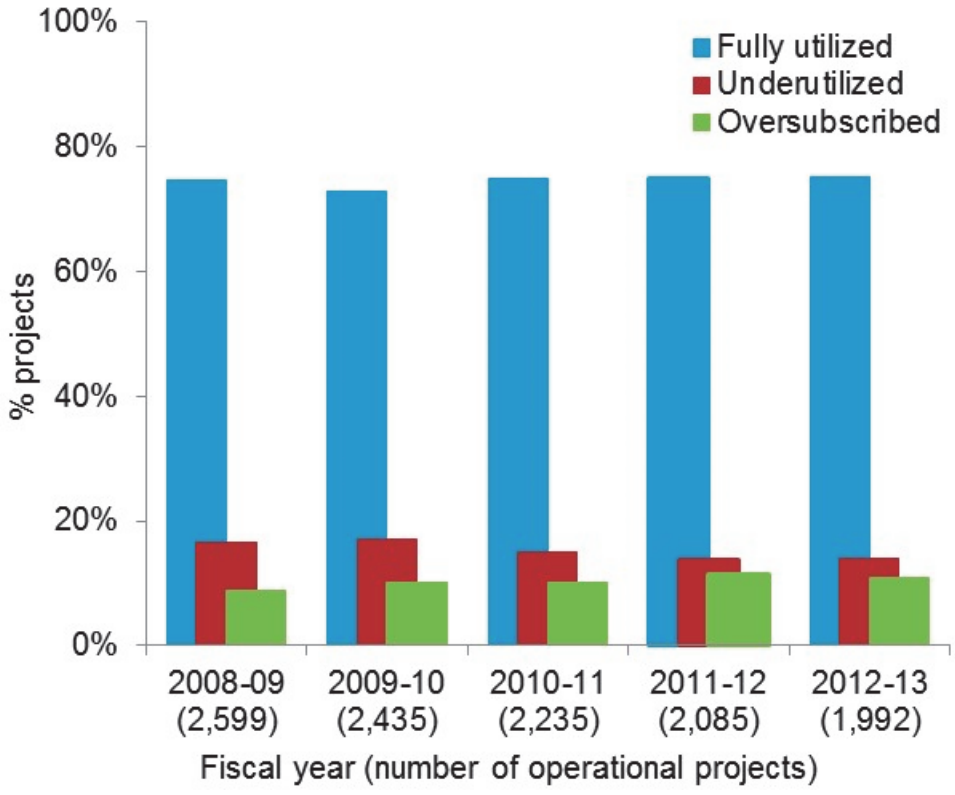


Figure 1. *The level of use of CFI-funded infrastructure*

A high proportion of project leaders report full utilization in each of their five consecutive reporting years

Although the majority of PPRs showed mixed levels of utilization across the five reporting years, PLs indicated infrastructure as fully utilized in at least 66% of projects in any given year (Figure 2a). On average, the proportion of projects reported as fully utilized reaches a plateau at about 80 % in the third year for both types of funds (Innovation Fund (IF) and John R. Evans Leaders Fund (JELF)).

