

Summative Evaluation of the Industrial Research Chairs Program

Final Report

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NSERC

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December 10, 2006



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Executive Summary

Introduction and Background

The purpose of the Summative Evaluation is to assess the Industrial Research Chairs program in terms of relevance, impacts and cost-effectiveness. Impacts are delineated in terms of Chairholder research capacity, impacts on industrial partner organizations and universities, and impacts on the training and employment of highly qualified personnel (HQP).

The IRC program is part of a cluster of programs belonging to the Building Critical Mass stream of programs in NSERC's Research Partnerships Program (RPP). In order to address gaps in major research capacity in areas of interest to industry, the IRC program provides significant, long-term funding to foster collaboration between university researchers and industrial partners.

The objectives of the Industrial Research Chairs program are as follows:

- to assist universities in building on existing strengths to achieve the critical mass required for a major research endeavour in science and engineering of interest to industry; or
- to assist the development of research efforts in fields that have not yet been developed in Canadian universities but for which there is an important industrial need.

Methodology

Multiple lines of evidence, both quantitative and qualitative, were employed to gain adequate depth and breadth of information with respect to relevance, impacts, and cost-effectiveness, as well as design and delivery issues.

The methodology consisted of the following data collection activities:

- Document review;
- File Review: Random sample of all IRC files (n=55);



- Key Informant Interviews with NSERC and Committee representatives, University representatives (Vice-Presidents of Research), unsuccessful Chairholder and partner candidates, and experts (n=38);
- Mini Case Studies (based on interviews with Chairholder, partner representative, file review) (n=20);
- In-depth Case Studies (based on interviews with Chairholder, partner representatives, university representatives and HQP, file review) (n=10); and
- Online surveys with Chairholders (n=120), University Representatives (n=25) and Partner Representatives (n=151).

Summary of Findings

Relevance

The program is viewed as highly congruent with both government-wide and NSERC priorities. According to key informants, the IRC program is aligned with government priorities relating to innovation and support for a knowledge based economy. With respect to NSERC priorities, the IRC program is considered to align with investing in people and innovation. This alignment is achieved with the program's aim to build a critical mass of Canadian university expertise in industrially relevant areas, and foster long-term partnerships with industry. By encouraging the productive use of research, the IRC program supports knowledge and technology transfer to Canadian industry.

The IRC program is viewed as a highly relevant program. The IRC program was generally regarded as an important model for strengthening linkages between universities and industry by encouraging universities to conduct industrially relevant research and by providing industry with access to expertise and high quality research. Salary support, shared costs, and the long-term funding commitment were generally considered critical and desirable features of the program.

Stakeholder respondents generally viewed the IRC program as distinct from other university research funding programs such as NSERC's Collaborative Research and Development (CRD) grant program and the Canada Research Chairs (CRC) program. In comparison to the CRD program, the IRC program was perceived to be a better vehicle for focussing on a program of research. It was generally held that the IRC program objectives could not be achieved through the CRC program. The holding of



joint IRCs / CRCs was primarily regarded as advantageous. However, concerns were raised that the Canada Research Chairs program could potentially overshadow the IRC program in terms of visibility.

The program is important from a number of vantage points. Chairholders particularly valued the longer-term financial commitment and the prestige associated with the Chair. Universities typically valued the program's salary support feature and viewed the Program as an effective means to retain or recruit high calibre researchers to focus on a key industrially relevant research area.

From an industrial perspective, the program was highly valued for its long-term funding commitment, close relationship with the Chairholder, shared costs and increased access to specialized research expertise, particularly with respect to access to early stage research or research involving more speculative technologies which tend to involve a greater amount of risk on the part of the investor.

A few partner and Chairholder case study respondents expressed the view that the appropriate role of universities is to conduct early stage research while industries conduct research in the intermediate or commercialization stages. However, some case studies highlighted the benefits derived from IRC involvement in both early stage research and more applied research projects. In these instances industrial partner participation in early stage research helped to facilitate technological development. Moreover, the Chair's fundamental research efforts also benefited from exposure to the industrial context and more applied research projects.

Design and Delivery

Level of Satisfaction and Delivery Challenges

All stakeholder groups were highly satisfied with the program and with most dimensions of the program. While not pervasive, administrative and infrastructure inadequacies for their IRC research programs were the most commonly reported challenges and in some cases impeded the Chair's research capacity and progress. From the university perspective, meeting costs associated with the Chair was difficult and was heightened with subsequent IRC renewals where salary support from NSERC is provided on a declining scale. Some universities experienced difficulties securing



resources for salary replacement within the five year time frame. Finding funding within the partner organization to sponsor the Chair program was the most commonly reported challenge by industrial partners.

The time frame for the application and approval process (between 1 and 2 years) was not a major source of dissatisfaction for either industrial partners or Chairholder survey respondents. Unsuccessful candidate key informants noted, however, that a pre-screening process would help to minimize unnecessary investments of time and resources. Additionally, more than one third of applicants are not approved for IRC funding.

Collaborations between Industrial Partners and the Chair

According to the survey results and case study evidence, the majority of IRC partnerships arose from existing collaborations between the Chairholder and the industrial partner. Involvement in the IRC tended to be initiated by either the Chairholder candidate or the university.

The majority of industrial partners have regular and direct involvement with the Chair. Primary partners reported somewhat higher levels of interaction with the Chair as compared to secondary partners. The majority of partner survey respondents reported that they regularly discuss research findings with the research team (72 percent). Sixty-one (61) percent of partner respondents indicated that they have provided direction for the research process. Only 8 percent of industrial partner respondents reported that they are not involved in the IRC apart from the financial contribution.

Impacts

Creation/Strengthening of Partnerships

The IRC program plays a strong role in strengthening existing partnerships and in creating new partnerships between industrial partners and universities. Sixty-seven (67) percent of industrial partner respondents reported that the existing partnerships with universities have been strengthened as a result of the IRC. Forty-two (42) percent of all partner respondents reported that their organization had formed new



partnerships with university researchers and 31 percent reported that they had formed new partnerships with other organizations as a result of the IRC.

Partnerships between Chairholders and industrial partners are strengthened through the IRC. Survey evidence indicated that most current Chairholders and partners intend to maintain their collaboration with each other upon completion of the IRC term (primarily through an anticipated renewal of the Chair), and that former Chairholders and industrial partners tend to continue collaborations through a number of mechanisms (e.g. another NSERC program; contract research; and formal /informal network) after the completion of the Chair.

The Program was considered to increase collaborations within and outside the Chairholder's university. Sixty-nine (69) percent of Chairholder respondents reported that the Program had strong to moderate impacts with respect to enhancing collaborations within their university. Eighty-five (85) percent of Chairholder respondents reported moderate to strong impacts with respect to increased collaborations outside the university.

Impacts on Chairholder Research/Research Capacity

All lines of evidence supported the assertion that the Chair program contributed substantially to the Chairholder's research capacity in terms of increased size of research team, increased ability to attract more qualified personnel, enhanced reputation within the research community, and increased visibility of the research program with industry in general. Reported impacts with respect to reduced administrative load and enhanced laboratory space were milder.

There was a strong consensus that research was strongly impacted by the IRC program in terms of increased productivity, and in terms of an expansion of the research scope.

According to case study evidence, collaborations with industry also benefit the Chair and its research in the following ways: by helping to keep informed of industrial needs and context; by helping to identify fundamental, long-term research objectives; by providing data for future research and development; by providing a "testing-ground" for tools and knowledge; and by providing feedback on the results of the research.



Industrial Partner Impacts

With respect to partner impacts, the majority of partner respondents reported the strongest impacts with respect to increased access to specialized expertise and research results. These impacts are consistent with the partners' expectations of the IRC program. Ongoing access to the Chairholder's expertise was considered to benefit the partner organizations by facilitating the transfer of knowledge/technology with respect to cutting edge research, and potential new processes, products and methodologies for exploring research problems. Moreover, the Chair, through its network of collaborations, provides the partner organization with access to expertise beyond the Chair. According to survey evidence, about half of the partner organizations experienced moderate to strong impacts with respect to increased R&D capacity.

Survey evidence shows that IRC research is being used by industry, most commonly to improve or develop processes and products. Additionally, other receptor organizations typically use research results. A comparison of earlier and more recent Chairs revealed that, with the exception of prototype or pilot development, a greater percentage of the earlier Chairs showed evidence of transfer of knowledge/technology (e.g. increases in the number of patents issued, numbers of technologies licensed, and improved and new processes and products), indicating that commercialization of results is being realized over time.

Overall, partner organizations experienced milder impacts with respect to a number of dimensions relevant to financial impacts such as improved revenues or cost reductions of the partner organization. According to partner survey evidence, the IRC program contributed considerably to the improved competitive position of partner organizations in 44 percent of reported IRC cases. For about one-third of the reported cases, the IRC program contributed substantially to increased market opportunities, improved productivity, and increased market opportunities of partner organizations. In about 20 percent of the reported cases, the IRC contributed substantially to the creation of new jobs; increased speed of supplying and/or delivering of goods; and increased cost-reductions. In just under 15 percent of the cases, the IRC contributed considerably to increased revenue and increased profitability. Additionally, the IRC program contributes, to some extent, to the realization of outcomes pertinent to



environmental and social issues.

Secondary partners experienced stronger financial impacts as compared to primary partners on a number of dimensions including increased speed of supplying and/or delivering goods; increased market opportunities; improved productivity; and increased revenues. These variations may be attributable to the different profile of primary and secondary partner respondents. The principal market of secondary partner respondents was more likely to be local and less likely to be international.

University Level Impacts

The IRC program was reported to contribute significantly to the achievement of critical mass and helped to bridge gaps in existing programs or developed niche areas (e.g. automotive sector, environmental science, construction engineering and management). The building of critical mass in industrially relevant areas was linked to a number of the program's features and benefits such as its leveraging effect, its effectiveness as a tool to recruit and retain faculty (through salary support and increased prestige), and its ability to attract HQP.

The salary support feature was considered to be particularly important in building critical mass, in that it enabled the university to attract external expertise and in the case of Chairholders selected from within the university, use the freed up salary funds for replacement faculty members in complementary areas of research. Just under half of the current active Chairs are external candidates; a good indication that the IRC program plays a substantial role in helping create critical mass in new research areas for those universities.

The recruitment of replacement faculty typically results in increased teaching and research capacity at the university. The impact of the replacement faculty on the Chair's research area is less clear as varying degrees of integration with the Chair's program of research were reported, with some replacement faculty members more peripherally involved than others in the Chair's research.

HQP Impacts

According to survey evidence, most HQP interact with industrial partners. The most common types of interactions between HQP and partners are the presentation of



research results and the discussion of research projects. The interactions were considered to provide training enhancements by improving knowledge of the industrial context and by developing an understanding of how research results are transferred to industry. About one-third of industrial partner respondents indicated that they have hired HQP. Survey results indicated that more than two-thirds of HQP who obtain employment are employed by industrial partners and industry upon completion of their involvement with the IRC. However, it is not clear from the evidence as to the extent of HQP that are employed with Canadian industry.

Cost-effectiveness

Overall, the Chair model was viewed as the most cost effective means to assist universities in building critical mass in industrially relevant areas. NSERC, Committee and expert key informants cited the Program's leveraging effect and the substantial cash and in kind contributions by the private sector as evidence of its cost-effectiveness.

The IRC program leverages industrial partner funds that contribute both to the costs of research and to the Chairholder's salary. Total NSERC contributions from 2000/2001 to 2005/2006 amounted to approximately \$72M. Private sector and other part cash contributions totalled approximately \$107M. Private sector and other partner in-kind contributions totalled \$36M for that same time period. Hence, the IRC program leverages 2 private and public sector dollars (including cash and in-kind contributions) to every 1 dollar it funds/provides (i.e., at a ratio of about 2 to 1). The Chair was reported to be a more effective model, as compared to other funding mechanisms such as the CRD and the CRC programs, in generating leveraging momentum.

Conclusions

Relevance

Concerning relevance, this evaluation set out to determine the extent to which the IRC program continues to be consistent with the federal government's and NSERC's priorities, and whether or not the program addresses the needs and priorities of both



industry and universities – the key partners in a successful Industrial Research Chair. The evidence gathered throughout this evaluation, and summarized above demonstrates that NSERC’s IRC program is highly relevant.

The thrusts in Canada’s Innovation Strategy to leverage the commercialization potential of publicly funded academic research, and to support the forging of partnerships between universities and the private sector to achieve commercialization, are both clearly being targeted through the IRC program. With the long term partnerships that are formed through many Chairs, industrially relevant research is carried out within the university sector, while private industry benefits from having access to this research – providing both input and receiving the benefits of transferred research results.

Within NSERC’s suite of Research Partnerships Programs, the IRC is clearly distinct and does not have unnecessary overlap with other programs. As pointed out above, the NSERC CRD program (which is most often cited as the program closest in design to that of the IRC) is better designed for carrying out an industrially relevant research project, while the IRC is best suited for tackling a longer term and wider-scope *program* of research. Arguably the closest program to the IRC is the Canada Research Chairs, which also provides salary support and assists universities in funding new or established professors. While superficially they may both appear to be similar, an analysis of each demonstrates them to be distinctive from one another, with the IRC program being uniquely focused on industrial research. Unfortunately, it appears that the CRC program overshadows the IRC program in terms of visibility and consequently prestige; a recommendation is put forth below to address this issue.

While not a panacea to university and industry alike, it can be concluded that the Industrial Research Chair program is one important method of addressing the complementary needs and priorities of the two sectors. From the university perspective, the Chair model forms an appropriate means to build linkages with industry and engage in needed industrially relevant research. Moreover, considering the salary support provided by the program, universities are furnished with a means to build critical mass in these industrially relevant domains. These benefits flow fittingly from the main objectives of the IRC program.

The activities and partnerships that result from the IRC program also meet industrial



needs, in particular facilitating access to research conducted at an earlier stage than that which is typically done within the commercial sector. The cost sharing in the program that is borne by NSERC, the university, and the private sector company helps to ensure that risk on the part of the partner is significantly mitigated, thus stimulating industry involvement in, and benefit from, university-led research.

