

**Analysis of reports on infrastructure projects funded by
the Canada Foundation for Innovation
(and other funding partners)**

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Introduction

This analysis summarizes the information found in:

1. institutional reports submitted in the fall of 2000 by universities and other institutions; and
 2. project reports submitted by principal investigators.
- Reports cover infrastructure approved by CFI before May 2000.
 - Many infrastructure projects involve the acquisition, construction, development and testing of complex facilities. Also, the CFI approves the release of funds only when all matching fund are in place. Therefore, a significant number of reports relate to infrastructure that will not be fully operational until late 2000 or mid 2001 or later.
 - This report focuses essentially on those projects for which actual research results have occurred, due to the infrastructure. With a few noteworthy exceptions, they report on awards made in 1998, especially New Opportunities and Innovation Fund under \$350,000.
 - Because CFI guidelines for the preparation of progress reports ask authors to focus on research outcomes, neither this analysis nor the reports dwell on the fact that investing billions of dollars into research equipment, by itself, is a major instrument of job creation and economic development. CFI investment and matching funding created
 - construction and renovation jobs
 - jobs with suppliers and developers of equipment and materials
 - technical and managerial positions in research institutions.This job creation impact is evident everywhere, but can make quite a difference in smaller towns across Canada.

Institutional reports¹

- CFI has had a major impact on research planning in institutions, large and small, bringing people together and building on strengths.
- Some institutions reported significant progress towards meeting the goals outlined in their plans, thanks in large part to CFI funding.
- CFI has had a major impact in attracting matching funding for infrastructure, especially from provincial governments (not all, but most provinces). In

¹ Institutional reports are available on CFI web site, www.innovation.ca.

Atlantic Canada, the Atlantic Canada Opportunity Agency was a major contributor of matching funding.

- CFI has had a major impact on morale of faculty members and research trainees.
- CFI has an impact on attracting and retaining faculty members, graduate students and other trainees.
- CFI infrastructure is also used for exposing undergraduate students to research, in both large and small universities.
- A number of reports reflect on the transformation of research that is taking place thanks to CFI, provincial government programs, and other federal initiatives. This is especially apparent in fostering collaboration and multidisciplinary research.
- In universities with a medical school, there are more interactions between hospital-based research and university-based research and more interaction between biomedical research and other disciplines.
- New inter-institutional collaborations are developing around shared infrastructure.
- The fact that CFI fosters multidisciplinary research has well prepared institutions for the Canadian Institutes of Health Research which stress collaboration and multidisciplinary research.
- There are new collaborations between colleges and universities, preparing colleges well to compete for NSERC funding, now that NSERC has opened its doors to college researchers working with university researchers.
- Institutions are convinced that the research infrastructure supported by CFI will have major social and economic benefits, but all agree that it is too early to provide solid evidence although progress reports contain numerous examples of early impacts.
- Most institutions note the impact of CFI infrastructure on research productivity, mentioning that researchers are now able to add new dimensions to their programs of research and to conduct studies that were previously not possible. CFI enables greater depth and breadth of investigation, in addition to accelerating the research.

- This is particularly important for researchers funded under the New Opportunities Mechanism: previously, new faculty members often had to delay the start of their research program or start slowly (with borrowed equipment or with modest institutional support) for lack of research infrastructure. Now, they can initiate a competitive research program upon joining the institution.
- All institutions also commented on the increased quality of training and on the importance of exposing research trainees to cutting edge equipment and facilities.
- Finally, all institutions, but especially smaller ones, are convinced that the new infrastructure has already had a major impact on the ability of researchers to obtain research funding from a variety of sources. This is good news, because funds are needed to manage and operate this new infrastructure.
- A number of institutions are concerned at the proliferation of grants programs, both provincial and federal, noting that the best researchers are suffering from “application fatigue” and that research administrators do not have the necessary resources to do as good a job as they would like to do.
- Although a small number of institutions are concerned about the ability to find sources for funding operating costs in the longer term, overall, there is optimism that funding will be secured thanks to the greater competitiveness of researchers and, in some provinces, thanks to increased provincial funding for research (new CFI funding for operating costs had not been announced at the time reports were written).

