



Impacts Analysis of the Canadian Photonics Fabrication Centre – Final Report

Prepared for: The National
Research Council of Canada

2009

ADVISORY

Table of Contents

<i>Executive Summary</i>	4
1 Introduction	7
1.1 This Study	7
1.2 The CPFC	7
2 Methodology	9
2.1 Overview	9
2.2 Sample Selection	9
2.3 Case Studies	9
3 Findings on Economic Impacts	11
3.1 Gross Commercial Impacts	11
3.2 Net Commercial Benefits	12
3.3 End-User Benefits	12
3.4 Context	12
3.5 Risk Analysis	12
3.6 Industry’s Ability to Raise Capital	13
3.7 Incrementality and Attribution	13
3.8 Alternatives to CPFC	14

- **Disclaimer**

This document has been prepared specifically for the Canadian Photonics Fabrication Centre of the National Research Council of Canada by KPMG LLP and is in all respects subject to completion of required professional inquiries, the negotiation, agreement and signing of specific contracts.

KPMG International is a Swiss cooperative of which all KPMG firms are members. KPMG International provides no professional services to clients. Each member firm is a separate and independent legal entity and each describes itself as such. KPMG LLP, a limited liability partnership formed pursuant to the laws of Ontario, is the Canadian member firm of KPMG International.

4	<i>Findings on Non-Economic Impacts</i>	16
4.1	Non-Fabrication Activities	16
4.2	Future Partnerships with CPFC	16
4.3	Risk Management	17
4.4	Other Indirect Benefits	17
4.5	Strengths and Weaknesses of CPFC	19
5	<i>Conclusions</i>	22

APPENDIX A: CASE STUDY INTERVIEW INSTRUMENT

- **Disclaimer**

This document has been prepared specifically for the Canadian Photonics Fabrication Centre of the National Research Council of Canada by KPMG LLP and is in all respects subject to completion of required professional inquiries, the negotiation, agreement and signing of specific contracts.

KPMG International is a Swiss cooperative of which all KPMG firms are members. KPMG International provides no professional services to clients. Each member firm is a separate and independent legal entity and each describes itself as such. KPMG LLP, a limited liability partnership formed pursuant to the laws of Ontario, is the Canadian member firm of KPMG International.

EXECUTIVE SUMMARY

This study. This project estimated the lower bounds for the economic impacts of a set of projects conducted by the National Research Council of Canada's Canadian Photonics Fabrication Centre (NRC-CPFC¹).

The CPFC. The CPFC is a pioneering photonics prototyping facility and leading-edge training facility intended to provide a world-class commercial grade fabrication facility dedicated to the fabrication of photonic device prototypes. It is housed within NRC's Institute for Microstructural Sciences (IMS). Through CPFC, photonics start-up companies can initially remain without internal photonics fabrication abilities, instead outsourcing their prototyping to the Centre. CPFC services substantially reduce start-up and product development costs, de-risking the technology for the client and the investment for the venture capital community. To date government costs have been about \$62 million for capital and operations over eight years. A typical annual operating cost is about \$9 million from public and private sources (fee-for-service revenues are about \$2.5 – 3.0 million per annum).

Study methodology. The study concentrated on CPFC services to firms that were believed to have resulted in high or very high economic impacts, and for which these services were critical to commercialization. Interviews were conducted with 12 key clients of CPFC. Because many of the results were considered highly confidential by the firms involved, we guaranteed that results would be reported only in aggregate.

Findings on economic impacts. A rough estimate of gross commercial value to the 12 firms from 2009 through 2014 is about \$500 million.

Exhibit 1 – Gross Economic Impacts (\$M) for CPFC Technologies for 12 Organizations			
Sales revenues per annum	<i>Year 2009</i>	<i>By ~ 2011</i>	<i>By ~ 2014</i>
	44.6	73.0	128
Cost savings to date	2.1 Production savings alone, not including costs avoided by not building "in-house" fab centre(s)		
Investments to date in commercial products	87.3 (Minimum, some deals in progress)		
Investments to date in related new R&D initiatives, collaborations, etc.	15.7 (Minimum, not including university investments in photonics research chairs, curricula, etc.)		

¹ We will refer to it simply as "CPFC" from here on.