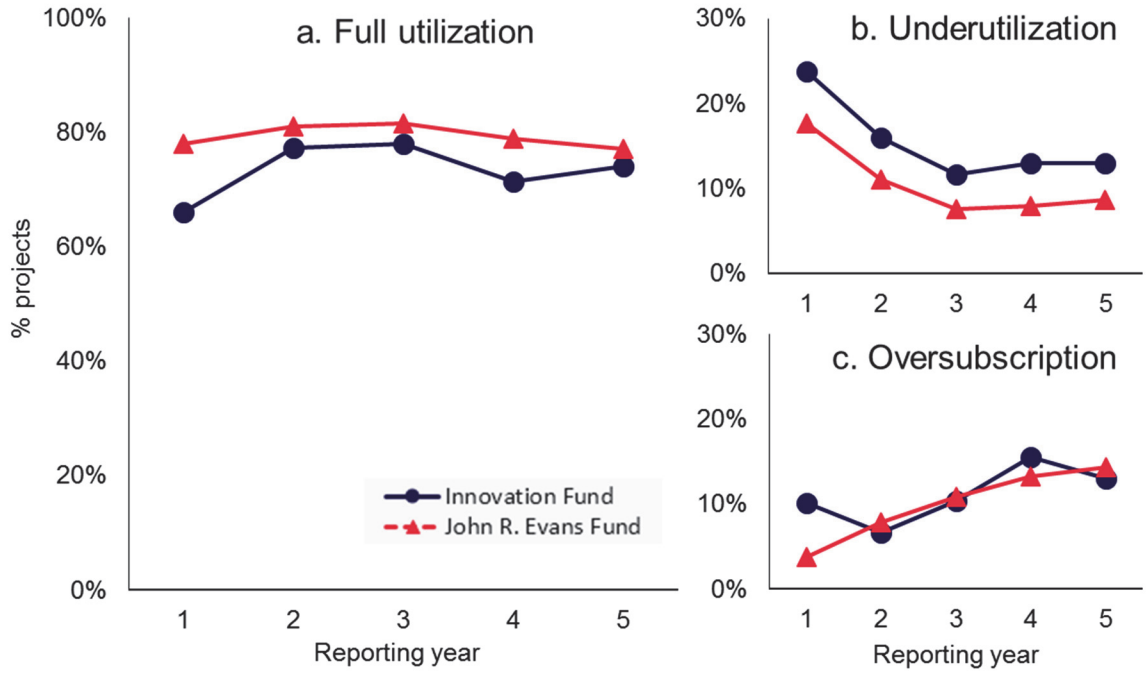


Figure 2. *The trend in the level of use of CFI-funded infrastructure across reporting year*

Both underutilization and oversubscription are typically temporary, resulting from either a necessary repair, a staff turnover, or an operation and maintenance (O & M) shortfall. Among the projects with mixed levels of utilization over their reporting cycle, 54% of IF and 73% of JELF projects were reported as fully utilized during at least three of five reporting years. The majority of projects reported as underutilized or oversubscribed in the first reporting year were subsequently reported as fully utilized in year five. This change is more pronounced in JELF than in IF.

The proportion of projects that reported underutilization decreased between years one and three, followed by a slight increase in years four or five (Figure 2b). Interviews suggest this is mainly due to setup time in the early years, and then an increased need for maintenance in later years. The proportion of projects reporting oversubscription tends to increase over time for both IF- and JELF-funded infrastructure (Figure 2c).

Recurring underutilization or oversubscription is very rare

Very few PLs reported that their infrastructure was underutilized or oversubscribed recurrently through their five year reporting cycle (Figure 3). Both patterns are observed in fewer than three percent of projects for both types of funds. Most recurrent underutilization appears to result from delayed setup due to a space constraint or the time it takes to train personnel to operate the equipment. Other reasons for recurring underutilization identified through interviews include the

departure of the original PL from the institution and challenges finding and retaining qualified personnel to operate complex infrastructure.