As was mentioned in the methodology section, one limitation of this evaluation, and thus upon the conclusions that can be drawn, is the evaluation's focus on only those industrial partners who *already* subscribe to the program. This approach does not address the extent to which the program is relevant and can meet the needs of *other* potential industrial partners. Therefore, a more thorough assessment of relevance would require an environmental scan or further consultation with non-participating industrial organizations and universities.

Design and Delivery

In order for any program to achieve desirable levels of relevance, impact, and cost effectiveness, its design and delivery must be appropriate. This evaluation has been able to bring forth the conclusion that, in fact, the design and delivery aspects of the IRC program are very strong. As stated above, all stakeholder groups are highly satisfied with the program, and with most dimensions of its design and delivery. Nonetheless, despite this, several of the recommendations put forward below in section 5.0, relate to the delivery of the program.

The most cited and most apparent deficiencies in the program's design relate to a need for administrative and infrastructure support for the Chairs – deficiencies that can have a direct impact on the quality and pace of research outcomes. Not surprisingly, administrative problems were most prevalent under somewhat predictable circumstances, such as when and IRC has numerous partners, collaborators, and a large research team. Furthermore, infrastructure difficulties are most likely within smaller institutions, or those under financial constraint. It is these findings that lead to the recommendation, described below, to consider a special funding mechanism to provide administrative and capital support under specific circumstances.

The salary support provided to support the Chairholder is obviously one of the



strongest elements in the design of the IRC program, and forms one of the prime advantages for the universities' participation. Nonetheless, for some universities, because of the diminishing salary support during subsequent IRC terms, the five year time frame during which full support is furnished is insufficient to secure sustained and adequate funding to take over responsibility for the Chairholder's salary. As such, the recommendation of extending full salary support for an additional two years, for those institutions with demonstrated need, is provided in further detail in the Recommendation Section.

Relating to design and delivery, the largest difficulty that has been observed to be experienced by the industrial partners is finding the funding within their own organizations. This challenge relates to factors external to the program's design and therefore addressing this issue may be more the role of industry or other programs aimed directly at helping Canadian industry build R&D capacity. The extent to which insufficient funding creates a barrier to industry participation in the IRC program should be further assessed in an environmental scan that includes consultation with non-participating industrial organizations.

The IRC program has a success rate of 62%, perhaps a relatively low number considering the investment of time and resources required to participate in what is a rather in-depth application process. Given the success rate, a more formalized pre-screening process would minimize unnecessary investments of time and resources for applicant, partner and Chairholder candidates.

Finally, the collaboration between industrial partners and Chairs is appropriate. The nature of the collaboration is somewhat dependent on the type of research conducted, the relationship between the Chairholder and the industrial partner prior to the formation of the IRC, and partner and Chairholder experiences with respect to industry and university contexts. Overall, these relationships have characteristics of being direct, transparent and ongoing.

Impacts

When considering the impacts of the IRC program, this evaluation was designed to determine the extent to which the program has been successful in meeting its program objectives and its intended reach. At this point it is worthwhile to review these



objectives: to assist universities in building on existing strengths to achieve the critical mass required for a major research endeavour in science and engineering of interest to industry; and/or to assist in the development of research efforts in fields that have not yet been developed in Canadian universities but for which there is an important industrial need.

It should be pointed out that, in general, the impacts achieved by the IRC program are stronger with respect to more immediate outcomes, and are moderate or milder where longer time horizons are necessary to achieve results. This is not surprising considering the evaluation's focus on more recent Chairs.

The results of the evaluation demonstrate that the IRC program is having significant impact in terms of meeting its objectives – as well as in areas beyond these precise bounds. The program directly contributes to building critical mass in universities in research areas relevant to industry, especially through the design element of salary support, which leads directly to the creation of new positions. Furthermore, taking into account that almost half of the current IRCs have been formed with external candidates, and that a substantial portion of these candidates come from outside Canadian academia, demonstrates the incremental impact the program is having.

The IRC program also has a strong impact with respect to building the research capacity of the Chairholder. The increased research capacity facilitated by the IRC program, coupled with an enhanced focus on a *program* of research contributes to increased research productivity and a broadening of research scope. Moreover, the distinct, longer term features of the IRC program encourage not only industrial partnership with universities, but also engagement in fundamental or more speculative research.

Related to the development of research capacity, the IRC program plays a strong role in strengthening existing partnerships between Chairholders/universities and industrial partners. The program also has a strong impact with respect to increased Chairholder research collaborations outside the university, along with a more moderate impact on increased collaborations within the university. Furthermore, with respect to partnering, IRC Chairs moderately contribute to the creation of new partnerships between universities and industrial partners, as well as between other organizations and industrial partners.



In terms of the impact of the program on the industrial partners, most generally, they benefit from increased access to specialized expertise. This increased access contributes substantially to building the R&D capacity of partner organizations and to the transfer of knowledge/technology to industry. With the formation and existence of an IRC Chair, many conditions exist for the transfer of knowledge and technology to industry. Direct and regular interactions between industry and the Chair do, for the most part, take place. HQP involved in the Chairs typically interact with industry and in many cases are eventually employed by industry. The knowledge from an IRC that is transferred is typically used to improve or develop processes and products. Moreover, research results are frequently used by organizations other than the specific industrial partners.

Not surprisingly, the extent to which IRC research is transferred to partner organizations and to other receptor organizations, generally increases over time. However, it should be noted that the extent to which an individual Chair is involved in knowledge and technology dissemination activities varies considerably. It is not clear whether Chairholders have the appropriate resources and capacity to perform necessary dissemination activities or whether other mechanisms for knowledge and technology transfer are needed.

For a small portion of partner organizations, involvement in an IRC has had a substantial impact with respect to the enhancement of commercial and financial outcomes. Given the evaluation's focus on recent Chairs and the evidence for achievement of more immediate outcomes, the IRC program likely results in more extensive economic and commercial impacts for partner organizations over longer timeframes. Secondary partners, as opposed to primary partners, are more likely to realize stronger commercial impacts as a result of the IRC program. This result is likely due to the different profiles of secondary partners: their principal markets are more likely to be local and less likely to be international – and therefore impacts may be more likely to be immediate. Although not one of the intended outcomes of the IRC program, the program contributes, to some extent, to the realization of outcomes pertinent to environmental and social issues, benefiting Canadians. However, current performance reporting does not fully track environmental and social outcomes



derived from the IRC program¹.

Finally, in terms of the impact on the development of HQP, the IRC program augments the training of HQP by providing them with access to a broader range of collaborators and partners, and by enhancing the HQPs' understanding of how technology and knowledge are transferred to industry. The incremental impact of the IRC program on HQP employment is less clear, except in those cases where the IRC has contributed significantly to the development of curriculum in niche areas where there is high industry demand. While a substantial portion of HQP are employed by industry immediately following their IRC involvement, the extent to which HQP are employed by Canadian industry is not known.

Cost-effectiveness

As stated in the methodology section, the analysis of cost effectiveness that has been carried out for this evaluation is limited to the leveraging aspect of the IRC program, and the perspective of stakeholders as to whether the IRC objectives can be achieved more cost-effectively through other alternatives. Nonetheless, the evaluation has yielded varied evidence that the Chair model is a cost effective means to assist universities in building critical mass in industrially relevant areas. Moreover, the objectives of the IRC program could not be achieved to the same extent through other funding mechanisms such as the CRD or CRC programs.

A key advantage of the IRC program's design is that it leverages private sector funds that contribute both to the costs of research and to the Chairholder's salary. Moreover, the long term funding commitment, flexibility, and prestige associated with the IRC contribute to the enhanced leveraging effect of the program. Finally, the IRC differentiates itself from the CRC program by focusing on industry-university partnerships, enhancing its visibility within the private sector.

Recommendations

Overall the evaluation provided strong evidence that the program meets overall expectations and needs of universities, researchers and industrial partners. Moreover,

¹ While the final report tracks contributions to policy or regulations, the progress report does not track indicators relevant to environmental and social outcomes



there is reasonable and varied evidence to support the fact that many of the impacts, particularly with respect to enhanced research capacity and building of critical mass in industrially relevant areas, can be attributed to the unique design elements of the IRC program. While no pervasive challenges were found, there were some aspects of the program that merit further assessment and modifications. The following recommendations address some of the key issues identified in the findings and conclusions.

1. Identify and implement additional efforts to further augment the visibility and prestige of the IRC program. The prestige and visibility associated with the IRC is of value to researchers and is viewed as an important factor in leveraging additional funding. The Canada Research Chairs program has the potential to overshadow the IRC program in terms of visibility and prestige, and thus there is a risk that this could negatively impact on the IRC program. Therefore, it is important to ensure that the visibility of the IRC program is maintained or enhanced. Efforts to enhance visibility could be targeted towards researchers, industrial partners, and industry in general. Additional efforts to recognize the endeavours of the Chair are worth further consideration. Increased awareness of IRC benefits to industry would enhance the industrial partners' level of commitment and support for the Chair. The prestige of the IRC could be further enhanced through more formal gatherings or events to recognize the Chairs' achievements.

2. Consult with non-participating universities and industrial organizations to assess opportunities and challenges with respect to IRC involvement. One limitation of this evaluation is its focus on those partners who subscribed to the program. Some universities may face more challenges in establishing and supporting a Chair. Additionally, there may be potential industrial partners that face barriers that could be addressed through adjustments to the program or improved marketing and outreach. Therefore, to better assess possible barriers and challenges to participation in the program, consultation with non-participating universities and industrial organizations is recommended. Specifically, NSERC could also assess whether smaller companies, or companies involved in emerging technologies or in more vulnerable sectors would benefit from the IRC program or whether other funding mechanisms can best address their needs. The evaluation found that finding funding within the partner organization to sponsor the Chair was challenging for many industrial partner organizations. Therefore, the environmental scan should also assess

the extent to which finding funding within the partner organization is a barrier to participation in the IRC program as well as possible strategies to address this challenge.

3. Consider making available a special funding mechanism, linked to the IRC program, to provide for administrative and capital costs of research in specific circumstances. The evaluation showed that in certain circumstances, administrative and infrastructure support was inadequate. A special fund could be made available for those IRCs demonstrating the need for additional administrative or infrastructure support. Application for additional funding would be made at the same time as application for the Chair or application for renewal. The applicant would have to clearly demonstrate the special circumstances that necessitate additional funding. Additionally, to help address administrative challenges faced by some Chairholders, NSERC should also consider the development and dissemination of best practice information to Chairholders with respect to the management and administration of IRCs.

4. In the case of second term renewals, NSERC should consider providing full salary support for the first two years with salary support provided on a declining scale the remaining three years of the renewal, for those universities who can adequately demonstrate need. The evaluation showed that the five-year time frame is insufficient for some universities to find adequate resources for salary replacement. Full support for salary during the first two years of renewal would engender more university support for IRC renewals.

5. NSERC should consider adopting a two-step application process. The application and approval process necessitates a considerable investment of time and resources. A more formalized pre-screening process would help to reduce unnecessary investment of time and resources for those IRC applicants not likely to be successful in the competition. A two-stage proposal process would be one option to address this challenge. The first stage would involve a précis proposal. A full proposal submission would be accepted only upon pre-approval of the précis. Pre-approval by all three parties (University/ Industry/ ACUIG) of the Chair and Chairholder candidate would be required. The industrial partner candidate(s) should be identified in the précis.



6. Modify performance reporting tools to ensure that environmental and social outcomes of the IRC program are adequately monitored. Although not directly part of the IRC mandate, the IRC program contributes, to some extent, to the realization of outcomes pertinent to environmental and social issues. However, current performance reporting does not fully track environmental and social outcomes derived from the IRC program. By improving tracking of these outcomes, data collected over time, could provide some guidance as to whether environmental and social results should be more clearly articulated in the program logic.





1.0 Introduction

This evaluation report presents the methodology, findings and conclusions with respect to the Summative Evaluation of the Industrial Research Chair (IRC) program. This section provides background information on the IRC program. The next section (2) outlines the methodology and approach used in this evaluation. Section 3 presents the key evaluation findings with respect to relevance, design and delivery, impacts and cost-effectiveness issues. Section 4 outlines the summary and key conclusions of the evaluation.

1.1 Background

1.1.1 NSERC

The overall strategic outcome for NSERC is “to provide Canadians with economic and social benefits arising from the provision of a highly skilled workforce, knowledge transfer of Canadian discoveries in the natural sciences and engineering from universities and colleges to other sectors, and informed access to research results from around the world.”² NSERC is structured along three program-delivery divisions. Within these divisions administrative staff are organized according to discipline, sector, and/or program.

1.1.2 Research Partnerships Program

The Research Partnerships Program (RPP), one of the two program directorates, builds on NSERC’s principal role: supporting research and training. Its programs create linkages between university researchers and the public and private sectors. The RPP directorate achieves its objectives by supporting research through a variety of programs. These may be grouped into three categories:

- i. ***Innovation Projects***: Strategic Projects, Strategic (renamed recently) Networks, Collaborative Research and Development Grants, Research Partnership Grants
- ii. ***Building Critical Mass Programs***: Industrial Research Chairs, Chairs in Design

² NSERC Report on Programs and Priorities 2004-2005



Engineering, Chairs for Women in Science and Engineering

iii. *Technology Transfer: Idea to Innovation, Intellectual Property Mobilisation*³.

The main objective of the RPP is," to foster interactions and partnerships between university researchers and the user sectors in order to generate new knowledge and develop new expertise, and to transfer this knowledge and expertise to Canadian-based organizations."⁴

1.1.3 Industrial Research Chairs Program

The IRC program is part of a cluster of programs belonging to the Building Critical Mass stream of programs in RPP. The IRC program was created in 1983. The first Industrial Research Chair was the NSERC/New Brunswick Power Industrial Research Chair in Nuclear Engineering. Since the beginning of the program, more than 300 Industrial Research Chairs have been established⁵. In order to address gaps in major research capacity in areas of interest to industry, the IRC program provides significant, long-term funding to foster collaboration between university researchers and industrial partners. A previous evaluation of all RPP programs found that the IRCs have the unique characteristic of fostering collaborations between university scientists and industry on an “on-going basis for a number of years”⁶. The IRC program, therefore, encourages the establishment of a long-term partnership between university researchers and industry representatives. Moreover, the collaboration is designed to address specific industrial needs and problems identified by industrial partners.