The risk of these sales not being achieved is relatively small, as there are already about \$45 million in existing gross revenues. These benefits can be compared to CPFC's costs, which are typically about \$9 million annually from both public and private sources.

Conclusions. These findings indicate that the CPFC is providing a highly sought-after and highly valuable service to its client firms. Although the clients engage CPFC mainly for fabrication services, in practice they obtain many other benefits from their involvement, including consultation, testing and technical assessments, advice on technology development and marketing, risk reduction, networking and linkages, access to HQP, and professional development. The staff are viewed as exceptionally competent and professional, and the infrastructure as state-of-the-art. These clients reported no feasible alternative services to be available within Canada, and international sources had little appeal. The very high cost of constructing a foundry internally made this option completely unfeasible for the clients.

The CPFC thus allows the client firms to develop technologies that would be impossible otherwise. In addition, the very high quality of the facility and its products allows the client firms to successfully raise capital – about \$87 million to date – because the state-of-the-art nature of the facilities and implicit CPFC “seal of approval” are very impressive to potential investors.

Overall, the CPFC appears to provide Canada with excellent value for money.

Opportunities. There may be opportunities to improve the timeliness of CPFC's services, investigate more creative commercial partnerships with its clients, and take more advantage of the implicit “seal of approval” that the Centre provides for its clients.

1 INTRODUCTION

1 INTRODUCTION

1.1 THIS STUDY

This study estimated the lower bounds for the economic impacts of a set of projects conducted by the National Research Council of Canada's Canadian Photonics Fabrication Centre (NRC-CPFC²).

The main intent of the project was to gather information on CPFC's economic impacts for its clients, especially sales revenues and cost savings associated with commercial products developed with CPFC's assistance, as well as additional investments made in commercial activities or new R&D initiatives. The project investigated the importance of CPFC assistance in helping create these commercial benefits, assessed the key mechanisms used by the CPFC, and investigated the relative importance of the CPFC within the context of the many other Canadian photonics initiatives currently in place. The study also obtained information on non-commercial impacts obtained through interactions with CPFC (e.g., strategic advice), impacts on training, and comments on the process of interacting with CPFC.

1.2 THE CPFC

The CPFC is housed within NRC's Institute for Microstructural Sciences (IMS). The CPFC is a pioneering photonics prototyping facility and leading-edge training facility intended to provide a world-class commercial grade fabrication facility dedicated to the fabrication of photonic device prototypes. Through CPFC, photonics start-up companies can initially remain "fabless" (i.e., without internal photonics fabrication abilities), instead outsourcing their prototyping to the Centre. Thus CPFC services substantially reduce start-up and product development costs, de-risking the technology for the client and the investment for the venture capital community.

CPFC works within a reasonably healthy Ottawa photonics cluster which currently numbers about 50 firms. In addition, there are a number of supporting initiatives in Ontario and Québec, including (among many others) the Ottawa Centre for Research and Innovation (OCRI), CMC Microsystems, the Agile All-Photonics Network, Photonics Research Ontario (a division of the Ontario Centres for Excellence), NRC-IRAP, the Canadian Photonics Consortium, the Institut National d'Optique, and the Ottawa Photonics Cluster. NRC has been heavily involved in the creation and/or operation of several of these initiatives³.

To date government costs have been about \$62 million for capital and operations⁴ over eight years. This consists of the initial \$43 million from federal and provincial sources, excluding \$3 million provided to Carleton University for training purposes, plus a second tranche of federal government funding of \$22 million, spread over the period April 2002 through March 2010.

² We will refer to it simply as "CPFC" from here on.

³ NRC staff sits on the Board of Directors, Steering Committee & Research Program Committee of 10 key international, national or provincial photonics related organizations.

⁴ Including salaries, taxes, etc.

2 METHODOLOGY

2 METHODOLOGY

2.1 OVERVIEW

2.1.1 CONCENTRATION ON “HIGH IMPACT” CASES

The study concentrated on CPFC services to firms that were believed to have resulted in high or very high economic impacts, and for which these services were critical to commercialization. The methodology was thus similar to that used in partial benefit-cost analysis (in which only projects obtaining high or very high impacts are studied), except that a full analysis of CPFC costs was not conducted. Because the lion's share of economic impacts typically results from a small or very small proportion of companies assisted through government R&D programs, concentrating on the “high impact” projects is far more cost-effective than attempting to identify impacts for all client firms.