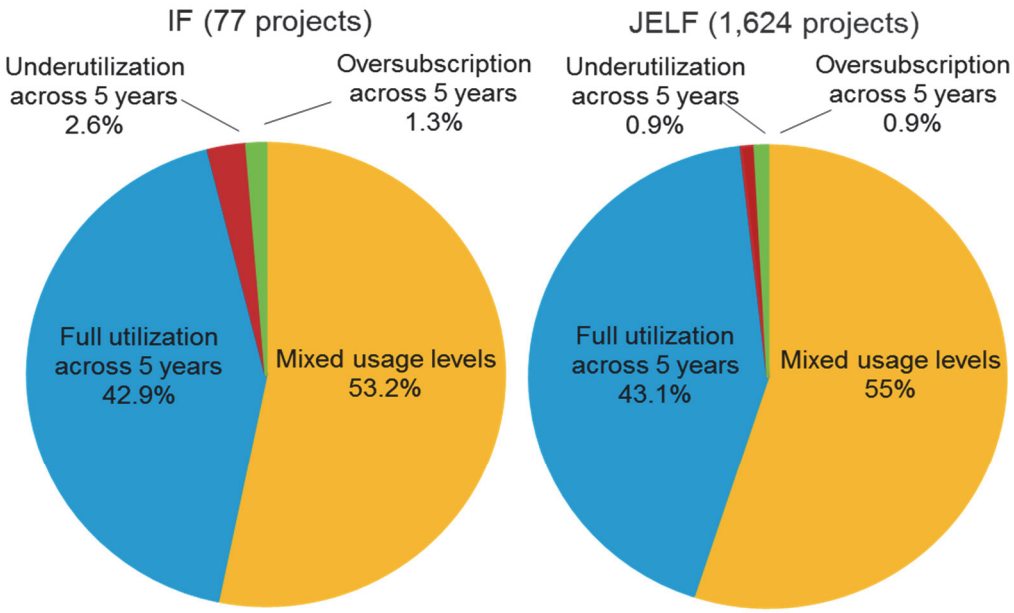


Figure 3. *The proportion of projects reporting different patterns of use across five reporting years*

2. Productivity may decrease slightly due to underutilization or oversubscription, but this does not typically affect the infrastructure's scientific lifespan

Underutilization

A finding that emerged from both interviews and PPR data is that underutilization in the early stages of a project reflects the fact that the infrastructure has not been completely installed, is not yet fully operational, or that the research team has not yet been fully trained to use it. Underutilization in a project's early stages could therefore be interpreted as part of the typical course of setting up a facility or installing equipment. Principal users need time to understand how best to exploit the full capabilities of state-of-the-art infrastructure in the early years to ensure its optimal use. This process can sometimes lead to the development of protocols for future use. Thus, underutilization in the early years should not be a cause for concern as it does not suggest low productivity. At the same time, underutilization in the early years could also be in part evidence of a premature PPR reporting cycle, which may not be fully taking into account the necessary time to set up research infrastructure. The fact that underutilization dropped slightly after the CFI introduced a new reporting schedule that takes operational status into consideration also supports this premise.

Underutilization beyond year one or two in the reporting cycle typically reflects either a need for repair or maintenance or, as mentioned earlier, a shortfall in resources (human or financial). Interview data suggests that when either of these situations arises, researchers, their affiliated department, faculty, and institution collectively act quickly to make every effort to remedy the situation.

Oversubscription

Both PPR and interview data suggest that oversubscription is not felt to have a negative impact on overall productivity. Rather, it typically suggests that a large group of researchers use the infrastructure. We heard examples of how this can lead to more collaboration and sometimes unique ideas and creative interactions between researchers. One PL suggested that having to wait can contribute to a more carefully and thoroughly planned experiment. Although having to wait to use infrastructure may seem to pose challenges to the user, overall we were convinced that prioritization systems in place generally ensure that those in greatest need are accommodated (e.g. someone requiring data for a grant application, to complete a graduate thesis, or for a ground-breaking publication). Both researchers and research administrators indicated that the benefit of additional users outweighed concerns related to wait times or accidental breakage or damages to the equipment by those users. All indicated a preference for infrastructure being used rather than aging or depreciating without users.

There were no situations identified where demand outstripped availability of the infrastructure sufficiently to cause concern. Institutions appear to endeavor to have the necessary infrastructure to meet the needs of their researchers. According to institutions, they rely on their researchers to identify mechanisms to ensure the optimal operation of the infrastructure.

Concerning the risk of decreasing the lifespan of infrastructure imposed by high levels of use, several PLs interviewed preferred to think of lifespan in terms of the total amount of science that can be done, rather than in terms of how many years the infrastructure remains in service. In other words, what is of importance is that the infrastructure fully delivers the expected research output. Interviewed PLs are well aware of the strengths and limits of their equipment, and make every effort to maximize usage while preserving its lifespan.