1.1.3.1 Program Objectives & Strategic Relevance

The objectives of the Industrial Research Chairs program are:

- to assist universities in building on existing strengths to achieve the critical mass required for a major research endeavour in science and engineering of interest to industry; or

³ NSERC's Report on Plans and Priorities, 2004-05

⁴ NSERC's Report on Plans and Priorities, 2004-05

⁵ NSERC history, <http://www.nserc.ca/about/history.htm>

⁶ NSERC Research Partnerships Program Evaluation, 1991

- to assist the development of research efforts in fields that have not yet been developed in Canadian universities but for which there is an important industrial need.

The IRC program aligns directly with the Federal Government's priorities to foster innovation, as announced in the Innovation Strategy in 2002. The IRC program furthers NSERC's strategic outcome by encouraging the creation of partnerships between universities and industry to create / improve and transfer new knowledge and technologies. The IRC program also supports NSERC priorities relating to investing in people, knowledge and opportunity. Specifically, the IRC program supports investing in people by helping universities to "build the critical mass of expertise and long-term relationships with corporate partners in areas of research that are important to industry"⁷.

1.1.3.2 Funding Arrangements

The IRC grant in its first five year term provides funding for the salary of the Chairholders and the direct costs of the research program (e.g., equipment, student and postdoctoral fellowship stipends, salaries of technical staff, materials and supplies, and/or conference travel) to assist universities in building upon their expertise in areas of interest to industry.

In the second five year term of an Industrial Research Chair, salary support from NSERC is provided on a declining scale, on the expectation that the University will increase its salary commitment to the Chairholder(s). The maximum NSERC contribution to salary each year in the second term is 45 percent, 37.5 percent, 25 percent, 12.5 percent, and five percent, respectively, of the value of the Chairholder's salary at the beginning of the second term. The remainder of the NSERC grant is contributed to the research program. In subsequent five year terms, NSERC funds are only directed towards the research program of the Chairholder(s): the salary is expected to come from the University, or possibly from the industrial partner of the Chair.

1.1.3.3 Application Process

All new IRC proposals are reviewed by site visit. A committee of experts in the field of the proposed Chair is assembled by NSERC staff and meets at the University with

⁷ NSERC's Report on Plans and Priorities, 2004-05

the Chair candidate, University staff, and representatives from the partnering organization. The site visit committee's assessment is provided to NSERC in the form of a site visit report. The report serves as the basis of a recommendation for funding (or not funding) provided to NSERC's Advisory Committee on University-Industry Grants (ACUIG), which makes the final recommendation on whether the Chair should be awarded or not.

Renewal of an Industrial Research Chair for the second and each subsequent term is determined by peer review conducted in the last year of each five-year term. Only in the case of particularly complex or large proposals, is the review conducted by site visit. The evaluation is based on the 48-month progress report, a new detailed research proposal for the next term, a continued commitment from industry, and the support of the university. The ACUIG makes final funding recommendations only for those applications requesting \$150,000 or more per year from NSERC⁸.

1.1.3.4 IRC Program Features

Industrial Research Chairs in the natural sciences and engineering are funded by NSERC and industry. In addition to a financial contribution, industrial support must include a willingness and interest to exploit the research results arising from the Chair. The initial award is for five years but recent Council changes have made Industrial Research Chairs renewable term by term, indefinitely, according to Chairholder designation.⁹ For universities, the Industrial Research Chair must be in an area of high priority. Universities must commit to the establishment of an Industrial Research Chair that includes tenured or tenure-track researchers and sufficient laboratory or office space. Chairholders are typically given a lighter administrative burden and teaching load by their university to enable them to focus the maximum amount of time on their research and in the development of the research team into highly qualified personnel.

Salary support is an essential feature of the IRC program. Both NSERC and the industrial partner(s) provide salary support for the new position created by the IRC. Should the proposed candidate be currently on staff (an internal candidate), the university must agree to establish a replacement faculty position in the same area (or

⁸ IRC Website, http://www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=c1

⁹ Executive Chairs are for 1 term only, Associate Chairs may be held for 2 terms; either of these Chairs may be renewed as a Senior Chair.



complementary area) as the Chair with the freed-up salary funds. This feature serves as an important mechanism for assisting universities in attaining the critical mass required for a major research endeavour in an industrially relevant area.

The program, since it was conceived, has had a number of changes. Currently it maintains the following features¹⁰:

- The IRC program offers three types of Industrial Research Chairs:
 - **Senior Industrial Research Chairs** for distinguished senior researchers of international stature (five-year appointment, renewable)
 - **Associate Industrial Research Chairs** for promising, tenure-track, junior researchers, (five-year appointment, renewable once), and
 - **Executive Industrial Research Chairs** for outstanding, non-academic R&D professionals (five-year appointment, non-renewable)
- All awards are based on peer review;
- Jointly funded by NSERC and industry (minimum 50% contribution from industry);
- Program proposals are in an area of high priority for both industry and the university;
- Proposals are incremental to the university: either a new position is created to establish the Chair, or if a proposed Chair candidate is internal to the university, the university agrees to establish an additional “replacement” position in an area related to the field of the Chair;
- Chairholders typically carry a reduced administrative and teaching load to enable a greater focus on the conduct of his/ her research and to a smaller extent, the training of highly qualified personnel; and
- Concurrent awards are permissible- Chairholders may hold other awards such as a Canada Research Chair and other NSERC grants (e.g. Discovery Grants, Strategic Project Grants) during their term.

1.1.3.5 Governance

Within the Research Partnerships Program, there are a total of seventeen program officers, seventeen assistants, three directors, four members of the budget and planning team, and one vice president. These staff share the administration of the IRC

¹⁰ IRC Website http://www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=c1

program; although the IRC program has no exclusively dedicated staff, one program officer and his/her director have the lead responsibility for this program.

There are two NSERC Committees that provide program and policy advice for the IRC program. The Committee on Research Partnerships (CRP) recommends the distribution of funds to the various program elements within its purview, which includes the IRC program. The Committee¹¹ also:

- Provides advice on and monitoring of the RPP programs; and,
- Provides advice to Council on policy issues and possible mechanisms in support of research partnerships in Canadian universities.

The second committee involved with the administration of the IRC program is the Advisory Committee on University-Industry Grants (ACUIG). The ACUIG is a selection committee with approximately 14 members and is chaired by an NSERC staff member. Committee members are from academic, industrial, and government sectors. They assist in the assessment of applications and are responsible for making final funding recommendations. With co-approval from the appropriate Director and/or Vice President, the Corporate Secretary to Council appoints committee members.

1.1.3.6 Program Resources

Program Directors spend approximately 5 percent of their time on IRC activities while Program Officers and Assistants spend 15 percent of their time on IRC activities. It should be noted that there is no specified limit on IRC funding.

Tables 1 and 2 gives an overview of operations and resources of the IRC program from 2000-01 to 2005-06.

¹¹ The Terms of Reference for CRP are under revision

Table 1: IRC Operations

IRC Statistics	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	Total / Average
Number of IRC applications	19	17	26	30	16	29	137
Average value of new awards	\$133,355	\$161,082	\$139,367	\$161,811	\$170,313	\$134,368	\$150,049
Number of new awards (1st term IRCs)	9	15	11	19	19	10	83
Success rate (of files processed)	64.3%	75.0%	52.4%	59.4%	65.5%	55.6%	62.0%
Total number of awards	78	90	91	96	102	102	n/a

Table 2: IRC Resources

IRC Funding	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	Total
Total NSERC Contributions	\$7,323,556	\$9,516,465	\$9,774,136	\$13,915,019	\$15,415,152	\$16,341,558	\$72,285,886
Cash Contributions: Private Sector and Other Partners*	\$9,981,827	\$14,727,630	\$15,640,873	\$20,929,075	\$23,253,187	\$22,866,122	\$107,398,714
In-kind Contributions: Private Sector and Other Partners*	\$1,725,446	\$4,659,719	\$4,090,793	\$7,669,771	\$8,506,919	\$9,015,752	\$35,668,400
Total Cash & In-kind Contributions (NSERC and all partners)	\$19,030,829	\$28,903,814	\$29,505,802	\$42,513,865	\$47,175,258	\$48,223,432	\$215,353,000

*Only contributions from private sector partners are considered for matching by NSERC.

Other Partners, which include other government agencies and departments - federal, provincial, & local; universities; hospitals; societies; and associations; etc., often contribute to Chairs in both cash and in-kind services. However, these amounts are not considered for matching by NSERC.





2.0 Methodology and Approach

Multiple lines of evidence, both quantitative and qualitative, were employed to gain adequate depth and breadth of information not only with respect to impacts, but also with respect to process issues.

Attribution of outcomes, particularly as one moves towards longer term outcomes, is a challenging issue inherent to any evaluation. To adequately assess causation and incrementality, particularly in the case of a summative evaluation, comparative studies are the ideal. However, in the case of the IRC program, there are no appropriate comparison groups. It should be noted that if comparison groups are not sufficiently matched, and comparative analyses are undertaken, then there is the real risk of severely underestimating or overestimating the program's impacts.

During the design stage of the evaluation a number of university and industrial representatives were interviewed to acquire a sense of the key evaluation issues and to gain an understanding of the feasibility of different data collection methods and evaluation design options such as comparison groups. The participant groups in the IRC program have relatively unique characteristics that make selection of an adequate comparison group very challenging. These characteristics are outlined below:

- **Chairholders** –These researchers must be of extremely high calibre and have a research program that is highly relevant to industry. They must be comfortable and have the desire to work within industry networks outside of academic settings.
- **Industrial Partners** – Similar to the Chairholders, the industrial partners in the IRC program appear to be relatively unique and possess characteristics such as an openness to working with academic institutions, experience partnering with universities, and possess R&D functions that can collaborate with university settings. These specific characteristics combined with other more general characteristics of market share, market area, and financial viability make them a unique group.
- **Universities** – About 36 universities participate in the IRC program. The participating universities for the most part are in the medical/doctoral category, as well as some comprehensive institutions. This leaves very few, if any, similar



universities that do not already participate in the IRC program.

The evaluation design offers a number of advantages. These include:

- Good coverage of university, Chairholders and partner representatives (through surveys, key informant interviews, and case studies) allowing for depth and breadth of information with respect to Chairholder, university and partner level impacts;
- The inclusion of some non-recipients of IRC funding among the key informant groups (i.e. unsuccessful IRC Chairholder and industrial partner candidates as well as experts).
- Industrial partner perspectives are gathered through two key data collection methods: survey and case studies. While industrial partners potentially benefit from the IRC program, they also provide substantial investments. Their viewpoint is critical in providing a balanced overview of the impacts of the IRC program.

2.1 Evaluation Objectives

The main focus of this summative evaluation is to assess impacts and effects in the areas of Chairholder research capacity, training of highly qualified personnel (HQP), and impacts on university and industrial partner organizations. The evaluation issues are grouped according to three main categories:

- **Relevance:** the extent to which the IRC program continues to be consistent with the federal government's and NSERC's priorities, and addresses the needs and priorities of industry and universities;
- **Impacts:** the extent to which the IRC program has been successful in meeting its program objectives and intended reach; and
- **Cost-effectiveness:** the extent to which the IRC program's delivery structure is effective in achieving results.

In addition to these issues, design and delivery issues are also included to provide additional process information. The overall approach for the IRC evaluation has been designed to address these evaluation issues.



The methodology consists of the following:

- Document review
- File Review: Random sample of all IRC files (n=55)
- Key Informant Interviews (n=38)
- Mini Case Studies (n=20)
- In-depth Case Studies (n=10)
- Online surveys with Chairholders (n=120), University Representatives (n=25) and Partner Representatives (n=151).

2.2 Online Surveys

The frame for the survey of Chairholders was developed from NSERC's administrative database (NAMIS). NSERC extracted the relevant information for all Chairs that either had:

1. Application *status code* as “active” as of June 01, 2005; or,
2. Application *status code* as “closed” and an *award end date* after January 01, 2000.

The survey frame contained all currently active and recently completed Chairs. There were 173 NSERC IRC Chairs that met one of these two criteria. All Chairholders included in the survey frame were invited to participate in the survey (n=173). Of these, 120 responded to the survey (69%).

There were 490 NSERC IRC industrial partners identified with the Chairs that met one of the two criteria outline above. All industrial partners for which there were email addresses available were included in the survey frame and were invited to participate in the survey (n=379). Of these, 97 (26%) had invalid email addresses (“bounce-backs”), so were removed from the survey sample. Of the remaining sample (n=282), 151 responded to the survey (54%).

The survey of university representatives was comprised of Chair “applicants,” most often the Dean of the faculty that hosts the Chair. All applicants who were included in the survey frame were invited to participate in the survey (n=53). Twenty (25) applicants responded to the survey (47%).



Sampling Error Estimates

The following table illustrates the sampling error estimates of the three groups of survey respondents (Chairholders, Industrial partners and university representatives). Confidence intervals reported are measures based on (proportions of 0.10 and 0.50 at a 95% confidence level, and adjusted for finite populations. It should be noted that confidence intervals are even higher for subgroups (Senior vs. Associate Chairholders and Primary vs. Secondary partners). Therefore, only larger differences between these groups (more than 10 percent) are reported.

Table 3: Sampling Error Estimates

Sampling error estimates		
Group	N	Confidence Interval
Chairholders	120	+/- (3.0 to 5.0)
Industrial Partners	151	+/- (4.1 to 6.9)
University Representatives	25	+/- (8.6 to 14.4)

2.3 Case Studies

The case studies (n=30) were selected after reviewing survey and file data for evidence of strong impacts and delivery challenges. Suggestions from NSERC staff as to cases exemplifying best practices as well as lessons learned were also taken into account during the selection process.