With this technique it is not possible to extrapolate the case study findings to all CPFC clients, since the sample selection is not random. (In practice this is not a weakness. Random selection techniques can easily lead to underestimation of total impacts if one or two of the highest impact projects are accidentally left out of the sample, or overestimation if an unrepresentative proportion of high impact projects are in the sample. Knowing a certain value for the lower bound is a much better option.)

The interview guide is found in Appendix A.

2.1.2 LOWER BOUND

The resulting impacts are lower bounds, since not all firms are studied, and often all impacts cannot be identified (e.g., if the time scale is too short for all impacts to have occurred) or quantified (e.g., if some impacts are inherently difficult to quantify in dollar terms, such as environmental impacts)⁵. This technique is therefore a conservative estimate of total impacts.

2.2 SAMPLE SELECTION

A sample of 15 firms and other organizations (like CMC Microsystems) that had benefited from CPFC technical services and/or training were selected for study. Identification of the key organizations was done through discussion with CPFC and IMS, and review of documents and presentations provided by CPFC.

2.3 CASE STUDIES

Interviews were conducted with 12 key clients of CPFC. Those firms not participating did so mainly because of lack of time by the firms. Because many of the results were considered highly confidential by the firms involved, we guaranteed that results would be reported only in aggregate.

⁵ For a full description of partial B-C analysis, see: *Partial Benefit/Cost in the Evaluation of the Canadian Networks of Centres of Excellence Program*, A. Dennis Rank and Douglas Williams. **Evaluation and Program Planning**, Volume 22, No. 1, February, 1999.

3 FINDINGS ON ECONOMIC IMPACTS

3 FINDINGS ON ECONOMIC IMPACTS

3.1 GROSS COMMERCIAL IMPACTS

For the 12 organizations contacted, their sales revenue, cost savings, and investment information related to CPFC-related products and services is summarized in Exhibit 3.1. These figures are gross values.

A rough estimate of gross commercial value to the firms from 2009 through 2014 is about \$500 million.

All figures are aggregated to maintain confidentiality. As is typical in such studies, a small number of firms account for the bulk of the anticipated economic benefits. However, we have not conducted a sensitivity analysis (e.g., by taking out the values for the “highest impact” firms), because the number of companies is so small – it may be possible for a knowledgeable person to identify the “highest impact” companies by the change in the figures. For the figures five years from now, the distribution of benefits becomes somewhat less skewed as products from other firms become more important.

Exhibit 3.1 – Gross Economic Impacts (\$M) for CPFC-Assisted Technologies for 12 Organizations			
Sales revenues per annum	Year 2009	By ~ 2011	By ~ 2014
	44.6	73.0	128
Cost savings to date	2.1 Production savings alone, not including costs avoided by not building “in-house” fab centre(s), and not including SR&ED rebates. Cost savings associated with use of CPFC services were of little interest to most organizations.		
End-user benefits	Could not be quantified in this study (see text)		
Investments to date in commercial products developed with assistance of CPFC	87.3 Minimum, some deals in progress		
Investments to date in related new R&D initiatives, collaborations, etc.	15.7 Minimum, not including university investments in photonics research chairs, curricula, etc.		

3.2 NET COMMERCIAL BENEFITS

To the very limited extent we have information on profit margins (very few firms were willing to discuss concrete figures), they are high because of the cutting-edge nature of the products – probably on the order of 50% or more (in some cases, likely much more). This implies net benefits from 2009 – 2014 of very roughly \$250M, assuming a 50% profit margin. The net benefits in 2009 alone are roughly \$22 million for these 12 organizations.

This can be compared to CPFC's costs. Costs vary somewhat by year, but in 2009 government funding was about \$6.25 million for salaries and operations. To this should be added costs to the client firms – all clients combined provide about \$2.5 – 3.0 million annually, which is used by CPFC for recapitalization to keep its infrastructure cutting-edge. Thus a typical total annual budget for CPFC is about \$9 million from public and private sources combined.

3.3 END-USER BENEFITS

Several of these technologies will have benefits for end-users who purchase them from the CPFC client firms. For example, a telecommunications customer might use the technologies to reduce their internal operating costs, or to provide new services to their own customers and enter new markets, gaining additional sales revenues. In a full benefit-cost assessment, such end-user benefits would be included in the estimate of benefits to Canada. However, the CPFC clients did not themselves know exactly what these benefits might be, and it was beyond the terms of reference of this study to follow up (typically there will be many end-users and many types of end-user benefits. The study team notes that end-user benefits for customers are frequently equal to or greater than benefits for the manufacturers.