To quote a report from a smaller university: “Overall, it is our whole science and technology capacity that is increased, with all the socio-economic benefits this entails “.

Project reports

New Opportunities

- Never before in Canada had new faculty members had such an opportunity to equip their laboratories with modern, state-of-the-art equipment.
- Again this year, the most striking impact is in the life sciences. A significant number of molecular biology and genetics laboratories from coast to coast are now equipped to use modern techniques and their students are acquiring skills that respond to the needs of the companies, laboratories and hospitals that will employ them.

- Infrastructure for research in environment, advanced material and information technology has also been acquired. The list of supported infrastructure projects, found on CFI's web site, should provide interested readers with an overview of the wide variety of facilities supported under this new mechanism.
- The above-mentioned list of projects is searchable by discipline and by area of application, enabling interested readers to see for themselves the large numbers of research areas that benefit from new infrastructure.
- To date, the major benefits of the infrastructure have been on the research itself, on highly qualified personnel and on fostering collaborations. There are early socio-economic benefits, but many more will continue to come in the future.
- The infrastructure accelerates the research (bottlenecks have disappeared, steps are automated, etc.).
- The infrastructure also makes research more efficient. Results are more reliable and researchers and students can explore new ideas and approaches. There is room for greater breadth and depth.
- CFI researchers are publishing results from research supported by the infrastructure, often in prestigious journals.
- Some researchers were attracted back to Canada.
- CFI researchers are filing patent applications.
- A number of researchers state that the availability of infrastructure was crucial in their decision to remain in Canada.
- The infrastructure enables the training of graduate students on state-of-the-art techniques. This is extremely important since employers are looking for personnel with broad skills in modern techniques. Student productivity is also much higher since results come out much faster with modern equipment.
- Researchers appear successful in attracting high quality graduate students to their laboratories. They attribute part of their success in this regard to the new infrastructure.

- The infrastructure also facilitated the recruitment of more faculty members in related areas, including some that were attracted back from abroad. In a number of cases, this was a crucial factor.
- CFI researchers collaborate with departmental colleagues, with other researchers in the institution, with other university researchers in Canada or elsewhere, with government researchers, with health practitioners and with industry. How much of this is due to CFI infrastructure? This is difficult to say, but there is definitely an impact because working together on a shared facility promotes exchange and collaborations. Also, it is easier to initiate national and international collaborations when you have full confidence that you can deliver timely results to collaborators.
- A significant number of CFI researchers have initiated collaboration with industry and received support from industry. Such collaborations often result in direct transfer of research results.
- A different type of collaboration is the collaboration that develops between equipment manufacturers and researchers. Laboratories are test beds for the equipment and often contribute to the development of a next generation of equipment or of new uses for the equipment. Canadian manufacturers are involved, as are multinationals with development programs in Canada.
- Researchers work with the public sector and agencies and there is potential for transferring results into policy.
- A number of reports mention that there is potential for commercialization. There are at least two start-up companies and a few more at the planning stage. At least two licences have been granted.
- Several reports mention that the infrastructure enables truly multidisciplinary research.
- Most, if not all CFI researchers report success with major granting agencies, federal, provincial, private and American. Although, it is early to assess the impact of CFI infrastructure on their ability to attract funding, some are convinced that there is a real impact because they can tackle more challenging research programs.
- Few problems were reported by researchers (note that the question was not asked explicitly in the guidelines for preparing the reports):
 - One researcher has to lower his expectations because the low value of the Canadian dollar did not allow him to purchase all the proposed infrastructure.

- Except for a number of delays, for various reasons, there are apparently no problems with matching funding. For example, one group reports delays due to the fact that the Department of Physical Plant is overwhelmed with requisitions.
- Two groups mention difficulties obtaining operating funding or funds to hire technical staff.

The Appendix includes a number of excerpts from project reports from CFI researchers.

Innovation Fund < \$350,000

For the most part, awards were made in 1998 and are now operational (except for a few delays). Research results and benefits are starting to show.