The case studies were selected using the following criteria:

- A mix of regions and universities;
- A mix of examples that provide illustrations of both successful and less successful IRCs;
- A range of active, recently completed, and renewed Chairs; and
- Inclusion of examples of Executive Chairs, Stand-alone Associates, and Chairholders holding both CRCs and IRCs.

The two sources of data for the case studies were key informant interviews and file documentation. However, in some cases the files could not be retrieved. The in-depth case studies (n=10) involved interviews with Chairholders, an industrial partner



representative, a university representative and one HQP. The Chairholder and the industrial partner representative were the primary sources of information with respect to the mini case studies (n=20).

2.4 Key Informant Interviews

A total of 38 in depth, semi-structured interviews were conducted with the following groups of key informants:

- NSERC management and staff (n=4);
- Committee representatives (n=5);
- Experts (n=4);
- Unsuccessful Chair (Chairholder and industrial partner) candidates (n=9); and
- Vice Presidents of Research at universities (n=16).

Vice Presidents of Research were selected from a mix of regions and universities. The selected experts had extensive knowledge with respect to industry/university partnerships. Two of the four selected experts represented industry consortia involved in sponsoring numerous IRCs on behalf of specific sectors/industry (e.g. University Network of Excellence in Nuclear Engineering (UNENE) and Pulp and Paper Research Institute of Canada (PAPRICAN)).

2.5 File Review

Fifty-five (n=55) files were randomly selected from a frame containing **all** IRCs (completed and active Chairs). A stratified sampling technique was employed to ensure inclusion of files across different time frames. Difficulties were experienced in retrieving files, particularly archived files. Difficulties were also experienced in retrieving all file volumes. In those circumstances, the evaluation team drew additional IRC files from a randomized back up list. Therefore, the file review is randomized with replacements.

2.6 Evaluation Limitations

Lack of comparison group

Comparative design helps to address issues around causation and incrementality. For this evaluation, suitable comparison groups could not be identified (see comments in Section 2.0 Methodology and Approach). To address this limitation, a variety of methods and a variety of sources (e.g. experts, non-beneficiaries, industrial partners, university representatives, Chairholders and HQP) are utilized. Triangulation of information sources helps to ensure that reasons given for impacts properly reflect multiple sources. Moreover, detailed case studies can also be useful in identifying explanations and causal linkages with respect to the achievement of results¹².

Focus on more recent Chairs

The assessment of longer-term impacts is more challenging given that the survey frames of Chairholders and industrial partners included only recently completed and active Chairs. The reason for including only these more recent Chairs was that the evaluation team needed to have accurate contact information for the online survey (i.e., email addresses). Some of the anticipated impacts will likely only be observed a number of years after the IRC given the typically early-stage nature of the research. There is a time lag of perhaps 7 to 15 years where many IRC investments can be expected to have significant results only over longer time horizons. This potential limitation was addressed, in part, with the case studies. The inclusion of Chairs that were established prior to 1998 (n=14) helped to illuminate longer-term impacts for those IRCs. Moreover, evidence of immediate and intermediate outcomes achievements, lends support to an increased likelihood of the achievement of longer-term outcomes.

Quality of partner survey frame and response rate

The survey frame developed for the partner survey contained inaccurate contact information (missing or incorrect email address) for approximately one-half of partners who were potential participants in survey. While NSERC staff made efforts to locate this information, in many cases they were not able to find updated email addresses. This factor, combined with a 50 percent response rate, indicates that the data presented from the partner survey should not necessarily be considered

¹² Yin, R. K. (1984). Case study research: Design and methods. Newbury Park, CA: Sage.



representative of the partner population for the time period covered.

Lack of overlap between Chairholders and partners for surveys

The sample of Chairholders responding to the survey and the sample of partners responding to the survey were not well connected to the extent that the two samples did not have a lot of overlap when examining individual IRCs. Approximately 61 percent of the respondents to the Chairholder survey (73 out of 120) did not have a primary partner as identified by NSERC respond to the industrial partner survey. Approximately 21 percent of the primary partners who responded to the survey (14 out of 68) did not have a corresponding Chairholder who responded to the Chairholder survey. The impact of this lack of overlap is that the Chairs about which the Chairholders are referring to as a group are different from the Chairs to which the primary partners are referring. This makes it particularly challenging to compare the responses of partners and Chairholders directly.

Heterogeneity of partner group

It should also be noted that given the heterogeneity of the partner survey group (e.g. a mix of primary and secondary partners¹³), caution must be exercised when comparing Chairholder and partner survey responses. These groups of partners associated with the Chair may include both primary partners that tend to be more directly involved with the Chair and secondary partners that are more peripherally involved. Whereas all Chairholders are very involved, the partner group showed greater variability as to levels of involvement with the Chair, as illustrated by the higher levels of ‘don’t know’ responses on a number of survey items. Therefore, to facilitate better understanding of the involvement of primary vs. secondary partners in the Chair, primary and secondary partner survey responses were compared.

Limitations of Cost-Effectiveness Analysis

Cost-effectiveness refers to the extent to which a program achieved its planned outcomes in relation to resources expended. To do a comprehensive cost effectiveness study would require a rigorous analysis of the costs of achieving IRC outcomes and comparisons with other alternative approaches. It would, therefore, additionally require a full understanding of the costs and achievement of outcomes of alternative methods. The ability to conduct this type of comparative analysis of data

¹³ Many Chairs have more than one industrial partner

for the IRC program and other similar programs is limited by the lack of quantitative information as to specific costs associated with the achievement of outcomes and the existence of a program similar to the IRC program.

NSERC's Collaborative Research and Development (CRD) Grant program has some similarities to the IRC program (e.g. partnership between industry and universities, industry access to university expertise and knowledge). However, there are a number of differences between these programs that can make a comparative analysis problematic (e.g. CRD Grants support well-defined projects while an IRC typically supports a program of research; CRD grants do not provide salary support).

Recognizing these limitations, the cost-effectiveness analysis contained in this report, presents the perspectives of stakeholders as to whether the IRC program objectives could be achieved more cost-effectively through other alternatives, such as the CRD program. The cost-effectiveness section also presents evidence with respect to the leveraging aspect of the IRC program.

Focus on Industrial Partners who Subscribe to Program

Another limitation of this evaluation is its focus on only those partners who already subscribe to the program. This approach does not address the issue of the extent to which the program is relevant to, and can meet the needs of, other potential industrial partners.



3.0 Findings

3.1 Relevance

Section Summary:

There was overall agreement among key informants that there is a need to conduct industrially relevant research using a university Chair program. The Chair program was generally regarded as an important model for strengthening linkages between universities and industry by encouraging universities to conduct industrially relevant research and by providing industry with access to expertise and research results. Chairholders particularly valued the longer-term financial commitment and the prestige associated with the Chair. Industrial partners viewed access to research expertise and fundamental early stage research as key incentives for participating in an IRC. University representatives regarded the salary support feature as a valuable design element of the program as it facilitated the hiring or retention of researchers to focus on a key research area.

There was a strong consensus among all stakeholder groups that the IRC program was distinct from other university research funding programs such as NSERC's Collaborative Research and Development (CRD) grant program. In comparison to other research funding programs, the IRC program was cited as having a number of distinct advantages, particularly with respect to its longevity, shared/leveraged costs, increased access to researchers, enhanced focus on a **program** of research, flexibility to adapt and expand the scope of research, and the prestige associated with the Chair.

It was generally held that the IRC program objectives could not be achieved through the Canada Research Chairs (CRC) program. The holding of joint IRCs / CRCs was primarily regarded as advantageous. Advantages included the retention of top researchers at the university (and in Canada), and faster growth and expansion of a research program. Concerns were expressed by a minority of key informants that the holding of both types of Chairs constrained the Chairholder's capacity to perform research, and related duties. Additionally, it resulted in large amounts of funding being directed towards a small pool of researchers. Some key informants indicated that continued growth in the number of joint CRCs / IRCs could potentially overshadow the IRC program.

3.1.1 Congruency with Government-wide and NSERC Priorities

NSERC and committee key informants viewed the IRC program as highly congruent with both government-wide and NSERC priorities. According to key informants, the IRC program is aligned with government priorities relating to innovation and support for a knowledge based economy¹⁴. With respect to NSERC priorities, the IRC program is considered to align with investing in people and innovation. This alignment is achieved with the Program's aim to build a critical mass of Canadian university expertise in industrially relevant areas, and foster long-term partnerships with industry. By encouraging the productive use of research, the Program supports knowledge and technology transfer to Canadian industry.

3.1.2 Need for the IRC Program

The demand for the IRC program has been steady for the last 10 years. Generally, stakeholder key informants, including those stakeholders who did not benefit from IRC funding, expressed the view that there is a need to conduct industrially relevant research through Canadian universities, and a Chair program is a practical method to address this need. Overall, university and expert key informants considered the IRC program as an appropriate model to bridge the gap between universities and industry. The model benefits both the university and industry by encouraging the university to conduct industrially relevant research, and by providing industry with access to high quality research.

The linkages between universities and industry resulting from the model were viewed as necessary to prevent university research from becoming "too remote" from industry and economic needs. One expert key informant cautioned that while there is a need to foster these linkages, there is also a need to ensure that the university and industry maintain their distinct identities (i.e. universities preserve their neutral role in

¹⁴ The IRC program is aligned with Canada's Innovation Strategy. It is consistent with the priorities and targets outlined in two key federal government reports: *Knowledge Matters: Skills and Learning for Canadians* and *Achieving Excellence: Investing in People, Knowledge and Opportunity*. Within one of these priorities contained in these reports "addressing key challenges for the university research environment" the government expressed its commitment to leveraging the commercialization potential of publicly funded academic research and to provide internationally competitive research opportunities in Canada. Specifically the government expressed its commitment to support academic institutions in forging partnerships with the private sector to commercialize research results.

society by maintaining their autonomy and freedom to generate information). Similarly, a few partner and Chairholder case study respondents expressed the view that the appropriate role of universities is to conduct early stage research while industries conduct research in the intermediate or commercialization stages. However, some case studies highlighted the benefits derived from IRC involvement in both early stage research and more applied research projects. In these instances industrial partner participation in early stage research helped to facilitate technological development. Moreover, the Chair's fundamental research efforts also benefited from exposure to the industrial context and more applied research projects.

All university key informants viewed the Program as relevant to university needs and priorities. The IRC program was frequently cited to be an important mechanism for shifting or building resources within the university to a particular research area. For example, the IRC program was used to transition from a less relevant area of research (an area of research that was not aligned with the university's strategic plan) to a more strategic and active area of research. Moreover, through the collateral and additional funding generated by the IRC, the university can support more graduate students.

The Program's salary support component was generally held by university key informants to be an important aspect of the program. Salary support helped to alleviate the financial burden of hiring external candidates, and allowed the university to hire junior faculty members for complementary research areas in the case of internal candidates. As well, key informants indicated that the salary support also assisted in filling the teaching void that results from Chairholders' reduced teaching loads. Decreasing contributions for salary with renewal of IRC terms, however, were reported by a few university key informants to render the IRC as more comparable to a CRD and more challenging to sustain.

Industrial partners who responded to the survey viewed access to research expertise (86 percent) and fundamental early stage research (60 percent) as key incentives for participating in an IRC. As well, numerous case studies identified these two areas of particular value from the perspectives of industrial partners and highlighted the attractiveness of the Program's long term time frame and cost-sharing features particularly when investing in longer-term fundamental research or research involving



“riskier, more speculative technologies”. A number of case studies illustrated the importance of the Chair program in providing an enhanced focus on a program of fundamental research and more unfettered access to high quality research expertise.

3.1.3 Comparisons with Collaborative Research and Development Grant Program

All stakeholder groups viewed the IRC program as distinctive when compared with other research grant programs such as the CRD grant program. Key informants described CRDs as more project directed, with more specific deliverables. In contrast the IRC program was depicted as being less constrained, and there is more capacity and flexibility to evolve the research and the relationship between industry and the Chairholder. As well, with the IRC the focus tends to be on the development of a research *program*. Despite the key differences between the two programs, key informants generally viewed the CRD and IRC as complementary. For example, the CRD was frequently described as a means of testing the partnership between industry and the university researcher, prior to embarking on a longer-term commitment, such as that required under the IRC.

The IRC program was also viewed as being more advantageous than CRDs (and other research grants/contracts) in terms of its long-term time frame, shared/leveraged costs, and the prestige associated with the Chair. According to survey data, the majority of Chairholders (80 percent), partner (74 percent) and university respondents (n= 16 or 64 percent) cited the longer time frame as a key advantage in terms of the nature and scope of research problem. Chairholders saw the longer-term financial commitment (78 percent) and the prestige associated with the Chair (72 percent) as key advantages. The majority of industrial partner respondents considered shared costs (65 percent), a closer relationship with the Chairholder (65 percent) and increased access to suitable researchers (58 percent) as key advantages. From a university perspective, shared / leveraged costs (65 percent) and contributions to salary (70 percent) were considered advantageous. However, a few Chairholder key informants noted that where there is a poor fit between the industrial partner and the Chairholder expectations of the Chair, the IRC is perceived to be more comparable to a funded research project.



3.1.4 Comparisons with Canada Research Chair Program

The IRC program was regarded by key informants as distinct from the Canada Research Chair (CRC) program in that they have different objectives and selection mechanisms. The CRC is targeted specifically towards the universities' needs, whereas, IRCs are directed towards both industry and university. Most university key informants agreed that the IRC program objectives could not be achieved through the CRC program because the focus on industry was critical in helping to attract industrial partners and in conducting industrially relevant research. A few university key informants noted that CRCs might be more attractive to university researchers because they are viewed as more prestigious with less reporting burdens.

While many key informants considered joint IRCs / CRCs as primarily advantageous, a minority of key informants disagreed. Advantages mentioned include: retention of top researchers at the university and in Canada, added prestige (for both the Chairholder and the university) and faster growth and expansion of a research program. It was also noted that the issue is not of serious import given that there are so few joint Chairs in existence (i.e. 16). However, the continued growth in the number of joint CRCs / IRCs could potentially serve to overshadow the IRC program in terms of its visibility, according to some key informants. While this does not mean that joint CRCs / IRCs should be discouraged, efforts to maintain the visibility of the IRC program should be considered.