3.4 CONTEXT

Since CPFC has only been operational for SMEs since about 2004 – 2005, many of the impacts are still “in process”.

Further, CPFC has had 45 individual clients, many of whom are repeat customers. CPFC knows there are some economic impacts for several of the firms not investigated in this study, although these impacts may be smaller than for the 12 cases studied.

3.5 RISK ANALYSIS

These are, of course, potentially high-risk commercial ventures. We did not attempt to estimate the explicit likelihood of each of these ventures succeeding⁶. However, three facts suggest a relatively low risk of these projected sales not being achieved:

⁶ Although we did exclude one projected sales figure that was reliant upon a future specific – and still far from certain – transformative impact in communications.

1. There are significant existing sales – roughly \$45 million per annum to date. These existing sales are accruing to several of the firms studied, not just one or two.
2. If the projected future revenues are included only from firms which already have existing sales – these presumably being the sales that are very likely to occur – then the total for gross revenues over 2009 – 2014 is roughly 85% of the complete estimate, or \$430 million. Thus the contribution to the complete estimate from firms which have not yet “proven themselves” is relatively small.
3. These products are said to have significant competitive advantages, including the implicit “seal of approval” associated with CPFC involvement (see section 4).

3.6 INDUSTRY’S ABILITY TO RAISE CAPITAL

As can be seen in Exhibit 3.1, the client firms studied have raised at least an additional \$87 million for the technologies under development. Nine of the 12 respondents reported that CPFC involvement had strongly increased their ability to raise such additional funding, and some of them said their project could not have proceeded without that funding. Much of this effect was attributed to the perceived excellence and expertise of both CPFC personnel and of their program. Comments made on this point were very strong:

Here’s an anecdote. Investors come in to see test facilities at a university, then their jaws drop when they see CPFC. They see where it is, see that it’s world class, and we have credibility as a result. It doesn’t take very skilled investors to see the difference between a university or a “garage lab” and CPFC. And that speaks volumes.

We got funding from a third party because of the [CPFC] state-of-the-art facilities and talented people.

For research, I can now propose things I never would have proposed before.

CPFC was a BIG help in our ability to raise funds. Otherwise there would have been a lot more questions about the final [development] steps. It’s such a hard process to raise the money, but it was a lot easier with CPFC being a reference.

For private investors, it’s good to show we’re working with a national lab facility, it really helps.

3.7 INCREMENTALITY AND ATTRIBUTION

A detailed examination of incrementality and attribution was not done, but all organizations stressed the high importance and value they placed on CPFC services, and alternatives to CPFC’s services were not compelling. (See section 3.8). At least two of the high impact projects would not have gone ahead at all without CPFC involvement, and several of the additional investments (which allowed the projects to proceed to commercial stages) would not have happened.

3.8 ALTERNATIVES TO CPFC

There are other organizations which provide similar services to CPFC, although they are often “packaged” differently. However, none of the 12 case study organizations seriously considered these alternatives.

Universities. Many of the 12 organizations had considered using university facilities, but the lack of control and especially quality control (e.g., cleanliness) made them utterly unsatisfactory.

[We considered them], but the chances of getting working devices out of a university fab centre are negligible

Private Companies. Many firms had also considered using private companies, but they were generally seen as less competent than CPFC. And for several reasons, respondents preferred dealing with a facility inside Canada, of which CPFC is the only one.

CPFC blew [the other organization] out of the water.

In-house fabrication. Using or building their own fabrication facility was considered by several participants, but the huge cost and significant time loss made it an unattractive option or, indeed, prohibitive.

4 FINDINGS ON NON-ECONOMIC IMPACTS

4 FINDINGS ON NON-ECONOMIC IMPACTS

4.1 NON-FABRICATION ACTIVITIES

CPFC's fabrication service was clearly a primary activity for all organizations contacted, and the key reason CPFC was initially contacted. But clients reported that experimentation and further development were also seen as major CPFC services. CPFC consulted continuously with its clients, and provided feedback all along the way.

CPFC worked with us on everything. There was intellectual input on design and development at every stage.