- Student numbers are increasing and the training provided to them is much better.
- Infrastructure was instrumental in retaining faculty members or attracting new ones.
- Research is more productive.
- Results of the research conducted with the infrastructure are starting to appear in print or to be presented at conferences. Some research findings could have major application to health, the environment or various industrial sectors. One group saw its research featured by the media around the world (after publication of a major finding in *Nature*).
- Patent applications have been filed.
- Collaboration is enhanced and multidisciplinary research is taking place.
- Researchers work with industry (including new collaborations), with government departments, with decision makers, community groups and other potential users of research results. Technology or knowledge transfer is started.
- Socio-economic impacts of the research will mostly occur in the future, but there is definitely possibility of commercialization. Some reports mention that graduates are in high demand by industry. One report mentions that there is no receptor capacity in Canada and that the technology will most likely be picked up in Europe.

- One start-up company is attributed in part to the presence of the new infrastructure.
- Others mention the likelihood of commercialization of results or the possibility of positive impact on health or on the environment. Two researchers have already established companies, others have filed for patents. The infrastructure enables the easier and faster dissemination of research results to the end-users.
- In general, researchers that benefited from the infrastructure report a positive impact on research funding, from various sources. One report reported problems with the fact that the group was unable to obtain funding to hire technical help to run the infrastructure.

To quote one of the most enthusiastic reports: “We anticipate additional intellectual property, significant outside investment and exponential growth in the next two years”.

Innovation Fund (institutional/regional/national) > \$350,000

These large awards were announced, for the most part, in the spring and summer of 1999. A number have not yet been paid, pending various conditions, such as securing the necessary matching funding. Others have just been paid. Many others will not be completed for several years to come, as they require construction, development, installation, etc. Reports generally stress that benefits resulting from research results will be in the future. However, there are already impacts on attracting and retaining highly qualified personnel, on fostering collaborations, multidisciplinary research and partnerships with other institutions and other sectors.

- Large CFI infrastructures are in institutional priority areas (see institutional plans at <http://www.chairs.gc.ca/english/research/strategic/index.html>) where recruiting is taking place and graduate programs are expanding. Some groups report success in attracting more and better graduate students and postdoctoral fellows who are interested in learning the new technologies and having hands-on experience with state-of-the-art facilities. Beneficiaries of large CFI awards also have been successful in filling new (and replacement) faculty positions. They credit the promise of the infrastructure as instrumental in attracting these individuals. One group reports losing a number of researchers to the US prior to the approval of the infrastructure. This brain drain has now stopped. Other groups are attracting people back from the US. Overall, the balance looks good.

- When the infrastructure is operational, reports state that training is better, given the hands-on experience on modern equipment, and given that results are more reliable and come out faster.
- The infrastructure is already having a major impact on collaborations, within departments, but, especially, between departments and faculties; in particular, between science and medicine, and engineering and medicine.
- Collaborations with companies are increasing. Instrument development offers opportunity for immediate collaboration.
- Collaborations with government laboratories are also increasing.
- Publications of results obtained with the infrastructure are starting to appear; some in high impact journals; a few patents as well.
- In terms of socio-economic benefits, most reports state that it is too early for the infrastructure to have measurable impacts (they believe that it will be two to three years before impacts can be measured). Some of the centres have already led to spin-off companies, but the technology was generally developed prior to the installation of the infrastructure. In two or three instances, the process of spinning off new technologies developed with the infrastructure is underway. Two groups are negotiating with a Venture Capital company.
- In numerous instances, commercialization is expected to take place in the future (for example: new drugs, new materials, new medical devices, new environmental technologies), either through spinning off new companies or granting licences to existing ones. Interaction with companies and creation of new ones will also enhance receptor capacity in Canadian industry.
- Major impact on the health of Canadians is expected through new approaches to disease treatment, new therapeutic treatments, new diagnostics, new drugs, new medical devices, reduced costs to the health system. Many of the potential applications are unforeseen at this time.
- Major impact on the environment and quality of life of Canadians is also expected from the research supported by the infrastructure. Some of the research results are expected to be incorporated in policies (resource management, environment, health care, etc.)
- Direct job creation is taking place now. CFI and other funders have invested millions of dollars in construction/fitting of new research space and renovations of existing laboratories. Instruments are being developed, installed, operated and maintained. Laboratories are expanding, creating

new research and technical positions. Funding for these new positions come from increased research grants and contracts from public and private sources, provincial programs and institutional sources. In the longer term, job creation outside the research system is expected to take place through the transfer/commercialization of research results.