A few university key informants expressed concerns that joint IRCs / CRCs direct excessive resources to a small pool of researchers. Other key informants saw this as an effective use of resources that focused more funding on high quality researchers. Concerns were also expressed with respect to disproportionate demands on the Chairholder's workload, potentially impeding the Chairholder's capacity to conduct research and to continue with teaching efforts¹⁵. Additionally, some universities do not permit simultaneous holding of both types of Chairs (e.g., Trent University, UBC).

¹⁵ Some university representatives indicated that it was critical for the Chairholder to maintain some teaching responsibilities (even though teaching load is reduced). These respondents contended that holding both types of Chairs placed excessive demands on the Chairholder and potentially limited the Chairholder's capacity to teach.

3.2 Design and Delivery

Section Summary:

The majority of survey respondents across all three respondent groups were satisfied with most aspects of the program. In terms of overall satisfaction, most university representatives (96 percent), industrial partners (89 percent) and Chairholders (93 percent) reported that, overall, they were satisfied with the program. These findings were further corroborated with the results from the case studies and key informant interviews.

The majority of Chairholder survey respondents expressed high levels of satisfaction with various dimensions of the IRC program. Highest areas of Chairholder satisfaction were: the adequacy of NSERC and partner funding; NSERC support during the application process; and, the adequacy of funding for research program costs. More moderate levels of satisfaction were reported with respect to the level of university support, teaching load reductions, and laboratory space.

Partner survey respondents expressed the highest levels of satisfaction with respect to mechanisms for disseminating results from the university to the industrial partner, adequacy of NSERC funding, opportunities to provide input into the research process and research timeliness. Respondents to the survey of university representatives reported most satisfaction with respect to the duration of the Chair and obtaining funds from industry. More moderate levels of satisfaction were reported with respect to the timeliness of the decision to approve the Chair.

While no pervasive challenges were identified, various groups cited areas for improvement, or areas that had provided them specifically with challenges in establishing and implementing Chairs. From the university perspective, meeting the costs associated with the Chair was difficult and this difficulty was heightened with subsequent term renewals (i.e. decreasing contributions to salary with each IRC term). Just over one quarter of Chairholder respondents identified inadequate administrative support as a key challenge. Finding funding within the partner organization to sponsor the Chair program was the most commonly cited challenge (40 percent) reported by partner survey respondents.

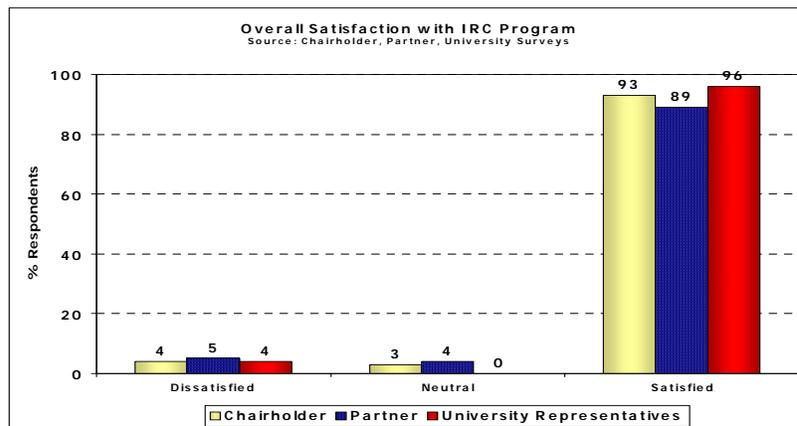
3.2.1 Satisfaction with the IRC Program

Satisfaction was assessed primarily through the surveys of Chairholders, industrial partners, and university representatives. Respondents were asked to indicate their level of satisfaction on various aspects of the program, including design and delivery components. As illustrated in the subsections below, the vast majority of respondents across all three respondent groups were satisfied with most aspects of the program. These findings were further corroborated with the results from the case studies and key informant interviews.

3.2.1.1 Overall satisfaction with the IRC Program

Respondents to the surveys expressed high levels of satisfaction overall with the IRC program. Most university representatives (96 percent, n=24), industrial partners (89 percent) and Chairholders (93 percent) reported that overall they were satisfied or very satisfied with the program (see *Figure 1*).

Figure 1: Overall Satisfaction with IRC Program



3.2.1.2 Partners' Satisfaction with the Chairholder

Most industrial partner respondents (89 percent) reported that they were satisfied with the specific Chairholder. When comparing primary and secondary partner responses, 83 percent of primary partners vs. 93 percent of secondary partners expressed overall satisfaction with the Chairholder. It is difficult to interpret this finding, as there were no differences as to primary and secondary partner satisfaction ratings with respect to various dimensions of the Program. Key informant and case study evidence yielded no specific references to help illuminate this variation.

3.2.1.3 *Chairholders' Satisfaction Levels with Specific Aspects of the Program*

Most survey respondents also expressed satisfaction with respect to specific aspects of the IRC program delivery. Highest areas of Chairholder satisfaction were:

- the adequacy of NSERC and partner funding (93 percent and 92 percent respectively);
- NSERC support during the application process (86 percent); and,
- the adequacy of funding for research program costs (85 percent).

In comparison, areas of lower satisfaction for Chairholders (between 65 and 68 percent indicating satisfied or very satisfied) included the level of university support, teaching load reductions, and laboratory space¹⁶.

3.2.1.4 *Industrial Partners' Satisfaction Levels with Specific Aspects of the Program*

Partner survey respondents expressed the highest satisfaction with respect to:

- mechanisms for disseminating results from the university to the industrial partner (85 percent);
- adequacy of NSERC funding (82 percent);
- opportunities to provide input into the research process (78 percent); and,
- research timeliness (78 percent).

There were no main sources of dissatisfaction indicated by partner respondents¹⁷.

3.2.1.5 *University Representatives' Satisfaction Levels with Specific Aspects of the Program*

Respondents to the survey of university representatives reported most satisfaction with respect to the duration of the Chair (96 percent, n=24), and obtaining funds from industry (91 percent, n=23). The area for which there was the lowest level of satisfaction included the timeliness of the decision to approve the Chair (65 percent satisfied, n=17).

¹⁶ Sixteen percent of Chairholders reported that they were dissatisfied with the laboratory space made available.

¹⁷ When the 'don't know' and 'not applicable' responses were factored out, there were no partner satisfaction levels below 70 percent. In addition only minimal levels of dissatisfaction were indicated. For example, 73 percent of respondents reported satisfaction with ownership of intellectual property when the "not applicable" and "don't know" responses were removed, indicating this was not a key source of dissatisfaction for partner respondents.

3.2.2 Delivery Challenges

The evaluation team identified delivery challenges through the surveys, case studies and key informant interviews. While overall there were no pervasive challenges identified, various respondent groups cited areas for improvement, or areas that had provided them specifically with challenges in selecting and implementing Chairs. These are described in the subsections below.

3.2.2.1 Administrative / Infrastructure Challenges

The inadequacy of administrative support for the Chairholder was reported by over one quarter of Chairholder survey respondents (29 percent). Moreover, meeting costs of the Chair, including administrative costs were reported as key challenges by university survey respondents¹⁸.

According to case study evidence, administrative challenges were heightened in circumstances where there were multiple industrial partners; where the Chair maintained a large laboratory and research team; where NSERC financial accounting requirements were substantially divergent from university accounting practices; and where the Chair was engaged in a large number of collaborations outside the university. Annual matching of budgeted vs. actual HQP expenditures was difficult as it was challenging to precisely estimate, within a yearly timeframe, the number of HQP that participate in the Chair¹⁹. Survey results show that Senior Chairholders as compared to Associates were somewhat more likely to cite inadequate administrative support as a key challenge (32 percent vs. 23 percent).

Inadequate laboratory space and delays in securing laboratory space were cited as two more common areas of dissatisfaction for Chairholders. It was reported by a few key informants that some universities face additional pressures in obtaining appropriate laboratory space given added provincial funding constraints and cutbacks. Case study

¹⁸ Finding additional funding for the Chair (61 percent); the decreasing contribution to Chairholder's salary (65 percent); and meeting administration costs (48 percent) were reported as key challenges by university survey respondents. Caution has to be exercised, as the number of university survey respondents is small (n=25). However, university key informant interviews tend to support the survey trends and responses, corroborating this line of evidence.

¹⁹ It can be difficult for the Chairholder to predict the fluctuations in the number of HQP on an annual basis. Some HQP may shift to another education or research program even though they were scheduled to participate in the IRC and the Chairholder may secure HQP at various times of the year to compensate for lower than anticipated numbers of HQP.

evidence also suggests that commitments to provide new/improved laboratory space are harder to meet in smaller universities where funds from the Indirect Costs program were considered to be insufficient. Finally, some university key informants noted that space shortages and infrastructure maintenance needs have accrued over a long period in which capital spending was frozen and enrolment growth increased. It will therefore take a considerable amount of time and funding to offset this past freeze and meet increased demands for space and renovated/upgraded infrastructure.

3.2.2.2 *Securing Replacement Faculty Members*

Overall, university key informants reported that they were able to meet their commitments with respect to securing replacement faculty members for internal candidates (i.e., the Chairholder was already a faculty member at the university)²⁰. Some delays were experienced when securing replacement faculty in highly specialized or competitive areas. A few university key informants noted that there were too many constraints placed on the university's choice of replacement, which served to limit the replacement faculty member's autonomy in pursuing their own research agenda.

3.2.2.3 *Associate Chairholders*

Associate Chairholder survey respondents were more likely to report challenges around partnership collaborations when compared with Senior Chairholders. For example, approximately one-quarter of Associate Chairholders (23 percent) indicated difficulty satisfying the needs of industrial partners as a key challenge compared with 9 percent of Senior Chairholders. Additionally, 14 percent of Associate Chairholders compared with 3 percent of Senior Chairholders indicated a lack of interest from partners for the research area as a key challenge.

Associate Chairholders were also more likely to report that partners were involved in research activities (79 percent vs. 63 percent) and that partners provided direction for the research process (83 percent vs. 60 percent). Given that Associate Chairholders reported a greater level of direct partner involvement in the IRC, one could also argue that a greater proportion of Associate Chairholders experienced challenges with respect to meeting industrial partners' expectations.

²⁰ Case study evidence shows that in the majority of cases (where the Chairholder was an internal candidate) the university was able to meet its commitments, although some delays were reported.

The variation in findings pertaining to partner lack of interest for the research area is difficult to interpret. While delineation of findings by linked and stand alone Associates (although sample numbers would be very small) might shed some light on this variation, the survey findings are not differentiated according to specific Associate Chairholder categories. Qualitative evidence yields no information to interpret this finding.

3.2.2.4 *Attracting Industrial Partners*

While not reported as a common problem, attracting industrial partners varies somewhat by circumstance and by region. Overall, approximately one-quarter of university survey respondents (26 percent) reported this as a key challenge. A few university key informants stated that the Atlantic universities face specific challenges in finding appropriate industrial partners, given the dearth of potential partners in this region. Within the broader Canadian context, the lower level of industrial R&D makes it more difficult to find Canadian industrial partners. While there are restrictions in partnering with multinationals without a Canadian presence, this was considered to be the only partnering option in some cases. There were also reported difficulties in finding partners where the industry sector is weaker such as mining/metallurgic engineering. In addition, potential partners in emerging industries/technologies (e.g. fuel cells) who could potentially benefit from the IRC program typically do not have enough money to invest in the program.

Reported barriers to partner involvement include lack of partner resources (i.e. smaller companies, in particular may have difficulty justifying the expenditure to senior management); and lengthy selection and approval process. Forty percent (40) of partner respondents cited the difficulty in finding funding within the partner organization to sponsor the Chair program as a key challenge.

3.2.2.5 *Recruitment of Chairholder Candidates*

Some university key informants reported specific challenges associated with the recruitment of external Chairholder candidates. Two university key informants indicated that recruiting external candidates is impeded by the requirement to have a candidate in place prior to the proposal submission. The university must therefore find a candidate who is comfortable with accepting a conditional offer as they take a risk if they guarantee the position before the proposal is successful. One university key informant also reported that there are some deterrents for potential Executive

Chairholder applicants, as there is no guaranteed permanent position for the external candidate once the Chair has ended.

3.2.2.6 *Chair Proposal/Application Process*

Approval of a Chair proposal was reported to be lengthy and generally takes between one and two years. Unsuccessful Chairholder candidate key informants commented that considerable effort is directed to developing a proposal and that a pre-screening process is needed to help minimize unnecessary investments of time and resources. A few university key informants noted that it is difficult to maintain the industrial partner candidate's interest and commitment during this process. When recruiting from industry, the lengthy selection and approval process was noted to create difficulties in keeping the candidacy confidential for this extended period of time.

NSERC was reported to play an important and satisfactory role during this stage in terms of providing advice, explaining the IRC program to the potential industrial partner(s) and consulting with the applicant prior to putting the proposal together.

3.2.2.7 *Intellectual Property Agreements*

From the university and Chairholder perspective, negotiating intellectual property (IP) agreements was not a key challenge, although a number of key informants reported that it was a very time consuming process. That the IP negotiation process was not typically viewed as a key challenge was attributed to the fact that in many cases, Chairholders and industrial partners had pre-existing relationships characterized by trust. However, it was noted that IP challenges are heightened in certain circumstances such as when universities are not experienced in negotiating these agreements; and when the industrial partner has not had a pre-established relationship with the university and/or Chairholder. Smaller companies may experience more difficulties during the negotiation process, given their lack of experience in this area.

A few university key informants mentioned that NSERC's present IP policy facilitates the negotiation process. Some industrial case study respondents indicated that the policy favours the university and felt that intellectual property should be made more readily available to industry as long as benefits to local and national industry can be demonstrated. A few industry and Chairholder respondents also noted that the IRC

should focus on early stage research, potentially minimizing disputes over IP issues²¹. Concerns were also expressed that the present IP policy presents a possible barrier for an open exchange of ideas between the industrial partner(s) and the research team.

Case study evidence also highlighted specific challenges around IP negotiations where many partners are involved. In one case, these challenges were minimized by negotiating individual responsibility clauses with each partner, and by limiting the sharing of some competitive intelligence to members of thematic sub-groups within the Chair.