It was really a joint project, a joint team. We provided our product details and designs. But then everything had to be agreed upon and coordinated with CPFC. There were weekly joint meetings, calls, etc. It was a true collaboration.

As part of this, CPFC provided a variety of analytical services, testing, and technical assessments. It also provided IP consulting and even advice and support around securing additional funding.

4.2 FUTURE PARTNERSHIPS WITH CPFC

An interesting point raised by several respondents was that – although fabrication services were the initial reason for contacting CPFC – the organizations had an interest in developing a long term CPFC partnership to explore new technology possibilities, to develop additional new products and technologies, and to address truly advanced research and development. More than one respondent commented that the technologies developed with CPFC assistance were going to “open doors” for other products and services.

The study team comments that there appear to be opportunities here for more creative, long-term relationships of CPFC with its client community, going beyond relatively simple provision of design and fabrication services, and moving towards joint commercial partnerships (assuming, of course, that its mandate would permit this).

We could develop a much more sophisticated relationship.

What is the best way forward to development regarding our marketing relationship – for example, outside Canada? We could open things up within the international supply plane – and CPFC could be part of that.

Looking at things from a joint marketing perspective could help. We will all do better if we can figure out how to leverage international connections to CPFC.

4.3 RISK MANAGEMENT

Clients reported that there are three major ways in which they dealt with risk management in collaboration with CPFC.

Project staging. Much of the work was done in multiple stages so that changes and decisions could be made all along the way, depending on outcomes at each intermediate stage.

They did it in two steps – a building blocks approach – to see if it would work – without our having to pay for whole thing up front. Their contracts are great – they break it down into small deliverables.

CPFC worked very closely with us. They reported progress very frequently. And their consultative interactive management system helps.

Multiple wafer copies and test surfaces. CPFC often recommended production of multiple copies of each set of wafers, or using different test surfaces on different portions of the same wafer, in order to mitigate against the risk of wafer breakage and loss. (In some cases, this approach had not been initially considered by the client as it involved somewhat higher costs.)

We know the wafers break and accidents happen, though it's not a big issue – it doesn't happen much.

Excellence of CPFC. Though not explicitly a risk management “technique”, participants saw the general CPFC excellence, the quality of their work, and the extremely high level of personnel (with little turnover), as strongly reducing their risk.

Continuity is very important at CPFC. Universities just don't have the same quality and rigorous control. This is a very strong form of our risk mitigation approach via CPFC!

We did risk management by basically excluding any risk. All [CPFC] people are from Nortel. And CPFC guaranteed delivery – a 100 % guarantee.

4.4 OTHER INDIRECT BENEFITS

Networking and linkages. Several respondents reported that a strong indirect benefit was exposure to important new contacts and development of new projects. This included exposure to other government programs, contracts, and leveraging opportunities.

It's a family of different experts with CPFC as the main hub. CPFC is the cornerstone. It has made our interactions much easier to do, with a very high level work with other organizations.

CPFC creates conditions for synergy, and moving beyond to leveraging it in some way. It brings people together.

They have relationships nationally and internationally that both could benefit from.

Professional development. Consultancy and access to high level, expert information at CPFC is another indirect benefit for all levels of personnel within the client organizations.

University faculty and students get involved with actual discussions with CPFC. And exposure to the fab facility is a fabulous experience.

This often leads to increased publications and opportunities for professional growth. There is also development of expertise in non-technical areas such as contracting. One company was particularly positive about the nature of CPFC contracts (in terms of breaking the process down into small deliverables to reduce risks) and intends to model their own company contracts on the CPFC technique.

We know that [the CPFC way of doing things] has beaten down some of our risks.

For projects involving universities, the wafer designers are often graduate students, coop students, postdoctoral fellows, and research associates. Because these individuals do not have direct access to the fab facilities (which require very high levels of expertise for operation) the students did not obtain direct fabrication experience. However, they were involved in the design, testing, and consultations referred to elsewhere, and are certainly aware of the CPFC capabilities. In this small sample, we did not obtain information on the impact of these activities on future career prospects (although it is certainly positive, and see the next sub-section), and several respondents specifically mentioned the importance of these impacts for training highly qualified personnel (HQP).

That's the point here, to strengthen industrial presence in Canada with HQP who have knowledge in photonics.