- In terms of funding, the reports state that the CFI funds, in addition to attracting matching funding, have already helped increase external funding, from provinces, Networks of Centres of Excellence, granting councils, industry and US sources. Expectations are very high for the future, based on the fact that increased research productivity will make the groups more competitive. This undoubtedly means increased pressure on granting councils programs and on institutions in years to come, given that most groups count on these sources for operating costs.
- There are a few problems with delays, for various reasons, but, for the large part, projects are on track.

Research Development Fund (Universities)

About half the smaller universities chose to focus on a small number of large projects in areas where they have strength or wish to develop strength. Most of these projects look promising, but, in most instances, the infrastructure is not fully operational yet. Others chose to apply for a larger number of smaller facilities, often in support of newly recruited researchers. Some of these infrastructures have been in place for a year or more.

- A number of institutions specialize in research areas relevant to the region, be it environmental (e.g., preservation of forest species), social (working with First Nations people), health (public health, epidemiology, genetics) or economic (mining, forest industry, wine industry, agriculture).
- For a significant number of researchers in smaller universities, the infrastructure was a major factor in their decision to remain at the university or to accept a position there.
- Many infrastructure projects enable researchers to tackle projects that were not previously possible. This in turn, makes them more successful in competitive research programs. Many researchers credit the infrastructure (in part) for recent new grants or renewal of support.
- With respect to highly qualified personnel, most reports stress the importance of exposing undergraduate students to research. Most universities that reported also have a number of graduate programs and

state that the infrastructure is helping them attract graduate students and postdoctoral fellows.

- Multidisciplinary research is becoming much more prevalent, in part because the development of infrastructure projects involved the mobilization of researchers from several departments around a facility.
- Increases in internal and external collaborations are also reported. There are collaborations with other Canadian universities, universities abroad, government laboratories and industry: Researchers state that collaboration is enhanced by the fact that they have more to offer.
- It is too early to talk about socio-economic benefits, except for creation of technical positions at the university and creation of short-term construction jobs. There are indications that such benefits will materialize in the future, given the nature of the research, and the numerous partnerships reported, with industry and public sector entities, including community groups. Some reports mention patents and collaboration with spin off companies. Technology transfer is taking place in several projects where the researchers and industry work together on solving problems, and knowledge transfer is occurring in projects where the partners are community groups.
- Institutions are in a much better position to support local industries by producing a highly qualified workforce with advanced technical skills. Indeed, a number of universities report that their graduates are more successful in finding jobs related to their fields.
- A number of universities (at least two) report the departure of (at least three) researchers supported by CFI. They moved to other Canadian universities, in one case to another smaller university. In most instances, they have been successful in recruiting replacement, thanks in part to the CFI infrastructure.

Research Development Fund (Colleges)

- Since most awards were approved in the spring and summer of 1999, some infrastructure is under construction and impacts are in the future.
- Colleges are involved in applied R&D, less so in basic research. For the most part, they work closely with industry. The fact of being recognized by CFI has been important to a number of colleges who had never received sponsored research support before.
- Technology transfer is taking place, as centres are providing services to companies. Some centres report increases in contracts.

- Some centres focus more on health, quality of life or environment than on strictly economic issues. In these case, they work with partners, in government, as well as with school boards, hospitals, community groups, non-government organizations and not-for-profit organizations. Knowledge transfer is occurring.
- With respect to highly qualified personnel, reports mention the experience that will be acquired by faculty members, the training of technologists, continuing education for employed individuals, including teachers and technologists. It is also expected that some of the research results will be incorporated in curricula.
- Attrition has gone down from 20% to 5% in one centre since the award, in part attributable to a more stimulating environment.
- In terms of collaboration and partnerships, college researchers collaborate with universities and hospital research institutes, community groups, government laboratories and agencies, with international colleagues and with industry. Collaboration with universities is definitely increasing.
- CFI infrastructure has led to the creation of jobs in the centres or institutes that received CFI support.