3.2.2.8 *Support for Candidates Entering Academia*

A number of case studies included examples of external candidates transitioning from industrial settings to academia, not necessarily as Executive Chairs. For those less familiar with the academic environment, additional teaching and administrative support were reported to be helpful (e.g. mentoring, summarized versions of university policy, etc.). In one example, early acquisition of a Post Doctoral Fellow was noted to be beneficial in easing the shift from industry. One Chairholder reported moderate challenges in transitioning to academia with respect to initially attracting and retaining students, which resulted in some delays in the research program.

3.2.3 Nature of Collaboration between Chair and Industrial Partners

Many IRC partnerships arose from existing relationships between the Chairholder and the industrial partner, as demonstrated by survey and case study evidence. Twenty of the twenty-five university survey respondents²² indicated that the Chairholder and partner typically have an established relationship prior to the IRC. This is further corroborated by case study evidence. In 23 of the 30 case studies, the IRC originated from a pre-existing relationship between the Chairholder and the industrial partner (e.g. CRDs, Chairholder was former employee of industrial partner organization, etc). Case study evidence suggests that IRCs work well when there is either an existing relationship between the partner and the Chairholder (e.g. many IRCs arose from

²¹ These respondents contend that universities should remain distinct from industries, focusing on early stage research, while industry focuses on research in the intermediate and commercialization stages.

²² This question was not included in the Chairholder and partner survey questionnaires. However, survey representatives were comprised, for the most part, of Deans. Given their position in the university, it is likely that these respondents were knowledgeable about the relationship of the Chairholder and industrial partner prior to the establishment of the IRC.

previous relationships established through CRDs) or where the Chairholder and the partner have a good understanding of academic and industrial contexts.

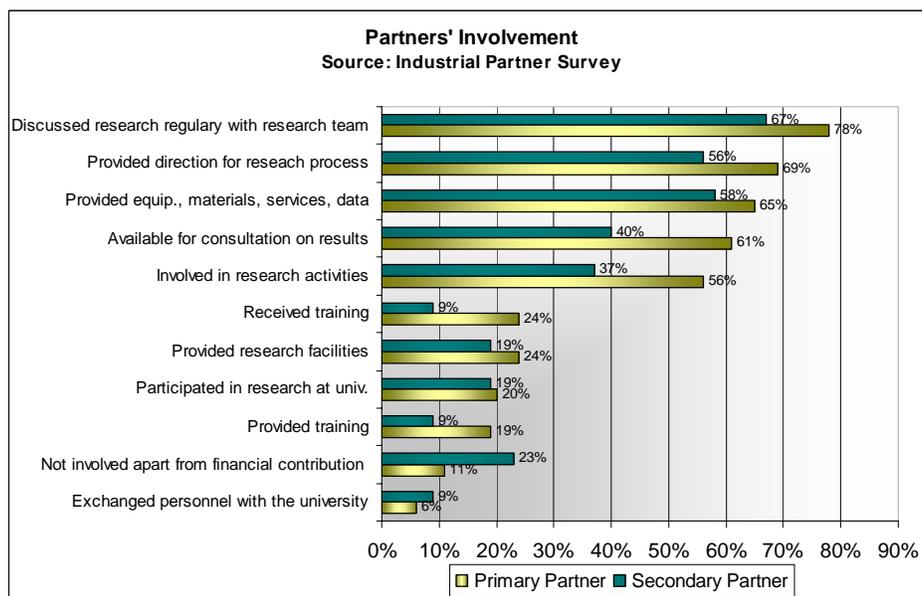
According to the surveys and case studies, involvement in the IRC tended to be initiated by either the Chairholder candidate or the university. In only 17 percent of cases did Chairholder survey respondents report that they were approached by industry for an IRC.

According to survey and case study evidence, industrial partners typically have direct and regular involvement with the Chair. Additionally, the majority of partner respondents indicated that they are satisfied (78 percent) with the opportunities to provide input into the Chair. For example, in the survey, most Chairholder respondents reported:

- partners discuss the research program regularly with the research team (86 percent);
- partners are available for consultation on results (84 percent);
- partners are involved in research activities (67 percent); and,
- partners provided research direction (64 percent).

Partner survey responses follow a similar pattern when compared with Chairholder responses. Additionally, the majority of partner respondents (78 percent) indicated that they were satisfied with the opportunities to provide input into the research process. As illustrated in Figure 2 below, primary partners generally reported higher levels of involvement in comparison with secondary partners. Approximately three-quarters of primary partners (78 percent) reported that they discussed the research program regularly with the Chair, and over two-thirds (69 percent) reported that they provide research direction. This compares to the secondary partners who reported only 67 percent and 56 percent respectively for these two areas of involvement.



Figure 2: Partners' Level of Involvement in the IRC

3.2.3.1 *Communication of Research Results*

As supported by survey evidence, research results are typically communicated to partner respondents. The survey indicates that only a small percentage of Chairholder (1 percent) and partner (2 percent) survey respondents reported that there was no communications of research results. Some of the most common means of disseminating research results to industrial partners, according to Chairholder and partner survey respondents, were informal communications, presentations, formal meetings, and written communications (i.e. reports and publications). The majority of partner respondents (86 percent) indicated satisfaction with the mechanisms for disseminating results from the university to their organization.

3.2.3.2 *Extent of Renewals/Reasons for Non-Renewal*

In a review of 55 random IRC files, 51 files were complete or were currently in their second or third term of renewal. As indicated by file review evidence, 29 of the 51 IRCs were renewed beyond the first term. The review indicated that only a small portion of cases were not renewed or were terminated due to conflicts between the Chair and industrial partner (3 out of 51 IRCs). Of the 51 Chairs, 18 IRCs either did not apply for renewal or were not approved for renewal²³ and four were terminated

²³ In the majority of the 18 cases, no applications for renewal were made.

prior to the end of the first term. In two of the termination cases the Chairholders left the University for other positions, and in the other two cases the partner organization withdrew its support²⁴.

The table below illustrates the reasons cited in the IRC files for either non-renewal or termination of the Chair. It should be noted that “objectives achieved during first term” was the reason cited in the file. However, it should not be assumed in the other cases that objectives were not achieved.

Table 4: File Review – Reasons for Non-Renewal/Termination

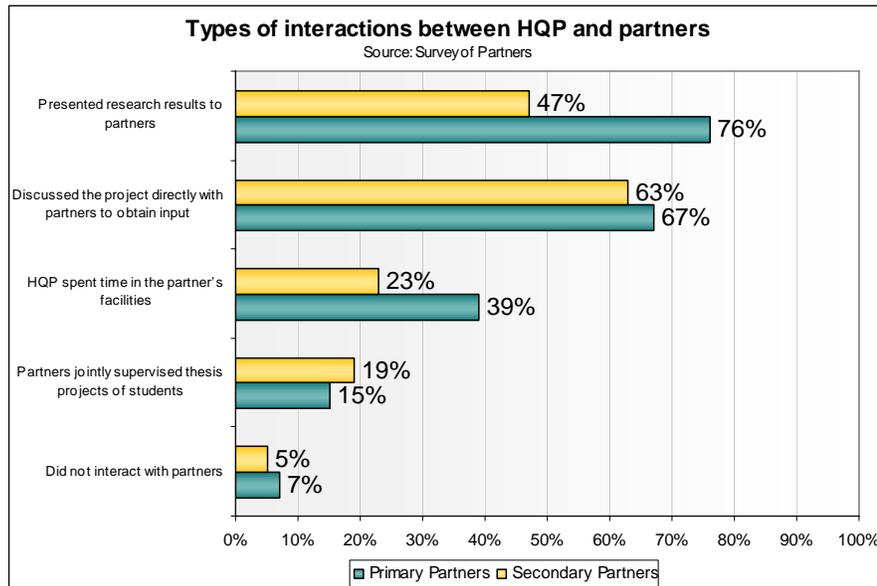
Reasons for Non-Renewal /Termination	Termination (prior to end of first term) Frequency	Non- Renewal Frequency
Industrial Partner organization underwent organizational changes/changed strategic direction	1	2
Industrial Partner/Chairholder conflicts	1	2
Chairholder retired		5
Chairholder left university for another position	2	0
Objectives achieved during first term		3
Partnership/research continued through other mechanisms (e.g. Strategic Grant, CRD)		2
Lack of university support		1
No reason cited in file		3
Total number (out of 51 completed IRCs)	4	18

3.2.4 Nature of Interaction between Industrial Partner and HQP

Survey data shows that only a small percentage of Chairholder (2 percent) and partner (7 percent) respondents reported that the HQP did not interact with partners. The most frequently cited types of interactions were HQP presentation of research results, and discussing research directly with partners to obtain input.

²⁴ Reasons cited in file for partner withdrawal of support: Partner organization underwent organizational change; and in one case there was a disagreement between partner and Chair.



Figure 3: Types of Interactions between HQP and Partners

3.2.5 Suggestions for Program Improvement

A number of suggestions for improvement were made by a small proportion of key informants. These include the following:

Infrastructure and Overhead Support. It was reported that universities are absorbing overhead costs and providing for the indirect costs of research, which creates some tension. While the Indirect Costs Program helps universities cover the indirect costs (e.g. infrastructure support) of conducting research, some university representatives indicated that this is not sufficient. Suggestions for addressing these challenges included a specific infrastructure funding program that enabled the Chair to apply for additional infrastructure related funding, where other existing funding sources were deemed inadequate.

As mentioned previously, over one quarter of Chairholder survey respondents reported inadequate administrative support as a key challenge. Some Chairholder key informants, interviewed as part of the case studies, reported that the Chair would benefit from sustained funding directed towards the management and operations of the laboratory. The streamlining of annual financial reporting requirements was also

suggested²⁵. Enhanced monitoring by NSERC was also viewed as a means to ensure universities fulfilled their commitments to the Chair.

Approval and Selection Process. While the lengthy approval and selection process was frequently cited as an issue, there were few specific suggestions as to how to ameliorate this situation. Some of the delays were regarded as necessary given that negotiations were considered important to establishing a successful IRC. According to survey results, timeliness of the approval and selection process is not a major source of discontent, as only 9 percent of partner respondents and 7 percent of Chairholder respondents expressed dissatisfaction with this aspect of the Program. Unsuccessful candidate key informants noted, however, that the process should try to minimize unnecessary investments of time and resources. Indeed a considerable portion of IRC applications, 38 percent, are not approved. A two-stage proposal process would be one option to address this challenge involving a précis proposal in the first stage followed by a full proposal submission upon pre-approval of the précis. Pre-approval by all three parties (University/ Industry/ ACUIG) of the Chair and Chairholder candidate based on a précis proposal (or letter of interest) would be required prior to submission of a full proposal.

Program Expansion. A few key informants believed that given the effectiveness of the Program, it should be expanded to fund a greater number of Chairs. While there is no specific limit or cap on funding set with respect to the IRC program, the expansion of the program is reported by university and NSERC committee key informants to be limited by the small pool of appropriate highly qualified researchers, by the number of industrial partners with the capacity or willingness to participate, and by the universities' levels of commitment. With respect to the first potential limitation, there is a risk that expanding the program will involve the inclusion of less renowned academics, therefore detracting from the program's prestige.

Possible efforts to expand the program might also involve strategies for increasing the number of industrial partners involved in an IRC. As this evaluation focuses on industrial partners already involved in an IRC, non-participating industrial partners

²⁵ Specifically a few Chairholders found that NSERC's requirement of reporting annual HQP expenditures to be burdensome. One Chairholder suggested that expenditures on HQP be reported to NSERC at the mid period of the IRC. A few Chairholders found that the university financial reporting requirements were heavy and not consistent with NSERC's requirements.

should be consulted to determine possible barriers and opportunities to IRC participation, to help assess the feasibility of program expansion (in terms of increasing the number of industrial partners).

Attracting More Diverse Types of Industrial Partners. According to some university key informants, efforts should be made to ensure the inclusion of smaller organizations, organizations involved in emerging industries and partner organizations from diverse regions of Canada. Suggestions were made to allow for more flexible funding formulas that do not necessarily require industry to contribute 50 percent of the costs. Greater recognition of in kind contributions was also recommended.

Reduction in Teaching Loads. Some key informants noted that there is a need to ensure that teaching loads are adequately reduced to allow for a focused program of research. However, only 10 percent of Chairholder survey respondents reported that they were dissatisfied with this aspect of the Program, indicating that this is not a pervasive concern. Suggestions were made to clarify what is meant by “reduced teaching load” during the negotiation period to minimize any potential misunderstandings.

Communications/Interactions among Industrial Research Chairholders. The establishment of fora to facilitate interchanges between current and new Chairholders was suggested. This would provide an opportunity for Chairholders to exchange “best practice” information, in order to increase the efficiency of new Chairholders with respect to the many administrative and management requirements associated with establishing an IRC. It was also noted that social exchanges/ gatherings among Chairholders would facilitate general exchange of information.

Enhanced Visibility of the IRC program. Some Chairholders, interviewed as part of the case studies, indicated that more publicity regarding the contributions of specific Chairholders and their Chair research programs is needed, both within and outside the university. NSERC has made some recent attempts to enhance visibility of these contributions (e.g., have created an online database of IRCs; have distributed plaques recognizing the work of Chairholders, etc.). However, some Chairholders believe that there needs to be a more concerted approach taken to enhancing the Program’s visibility. Two Chairholder key informants suggested a formal gathering



of industrial partners and (on a regional and/or on a national basis), where the IRC program formally recognizes contributions of Chairholders and partners.

3.3 Impacts

Section Summary:

According to all lines of evidence, the IRC program has strong impacts in terms of Chairholder research capacity, which generally contributes to research productivity and broadening of the research scope. The IRC program was reported to contribute significantly to the achievement of critical mass in areas relevant to industry by helping to bridge gaps in existing programs or by developing niche areas (e.g. automotive sector, environmental science, construction engineering and management). The Program's leveraging effect, its effectiveness as a tool to recruit and retain faculty, and the enhanced ability to attract HQP were considered essential to building critical mass.