Having students working with us is a big advantage. They get to know the facilities and capabilities that exist.

Access to HQP. Five of the 12 respondent organizations have already hired HQP as a direct result of this interaction with the CPFC, and two more respondents intend to do so in the near future.

We hired a second design engineer based on our first year of CPFC involvement because we saw the revenue stream.

Yes, we hired an excellent, excellent person.

Our company hired three people from the university.

We hired an HQP who was referred by CPFC, full-time. We would never have found this person without CPFC.

It's very difficult to find senior types of HQP – so we would steal from CPFC if we could!

“Seal of approval”. Some respondents reported a variety of non-commercial outcomes, including awards, publications (sometimes first publication of important results), potential health and environmental benefits, and “bragging rights”.

Publishing the first paper on this was fantastic for both of us.

The study team notes that an implicit “seal of approval” often results from involvement with a high profile, top quality, government R&D organization. Clients of other such organizations have often leveraged this into increased publicity, market awareness, and (ultimately) technology sales. This effect appears to be in place for CPFC as well, and we encourage the CPFC to take advantage of this effect where appropriate. (See the earlier comment about opportunities for more creative commercial partnerships.)

4.5 STRENGTHS AND WEAKNESSES OF CPFC

Strengths. CPFC was chosen instead of other options for the reasons discussed in section 3.8, but fundamentally because CPFC is seen as having the highest level of intelligent, professional, expert, and helpful individuals, who are running the most sophisticated, highest quality, and well-run facility imaginable. In the experience of the study team, the comments made on this point were exceptionally strong.

Incredible process control – no students or inexperienced people in the lab.

I can only say wonderful things about CPFC.

The CPFC mandate is to make my company successful. They really delivered.

CPFC bridges the gap between sandbox playing [at universities] and the real world with a real expectation of revenue. It's VERY valuable to be exposed to that, and the research excellence that's part of NRC.

The guys are absolutely top class people to work with. I like, enjoy, and respect them.

I couldn't say enough good things about this crowd.

This [facility] is absolutely a must in order [for us] to do innovative work.

Hugely valuable service to Canada – incredibly!

CPFC is very positive in terms of their expertise and outlook. And it's extremely important for Canadian competitiveness.

Weaknesses. No serious weaknesses were identified.

The most common complaint was that delivery times were occasionally slow. It was mentioned that CPFC may have had a more “researchy” focus initially, but needs to be very commercial in its thinking. It was mentioned it had recently improved substantially in this regard.

The sense of hurry is not as present in CPFC as we would like.

[Delays were] the biggest bugaboo.

Sometimes they're a little too slow. But we also know CPFC won't compromise on quality.

It's now much more like a "real" foundry – they've improved enormously.

A related problem is that these delays may be more serious for large firms than SMEs.

The same priority is not given to us by CPFC as at a commercial foundry, because CPFC has too many clients they have to serve because of their mandate. This may be great for start-up companies. But my company is much bigger and needs things done ASAP.

The study team notes that concerns about timeliness tend to plague government R&D organizations which offer fee-for-service activities to industry. Although CPFC does not appear to have serious problems in this regard, it is of the utmost importance that this situation is not allowed to worsen.

A few respondents commented on the high cost of CPFC services, although most believed it was reasonable given the highly customized nature of the wafers, the additional design and consulting expertise provided, and the alternatives available.

One respondent commented on IP issues. This was not investigated in detail, but involved lengthy discussions about who owned which portion of the IP. This hindered the project somewhat, but it was considered by the client to be for mostly reasonable reasons, with both organizations being careful in their due diligence.

5 CONCLUSIONS

5 CONCLUSIONS

These findings indicate that the CPFC is providing a highly sought-after and highly valuable service to its client firms. Although the clients engage CPFC mainly for fabrication services, in practice they obtain many other benefits from their involvement, including consultation, testing and technical assessments, advice on technology development and marketing, risk reduction, networking and linkages, access to HQP, and professional development. The staff are viewed as exceptionally competent and professional, and the infrastructure as state-of-the-art. These clients reported no feasible alternative services to be available within Canada, and international sources had little appeal. The very high cost of constructing a foundry internally made this option completely unfeasible for the clients.