3. Challenges observed and best practices to optimize infrastructure use

Challenges

One of the challenges most frequently reported in PPRs and in interviews associated with underutilization early in the reporting cycle relates primarily to delayed project initiation due to the issues in acquiring space or equipment. In some cases, underutilization in early stages were linked to the time lags between funding application, decisions and award finalization. Some of the specific challenges associated with these delays, when they occur are:

- Loss of matching funds from expected partners or funding agencies due to budget cuts or priority changes;
- The model or types of equipment requested in the application becoming out of date due to major technology advancement between the time of application and award approval, requiring a revision of the list of requested infrastructure;
- Changes in currency exchange rates leading to unforeseen increased costs for the infrastructure.

Another challenge associated with underutilization and oversubscription, frequently reported in PPRs and interviews with both PLs and research administrators, is a lack or limited availability of human and financial resources for operations and maintenance (O & M). An analysis of PPR data relating to the adequacy of O & M resources for JELF projects shows that full utilization occurs in 80-85% of the projects where both human and financial resources are reported as adequate. For projects where O&M resources were said to be inadequate, the percentage of projects reporting full utilization dropped to 60-72%. Insufficient data precluded a similar analysis of IF projects.

Best practices

During interviews, researchers were asked to provide recommendations to new CFI applicants or awardees on how to ensure optimal utilization, based on their experience. The following is a summary of the key suggestions put forth by researchers currently managing CFI funded infrastructure:

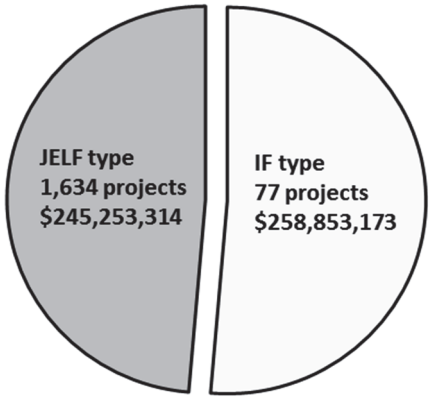
- **Ensure alignment of infrastructure with the institution's strategic research priorities**. This will help guide the approach to secure necessary O & M resources for the anticipated scientific lifespan of the infrastructure. It will also help ensure the selection of optimal equipment, based on what the equipment can do to support institutional research priorities.
- **Ensure the appropriate human resources are in place**, both in terms of having individuals with the proper expertise to manage and operate the infrastructure, and selecting users/collaborators and scheduling their access to the equipment in order to maximize its use and advance the research agenda.
- **Ensure a flexible and transparent oversight model**. The oversight model including the daily management and ongoing maintenance of the infrastructure should be tailored to the infrastructure, the types of projects, size of facility, and potential user demand. Some infrastructure is well-suited to core facilities, while other specialized infrastructure is difficult to share beyond a narrow group of users.

Appendix

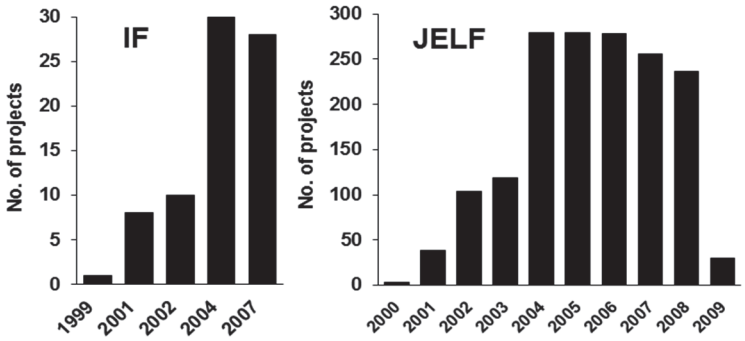
Sample cohort used in the analyses of Project Progress Reports

	Reporting period	2001 -2006	2003 -2007	2004 -2008	2005 -2009	2006 -2010	2007 -2011	2008 -2012	2009 -2013	Total
77 Innovation Fund (IF) type	Innovation Fund	9	3	1	8	24	4			49
	Leading Edge Fund / New Initiatives Fund 2006							19	9	28
	Total	9	3	1	8	24	4	19	9	**77**
1,624 John R. Evans Leader's Fund (JELF) type	New Opportunities Fund	42	37	66	165	176	79	8	1	574
	Canada Research Chairs (CRC) Infrastructure Fund	22	42	43	127	100	75	32	9	450
	CFI Career Awards			1	5	3				9
	Leaders Opportunity Fund - CRC						7	77	68	152
	JELF- Funding for research infrastructure						71	152	216	439
	Total	64	79	110	297	279	232	269	294	**1,624**
	Grand total	64	82	111	305	303	236	288	303	**1,701**