The IRC program was generally held to provide HQP with enhanced and industrially relevant training that better prepared them for employment. About one-third of industrial partner respondents indicated that they have hired HQP. Survey results showed that 69 percent of those who obtained employment were employed by industrial partners or industry subsequent to the IRC.

With respect to partner impacts, the strongest reported impacts were increased access to specialized expertise and research results. The case studies underscored the importance of the Chair (i.e. its long time frame, Chairholder's enhanced focus on the research area) in contributing to better access to specialized expertise. From the industrial partner perspective, ongoing access to the Chairholder's expertise facilitated transfer of knowledge/technology with respect to cutting edge research, and potential new processes, products and methodologies for exploring research problems. Moreover, the Chair, through its network of collaborations, provides the partner organization with access to expertise beyond the Chair.

The Chair program was reported to have moderate to strong impact in terms of



increasing R&D efforts and capacity building (e.g. better prepared personnel to meet organizational needs and to conduct relevant research) and milder financial and commercial impacts on the partner organizations. An examination of case studies beginning prior to 1998 illustrated the longer time lines needed for achievement of results related to commercialization and economic benefits. For example, in one case study the commercialization of early research results is being realized ten years from the inception of the Chair.

While not the primary intended benefit of the program a few case studies highlighted social or environmental benefits achieved by the Chair such as the creation of areas for cod spawning grounds; and the development of a provincial restoration and reclamation policy identifying appropriate after-use of harvested peat lands.

3.3.1 Impacts on Research/ Research Capacity of the Chairholder

3.3.1.1 *Research Capacity*

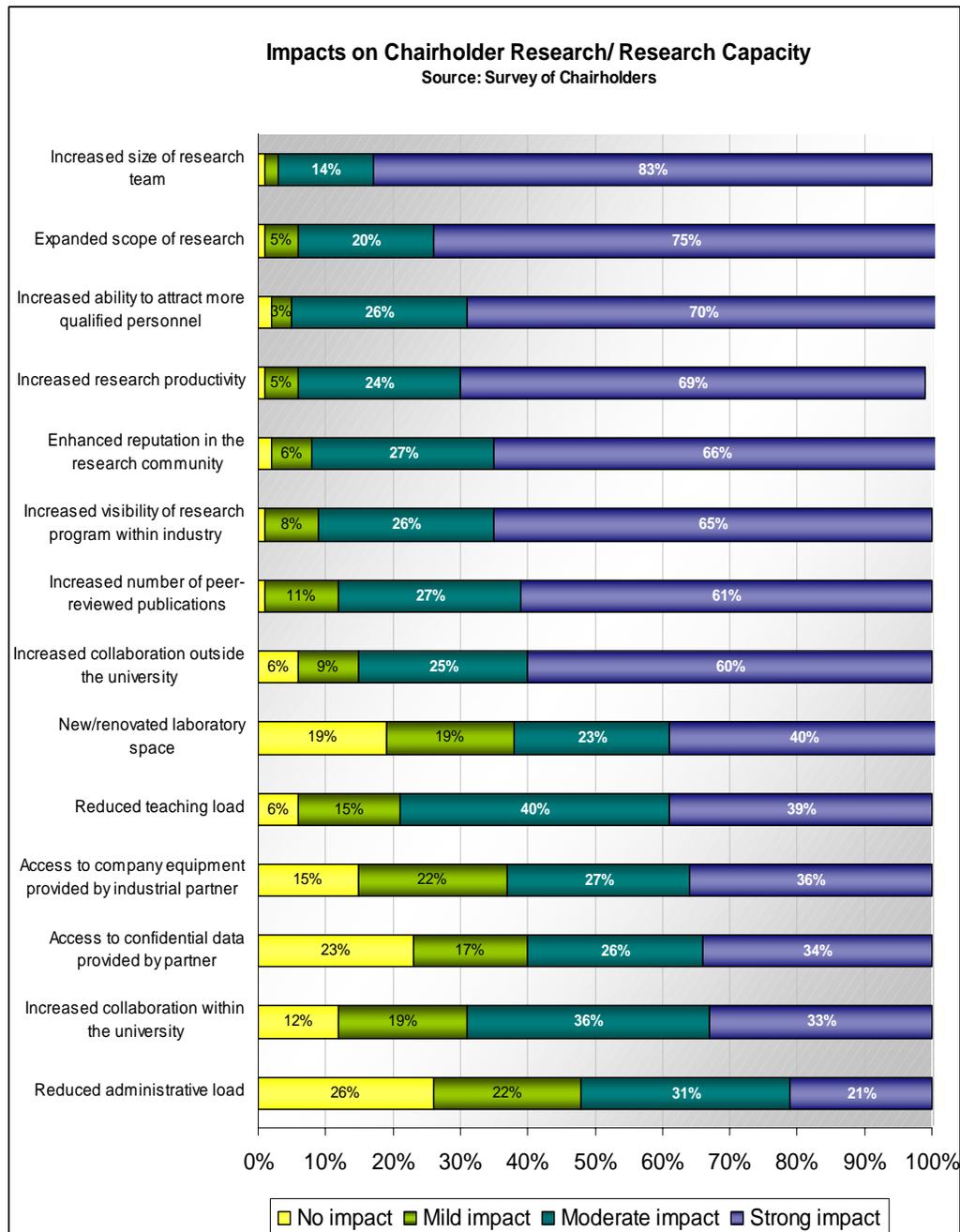
According to all lines of evidence, the IRC program has had strong impacts in terms of building the research capacity (in industrially relevant areas) of Chairholders with respect to increased size of research team, increased ability to attract more qualified personnel, and enhanced reputation within the research community (see *Figures 4 and 5*). On average, Chairholders reported spending about one-half of their time (49 percent) on IRC-related research and another 17 percent on additional research not necessarily related to the IRC. The remainder of their time is reportedly allocated to teaching (17 percent) and administration²⁶ (14 percent). However, there is a great deal of variance in these percentages indicating that the amount of time allocated to these activities varies considerably across Chairholders.

Consistent with the delivery findings reported in Section 3.2, reported impacts were weaker with respect to reduced administrative load and enhanced laboratory space (see *Figure 4*): 48 percent of Chairholders respondents reported that the Chair had only a mild or no impact on reduced administrative load, and 38 percent reported only a mild or no impact with respect to obtaining new/improved laboratory space.

²⁶ Refers to total time spent on administration – both university and IRC administration.

Some of the case studies illustrated that a considerable portion of the first term can be dedicated to building research capacity (i.e. new/improved infrastructure, acquisition of research team), particularly in those instances where the Chair is “starting from zero.”

Figure 4: Impacts on Chairholder Research and Research Capacity



3.3.1.2 *Impacts on Research*

As illustrated in *Figures 4*, the Chairholder survey reported strong impacts with respect to expanded scope of research (75 percent)²⁷ and increased research productivity (69 percent). The case studies were useful in illustrating what some key informants have referred to as the Program's "multiplier effect" whereby the Chair program builds upon itself, facilitating the broadening of research scope and quicker pace of research. It was asserted that the Program's design elements (i.e. its long-term nature, reduced teaching and administrative load, rigorous peer review process) helped to highlight a research area or theme, which enhanced the Chairholder's ability to secure additional funding, and attract more HQP. This enhanced capacity enabled increased research productivity and an expanded scope of research.

Specific design elements of the Program were reported to positively influence research. Long term, sustained funding results in the research team not having to wait for funding, allowing the research to move forward more quickly. Another Chairholder reported that the IRC facilitated the broadening of the research scope as it afforded more time (attributed to the Chairholder's reduced teaching and administrative load) for increased academic collaborations enabling the examination of the whole spectrum of research related to the Chairholder's research area.

Case study evidence highlighted how the IRC influences research. In one case, the IRC contributed to the establishment of a Centre for Research. The Centre provided opportunities for international collaborations and enhanced ability to synthesize data, which facilitated integration of the Chair's research. In another case, new research instrumentation enhanced the quality of the research and made the research more industrially relevant (leading to additional funding by the industrial partner).

There were also notable cases where collaborations with industry have impacted positively on the Chair's research. For example, in one case the development of IT solutions for industry provided the Chair with production data for future research and the development of new production management techniques and simulation.

Some cases also highlighted the interaction between longer-term research and more

²⁷ Five (5) percent of Chairholder respondents reported that the research scope was too confining.

applied research projects. The interaction was reported to have positively influenced the Chair's longer-term research by helping to identify fundamental, long-term research objectives, by providing data for future research and development, and by providing a "testing-ground" for tools and knowledge. The longer-term research was considered to be more industrially relevant as a result of this interaction.

3.3.1.3 *Impacts on Research Capacity/Research – Senior vs. Associate Chairholders*

Senior and Associate Chairholders reported similar levels of impact on a number of dimensions relevant to enhanced research capacity such as increased size of research team; ability to attract more qualified personnel, new/renovated laboratory space; and increased collaboration outside the university. While the majority of Associate Chairholders experienced moderate to strong impacts with respect to enhanced reputation in the research community (87 percent); this was somewhat lower than Senior Chairholders where 96 percent reported moderate to strong impacts. Additionally, Associate Chairholder respondents were less likely to report stronger impacts with respect to the following aspects of research capacity:

- Seventy (70) percent of Associate Chairholders vs. 83 percent of Senior Chairholders reported moderate to strong impacts regarding reduced teaching load.
- Associates Chairholders were less likely to report moderate to strong impacts with respect to reduced administrative loads (32 percent vs. 56 percent);
- Associate Chairholders were less likely to report moderate to strong impacts with respect to access to confidential data provided by industrial partner (50 percent vs. 63 percent) and with respect to increased access to company equipment provided by industrial partner (55 percent vs. 64 percent); and
- Associate Chairholders were less likely to report moderate to strong impacts as to increased collaboration **within** the university (58 percent vs. 74 percent).

Regarding impacts on research, Associate Chairholder respondents reported similar levels of impact compared to Senior Chairholders with respect to increased research productivity (96 percent vs. 93 percent reported moderate to strong levels of impact); increased number of peer-reviewed publications (87 percent vs. 88 percent); and expanded scope of research (100 percent vs. 93 percent).

3.3.1.4 *Research Autonomy*

According to survey and case study evidence, Chairholders were, for the most part,



able to pursue their academic interests through the IRC. Only five (5) percent of Chairholder respondents reported that the research scope was too confining and only four percent reported that loss of academic freedom was a key challenge. Additionally, four percent indicated that industrial partners overly influenced research. A number of case studies illustrated how the Chair combined and balanced the flexibility and freedom of academic research with more goal oriented methods of industrial R&D (e.g. beta testing of prototypes, applied research projects to help industry resolve more pressing challenges).

In two of the case studies, Chairholders indicated that the IRC served to constrain or limit their research. In those cases, Chairholders and industrial partners expectations as to the appropriate direction of the research were divergent. Two Chairholder respondents interviewed for the case studies noted that there were some undue delays in research publications, attributed to the time taken by the industrial partner to review the reports.

3.3.1.5 *Partnerships/Collaborations*

Survey evidence indicated that most current Chairholders intend to maintain the collaboration with the industrial partner(s) in the post-IRC period, and that former Chairholders do tend to continue these collaborations after the completion of the Chair. Ninety-seven (97) percent of active Chairholders reported that they intended to maintain the collaboration (upon completion of the term) mainly through the renewal of the Chair. Of those Chairholder respondents who had completed the Chair, 72 percent reported that they had maintained collaborations with the industrial partner through another NSERC program (44 percent), through contract research (61 percent) and/or through a formal or informal network.

The Program was considered to increase collaborations both within and outside the Chairholder's university. Sixty-nine (69) percent of Chairholder respondents reported that the Program had moderate to strong impacts with respect to collaborations within their university. Eighty-five (85) percent of Chairholder respondents reported that the Program had moderate to strong impacts with respect to increased collaborations outside the university.

3.3.2 Impacts on Industrial Partners

3.3.2.1 *Increased Access to Specialized Expertise and Research Results*

According to industrial partner respondents, the strongest reported impacts were increased access to specialized expertise (81 percent) and increased access to research results (78 percent). This is consistent with industrial partner expectations in that 86 percent of partner respondents indicated that access to specialized research expertise was one of the primary incentives for supporting an IRC.

The case studies served to underscore the importance of the Chair (i.e. its longevity, Chairholder's enhanced focus on the research area, leveraging effect) in contributing to better access to specialized expertise. For example, in one case study, the industrial respondent reported that the Chair provided the partner with ongoing exposure to "cutting edge" research facilitating the development of up-to-date processes within the company.

Another case study illustrated that having better access to specialized expertise facilitated the industrial partner's exploration of new areas of potential research products, innovation, and consideration of new approaches in addressing research problems. In another case, the availability of the Chairholders to provide industrial training seminars in-house to their engineers was viewed as having an influence on how the industrial engineers viewed the impact of technology on changes in the processing cycle. In addition, the Chair, through its network of collaborations, was viewed by some industrial partner respondents as providing them with access to international expertise beyond the Chair.

3.3.2.2 *Capacity-building*

According to both the partner²⁸ and Chairholder surveys, some of the strongest areas of impact on the partner organization relate to capacity building primarily in terms of increasing the organization's R&D effort. Fifty-eight (58) percent of partner respondents reported moderate to strong impacts with respect to increased R&D

²⁸ Highest impact areas are defined as those areas where over 50 percent of the partner respondents reported moderate or strong impact. While a higher percentage of Chairholder respondents reported stronger and moderate impacts on partner organizations, a comparison of the partner and Chairholder survey findings found similar trends with respect to those areas reported as having moderate/strong impacts and those areas more frequently reported as having no impact. Once again caution must be exercised in comparing the actual percentages of the two groups given the heterogeneity of industrial partner respondents.

efforts. Fifty-five (55) percent reported that the IRC had a moderate to strong impact in terms of better preparing personnel to meet organizational needs (see Appendix B for Impacts on Partner Organizations). Fifty-two (52) percent of partner respondents reported moderate to strong impact with respect to increased access to specialized facilities. Fifty-one percent of respondents indicated moderate to strong impacts with respect to increased trained personnel available. Interestingly enough, secondary partner respondents as compared to primary partner respondents (56 percent vs. 42 percent) were more likely to report moderate to strong impacts with respect to increased trained personnel available. Almost one half of all partner respondents reported moderate to strong impacts with respect to increased capacity of the organization's personnel to conduct research related to business lines (49 percent).