Appendix—Excerpts from New Opportunities Project Reports

(these excerpts are in the language of the reports)

- The new infrastructure functions as a catalyst for multidisciplinary research and enables research teams of several users from different institutions to tackle problems that individual scientists would be unable to solve. After the analytical capabilities of the new infrastructure are fully explored, new research partnerships with the private and public sector will be actively pursued.
- This CFI application and our remarkable discovery of so many novel genes helped catalyze a start-up company.
- The four HQPs who have graduated from his group were highly sought after: two former PDF are currently research scientists with companies, an M.Sc graduate is an application scientist with one of these companies, and a former research assistant is currently a technical officer at the National Research Council.
- Our successful endeavour has resulted in a high profile manuscript accepted by the journal Science and will be printed in a forthcoming issue.
- Economic growth has been seen in our interactions with a private company, where we have made positive suggestions from our research results for their production lines.
- Some of our research results obtained using the infrastructure acquired by the CFI grant are under consideration for patent protection and can be used directly in Canada's information technology and communications industry.
- Since acquiring the CFI infrastructure we have filed two provisional patents. Could well spur the spin-off of a Canadian-run research and development company.
- We have recently been able to develop a novel method for detecting changes in the way that genes are turned on and off in response to environmental change.
- This breadth of activity would not be possible without the instrumentation to accomplish a wide variety of experimentation. It is my hope that the researchers in my laboratory will learn to take problem-based, rather than technique-driven, approaches to experimental research.
- It is clear to me that often for reasons of infrastructure and resources, Canada's top Ph.D.-level scientists choose to study in the laboratories of investigators in the United States. In the past year I have recruited one such top-flight post-doc as well as two very promising graduate students. I believe that Canada can go a long way to stemming this flow by investing in the infrastructure of its research institutions. Without first rate resources and infrastructure we can simply not compete for the best trainees.
- The trainees are enthusiastic and provide an environment that is conducive to creative and forward-thinking individuals.
- The competitiveness for securing excellent trainees has been increased by at least fourfold.

- The collaborations have been tremendously increased as a result of the infrastructure support. The collaborators view the interactions amongst scientists at an intellectual level rather than on infrastructure support. The outcome of the positive impact is increased efficiency and productivity of the collaborations.
- Research programs have been greatly accelerated, providing researchers with ample opportunity for the rapid dissemination of scientific knowledge in the form of published manuscripts and/or presentations at international conferences.
- This infrastructure was critically important in attracting two new recruits to the Department
- The CFI researcher is the founding scientist of a recently formed biotechnology company. While currently employing only a small number of research personnel, this company is likely to expand thereby providing new knowledge-based jobs
- This grant has had a major impact on the productivity, optimism and future capacity of my laboratory, which is the #1 factor contributing to my contentment at this university and the main contributor to my not considering other job prospects at other institutions or in the United States.
- The unique opportunity of experimenting, modeling and controlling real industrial equipment, such as our two robots, enables us to expose our students to a unique environment.
- My research lab group is at the international 'cutting edge' of climate change and land-use change research in wetland ecosystems. This research has large implications in light of the Kyoto Protocol climate change initiative.
- Plus de la moitié de mes projets de recherche sont directement liés aux besoins du secteur de la foresterie, un important secteur pour l'économie canadienne.
- Nous avons aussi conçu et breveté un robot sphérique, peu coûteux, capable de se déplacer sur une grande variété de surfaces.
- In addition, the infrastructure has helped to retain the three co-principal investigators. Each of us is presented with several opportunities elsewhere to pursue each year.
- We have undertaken an aggressive recruiting campaign that has resulted so far in the retention of 38 staff encompassing a large number of different job descriptions and titles. We anticipate our staff will increase in size to 50 before the end of the year.
- A variety of implant manufacturers have expressed a high degree of interest in research cooperation, due partially to our research facilities. We have signed one significant contract and are in negotiation on several others.
- Our new group has published 14 papers in high impact journals. All of the published data required use of the funded infrastructure.
- I moved my laboratory from the US to UBC in 1996. My goal was to establish a facility that will allow us to conduct cutting-edge research on the discovery of previously unknown microbes in the sea and for the detection

and quantification of microbes in a dilute environment. It is the acquisition of equipment such as this that makes it attractive to keep my laboratory in Canada.