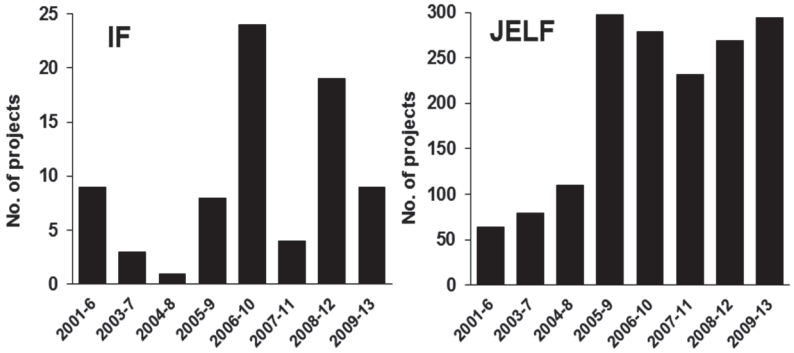
Amount awarded by type of project



Number of projects awarded by year



Number of PPR submitted by reporting period

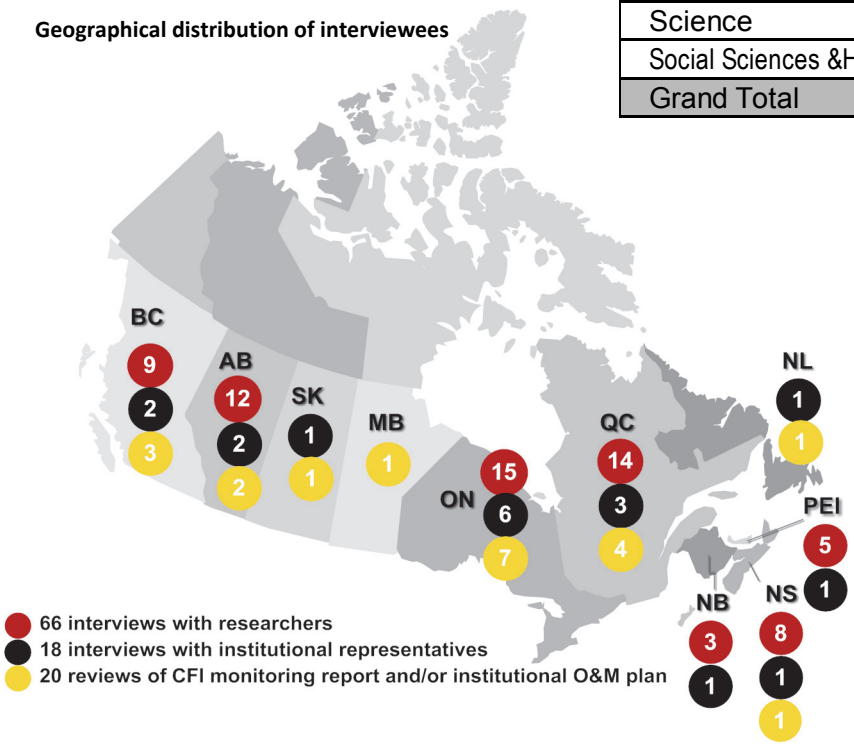


Profile of interview sample of researchers (project leaders) and institutional representatives

Research area associated with projects of interviewed researchers

Research area	#	CFI contribution
Engineering	11	$29,165,153
Environment	4	$936,496
Health	26	$33,879,267
Science	16	$20,785,747
Social Sciences &Humanities	9	$3,178,372
Grand Total	66	$87,945,035

Geographical distribution of interviewees



Key information asked in interview questions