The CPFC thus allows the client firms to develop technologies that would be impossible otherwise. In addition, the very high quality of the facility and its products allows the client firms to successfully raise capital – about \$87 million to date – because the state-of-the-art nature of the facilities and implicit CPFC “seal of approval” are very impressive to potential investors.

Gross commercial benefits for the 12 organizations studied are roughly \$45 million in 2009, and are estimated to be cumulatively about \$500 million from 2009 – 2014. To this can be added production cost savings of at least \$2 million to date, with more likely in the future. The risk of these sales not being achieved is relatively small, as there are already about \$45 million in existing gross revenues. Profits are likely to be high for these high-tech ventures (probably in the order of 50%) but our data are slim here. These benefits can be compared to CPFC’s costs, which are typically about \$9 million annually from both public and private sources.

There may be opportunities to improve the timeliness of its services, investigate more creative commercial partnerships with its clients, and take more advantage of the implicit “seal of approval” the Centre gives its clients.

Overall, the CPFC appears to provide Canada with excellent value for money.

Appendix A

Case Study Interview Instrument

Interview Guide, Canadian Photonics Fabrication Centre Impact Review

The purpose of this study is to investigate the “downstream” impacts of the Canadian Photonics Fabrication Centre (CPFC) for its clients. We would like to discuss your involvement with CPFC, as well as what your organization *did* with the technologies that CPFC helped develop; e.g., were commercial products developed and sold?

All commercial information will be kept confidential, even from CPFC and the National Research Council. Sensitive data (e.g., sales revenues) will be aggregated in order to maintain confidentiality. The Consultants have signed Non Disclosure Agreements with the NRC.

Not all questions are relevant to your particular involvement with CPFC. Please feel free to let me know which ones are not relevant.

For further information, please call Sylvain Charbonneau of NRC at (613) 998-9414, or Frank Shepherd of CPFC at 613-949-1322.

Name:	
Organization:	
Telephone:	
E-mail:	
CPFC project:	

Background

1. Please describe your involvement in working with the CPFC. How did you become involved, what roles did you and the CPFC play, etc.
2. What alternatives did you consider, and why was the CPFC chosen?
3. What considerations were given to risk management (e.g., financial, or technological) during your involvement with CPFC?

CPFC Interaction

4. What were your short and long term goals in working with CPFC?

5. What services did CPFC provide? (This may include services other than fabrication, for example consulting, technology assessment, assistance with general product development, commercialization strategy, IP issues, etc.)
6. What were the main activities carried out during the project(s), and who carried them out?

Outcomes

7. What commercial outcomes have resulted so far (or are likely to result in future) in the product or technology areas in which CPFC has done work for you? (This could include important intellectual property, and new commercial products or services that have been developed or are in active development.)

We do not need any proprietary details. However, please indicate if these data need to be kept confidential (even from NRC and CPFC).

- Are there any existing sales revenues from these products and/or services?
 - What sales revenues are anticipated in the future?
 - Over what time period?
 - Have there been any cost savings for your organization? (Cost savings can come at stages other than during prototyping; e.g., by utilizing best practices when manufacturing is eventually undertaken.)
8. Have there been any important *non-commercial* outcomes from your involvement with the CPFC? (For example, environmental, health.)
 9. Will there be benefits to the end-users (buyers) of the photonics technologies, components or systems that have been developed with CPFC involvement? Can these be estimated in dollar terms?
 10. Have there been any indirect benefits from CPFC involvement? (This might include improvements to your in-house R&D capability or know-how, access to highly-skilled new hires, development of competitive market intelligence, ability to exploit world-wide research findings, improved problem-solving abilities, access to enabling technologies, etc.)
 11. If CPFC had not been available what would you have done instead?
 12. What would have been the implications of this in terms of timing, sales, costs, etc.?

Investment

13. What additional investments (if any) have been made or may be planned as a result of your involvement with the CPFC? (This could be from your own organization, or by outside interests.)
14. Has your involvement with the CPFC influenced the ability to raise additional funding?

Highly Qualified Personnel (HQP)

15. What involvement did your organization's students, postdocs, and other HQP (including existing staff) have with the CPFC during the scope of this work?
16. Was this involvement useful to your organisation, and in what way?
17. Did you hire any HQP as a direct result of this interaction with the CPFC? Do you plan to hire more of these HQP in future?
18. What factors have helped or hindered this interaction with the CPFC?

Other

19. Any other comments on CPFC?