- Even though the instrument arrived (as I did) just last year, we have exciting results already.
- I believe that it is crucial to point out that this new infrastructure has allowed me great freedom to take my research into new directions that I would otherwise have been unable to consider. In the absence of such funding and resources, one tends to be more conservative and unwilling to take risks.
- Perhaps the most significant impact of the facility so far, has been in attracting bright young students who might otherwise have gone south, or directly into industry.
- Two recent spin-off companies are both very keen on being able to access the infrastructure.
- The overall impact of the CFI funding has yet to be fully realized. In the early stages the CFI funded CRF has easily doubled the amount of funding available to the primary proponents.
- Licensing of the rights has been completed to an Ontario corporation and this has directly created and sustained three full-time positions as well as supported ancillary Canadian business.
- 8 out of the 9 Master's students found employment in high tech companies. One of them decided to pursue PhD studies under my supervision.
- We are doing research that was (and still is) out of the reach of most of the university institutions in North America and around the world.
- L'exode des meilleurs scientifiques vers les États-Unis est un désastre économique pour le Canada. Cependant, il est possible de lutter contre ce phénomène, et notre centre de recherche le prouve avec le recrutement de chercheurs étrangers qui sont des autorités dans leurs domaines respectifs, et le rapatriement des meilleurs étudiants.
- Notre centre est également en voie de monter un partenariat avec des investisseurs privés et l'Université pour pouvoir développer des projets qui émaneraient des laboratoires du centre.
- Finalement, notons que l'infrastructure a permis un avancement plus rapide des travaux de recherche des étudiants. Ceci devrait se traduire par une réduction de la durée des études de maîtrise et de doctorat comportant des travaux expérimentaux.
- Research already received attention and was featured in broadcasts around the world: research shows that pollutants are progressively distilled towards colder climates.
- Notre recrutement au département s'était effectué dans des conditions sous-optimales du point de vue équipement. La proximité physique dans le même pavillon et le partage d'appareillages communs facilitent grandement les contacts et les échanges entre nos équipes de recherche, et entre nous, chercheurs.

- Ainsi, les pertes de temps ou d'argent liées à l'utilisation d'appareils inadéquats sont réduites de façon significative. En somme l'amélioration de notre parc d'équipements a permis à notre Département de maintenir une réputation de recherche d'excellente qualité.
- Le personnel formé grâce à l'infrastructure est compétitif et en mesure de répondre aux exigences de la compétition internationale dans les domaines de recherche académique en santé.
- Deux demandes de brevet ont été déposées cette année. Les travaux décrits dans ce brevet ont été rendus possible grâce à l'infrastructure acquise. La propriété intellectuelle de ces inventions sera partagée entre l'Université et un partenaire industriel canadien.
- Sur le plan technique, l'acquisition de nouveaux équipements a permis de réduire de façon marquante le temps investi par nos techniciens pour des tâches qui sont maintenant accélérées ou automatisées. Minuterie qui est nettement plus raffinée et qui augmente de façon significative la qualité de nos études. Gain de temps et d'argent de l'ordre de 20:1. Bien que cette première année reliée à la création de ce laboratoire réponde déjà à nos espérances à plusieurs niveaux, nous considérons que nous sommes encore en pleine expansion et en période de rodage et nous considérons que nous devrions approcher notre pleine vitesse de croisière au cours de la prochaine année.
- A titre d'exemple, un projet de recherche impliquant l'ensemble des centres de réadaptation pour personnes alcooliques et toxicomanes, a développé un modèle unique et inédit de collecte de données. Meilleure efficacité, gain de temps, coût d'opération moindres, diminution des risques de pertes de documents.