3.3.2.3 *Partnerships and Collaborations*

Partner survey evidence indicated that most current industrial partners intend to maintain collaboration with the Chairholders in the post-IRC period. Seventy-two (72) percent of partners involved in current Chairs reported that they intended to maintain the collaboration (upon completion of the term) mainly through the renewal of the Chair.

Of those partner respondents who had completed the Chair²⁹, 55 percent reported that they had maintained collaborations with the Chairholder through a number of mechanisms³⁰: another NSERC program (23 percent), through contract research (18 percent) and/or through a formal or informal network (32 percent).

Additionally, 67 percent of all partner respondents indicated that their existing partnerships with universities were strengthened as a result of the IRC. Forty-two (42) percent of all partner respondents reported that they had formed new partnerships with universities and 31 percent reported that they had formed new partnerships with other organizations as a result of the IRC.

3.3.2.4 *Knowledge/Technology Transfer*

According to survey evidence (see Figure 5), industrial partners most frequently reported that the research is used by other organizations (including other industrial

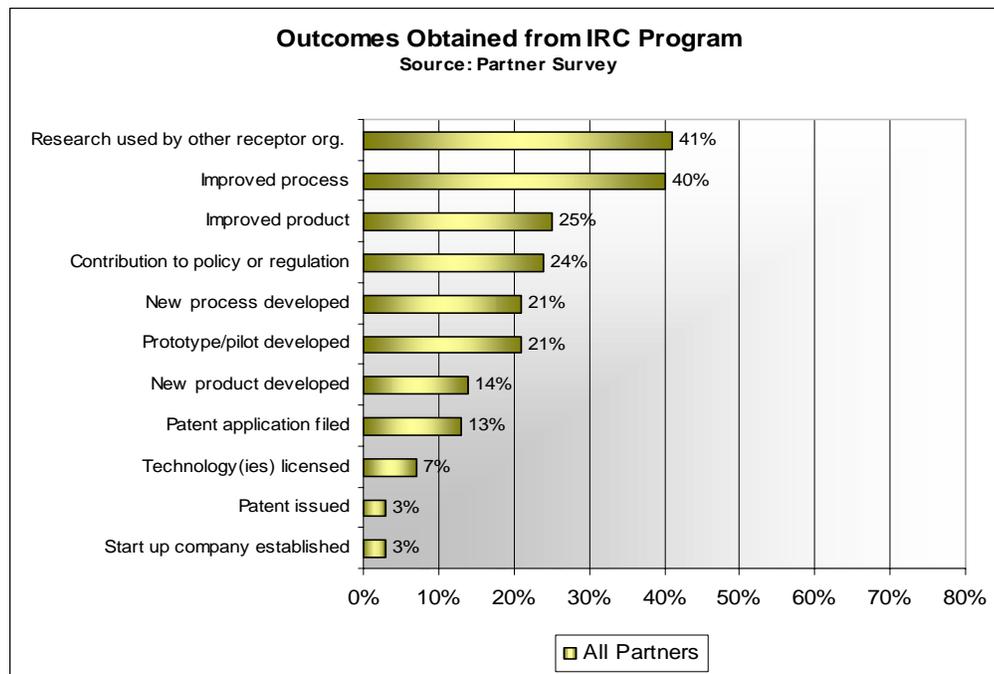
²⁹ Fourteen percent of partner respondents did not know if their organization had maintained collaboration with the Chairholder upon completion of the IRC.

³⁰ The percentages are expressed as a percent of the entire Chairholder sample.

partners and other organizations) (41 percent) and that that the IRC resulted in improved processes (40 percent). Additionally, 25 percent of partner respondents reported that the IRC had resulted in an improved product; 21 percent reported that a new process had been developed; and 21 percent reported that a new prototype or pilot had been developed. While these percentages are lower than those reported by Chairholder respondents, once again prudence has to be exercised given the heterogeneity of the partner sample and the fact that not all partner respondents have detailed knowledge about the IRC (i.e. 9 percent of partner respondents indicated that they did not know whether these outcomes were realized or not).

In a comparison of primary and secondary partner responses, primary partners were more likely than secondary partners to report that a patent application had been filed (21 percent vs. 3 percent); and that a prototype/pilot had been developed (26 percent vs. 13 percent).

Figure 5: Knowledge and Technology Transfer (Partner Survey)



*Multiple responses possible



It should be noted that in addition to indicators such as number of patents issued, there are other measures such as the nature and extent of collaborations between the industrial partner and the Chair that provide a good indication that appropriate conditions for the transfer of knowledge are in place³¹. As reported in sub section 3.2.3, the majority of industrial partners have regular and direct involvement with the Chair further buttressing the argument that transfer of knowledge/technology is occurring.

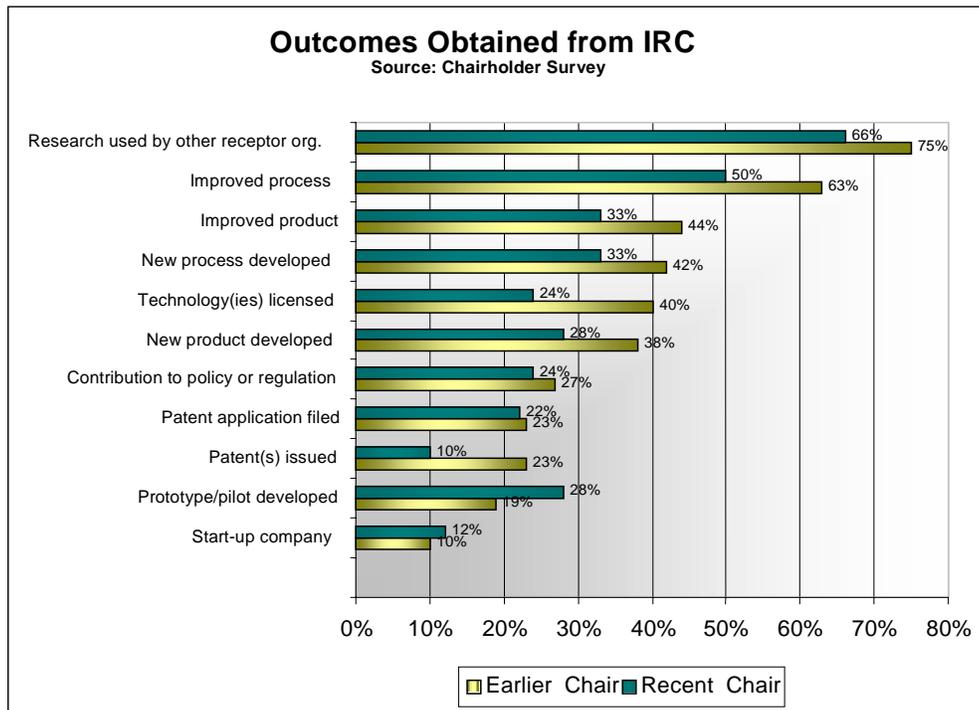
Timelines for Achievement of Results

The transfer of knowledge is not a linear process and involves multiple stages and pathways over a longer time frame. To illustrate results achieved over time, a comparison of outcomes achieved by early and more recent Chairs as illustrated in *Figure 6*. It was found that earlier Chairs reported greater outcomes when compared with more recent Chairs, with the sole exception of prototype/pilot development. Of particular note are the survey findings for improved or new processes and products (63 percent vs. 50 percent), technologies licensed (40 percent vs. 24 percent), and patents issued (23 percent vs. 10 percent). Some of these differences are likely attributable to the fact that the impacts of research results may not be immediately realized given the longer time horizons needed to attain commercialization of results. The file review corroborated the Chairholder survey in that it yielded similar trends³² (e.g. 55 percent of the files indicated improved process, 27 percent indicated new process, 25 percent of the files indicated patent application was filed).

³¹ Langford, C.H., Hall, J., Josty, P., Matos, S., and Jacobson, A. Outcomes of University Research in Canada: Innovation Policy and Indicators of Triple Helix Relationships.

³² NSERC has recently implemented a progress report template designed to provide more consistent performance information. The file review encompassed many files that predate those changes. Therefore, given inconsistencies in performance reporting, the reported percentages are an estimate of the minimum level of achievements in those areas, but likely do not encapsulate all outcomes, as Chairholders may not have consistently reported all impacts.

Figure 6: Knowledge and Technology Transfer (Earlier and Recent Chairs)



*Multiple responses possible

An examination of case studies (renewals) and those beginning prior to 1998 illustrated the longer time lines needed for achievement of results related to the commercialization of research. One case study highlighted how commercialization of early stage research results is being realized ten years from the inception of the Chair.

Another factor that can affect the time horizons with respect to the transfer of knowledge and technology, is the time taken to establish Chairholder and university research capacity, particularly where substantial renovations or new construction is taking place. Some case studies highlighted the time needed (one to two years) to build new/improved infrastructure and to establish and develop a strong research team. In two cases there were delays in building infrastructure, which impeded research progress to some extent.

From the industrial perspective, it can also take time to build receptor capacity, particularly for those companies who do not have internal R&D capacity. As one industrial partner pointed out, “Within the first five years of the Chair, our company needed the time to build awareness and knowledge and to consider how the research

results could be applied.” Some case studies also illustrated the importance of a strong champion within the industrial organization to facilitate the effective transfer of knowledge/technology to the company.

While commercialization of research typically occurs over a longer period of time, particularly where the Chair is primarily engaged in early stage research, some case studies illustrate more immediate partner impacts. They demonstrate a balanced program of longer-term research and applied research projects directed at resolving more immediate industry problems. In one case, the Chair beta-tested prototypes, resulting in enhanced product development. In other cases, the Chairs collaborated with partner representatives on specific applied research projects designed to address more immediate partner needs or challenges.

Other factors that enhance transfer of knowledge /technology

An analysis of case studies shows that Chairs vary as to the extent and nature of dissemination activities directed to industry. A number of case studies underscored the involvement of the Chair in disseminating research, networking, and advocating for adoption of knowledge/technology (to partners and to industry as a whole). In one case, stakeholder respondents reported that a key factor in the stronger buy-in and the adoption of the new technology by civil engineers and transportation authorities was the Chair’s strong focus on the dissemination of its testing results to partners and industry.

Other case studies accentuated the importance of having sufficient mechanisms to fund research throughout various stages ranging from idea generation through to applications relevant to industry. For example, two case studies illustrated the Chair’s involvement in “packaging knowledge” (e.g. developing a user friendly software product for industry) to enable industry utilization of the research results. One Chairholder noted that there were insufficient NSERC or university resources to conduct this extra work. This raises the issue as to whether knowledge diffusion between the Chair and industrial partner could be enhanced by providing additional incentives and support for the Chair (or whether other mechanisms are needed to address possible gaps). Given that only two Chairholders raised this issue, knowledge as to the breadth of this challenge is limited. Further consultation might shed more light on this topic.



3.3.2.5 *Commercial/Financial Impacts*

Many partner respondents indicated a mild to moderate impact with respect to a number of dimensions relevant to improved revenues or cost reductions of the partner organization. Only a minority of partner respondents reported strong financial impacts attributable to their participation in the Chair. This is not particularly surprising considering the most frequently cited reasons or rationale for participating in the Chair were not to garner direct (or immediate) financial benefits (see Section 3.1 – Relevance).

Areas of highest impact (i.e. moderate and strong combined) included:

- improved competitive position (44 percent);
- increased market opportunities (31 percent); and
- improved productivity (29 percent).

Areas of lowest impact (i.e. highest percentages of partner respondents indicating no impact and lowest percentages of respondents reporting moderate to strong impacts) included:

- increased cost-reductions (36 percent reported no impact);
- creation of new jobs (33 percent reported no impact);
- increased profitability (32 percent reported no impact);
- increased speed of supplying and/or delivering goods (32 percent reported no impact); and
- increased revenue (31 percent reported no impact).

As the case studies illustrated, the IRCs are diverse in terms of types of research conducted, areas of research focus, and types of partners. Outcomes applicable to increased revenues and profitability may not be pertinent to all IRCs or may be the longer-term focus, particularly for those Chairs primarily engaged in early stage research. Indeed for many of the ‘low impact areas’ a substantial portion of partner respondents indicated “not applicable” (e.g. 37 percent of respondents reported that increased revenue and increased profitability were “not applicable”; 34 percent indicated that creation of new jobs was “not applicable”).

The fact that the partner survey sample represents a fairly diverse group has implications as to the relevance of commercial impacts for all partners. Survey results indicated that partner survey respondents were comprised of the following groups:



privately owned firms (28 percent); publicly traded firms (28 percent); Associations (8 percent); Crown Corporations (8 percent) government (9 percent); and other (18 percent). In the other category the most common cited responses were as follows: not for profit organizations; universities or research centres; and privately held firms with the government as the single shareholder.

An analysis of the case studies shows that economic results are achieved through various pathways and mechanisms. In a small number of cases, more immediate commercial benefits were achieved through the Chair's involvement in more applied research projects. Another case study demonstrated how other IRC program factors influence outcomes. For example, in one case, the Chairholder's reputation and the Chair's interaction with customers helped to promote sales and enhance the company's credibility, contributing to the company's increased revenues within a relatively short time period.

A minority of case studies highlighted a more direct relationship between the IRC research and economic impacts. For example, in one case the Chair's research led to an improved methodology that is likely to lead to increased profitability. Commercial benefits can also be derived more indirectly through the enhancement of R&D and personnel capacity or through a process of transferring IRC research results towards commercialization efforts. Furthermore, whether or not there is a direct or incremental financial return on investment to industrial partners, knowledge dissemination/technology transfer may yield broader benefits to the Canadian economy. For example, in one case study the building of new transportation infrastructure (resulting in an improvement of the durability of concrete) will potentially result in considerable savings to Canadian taxpayers. If widely adopted, the use of the reinforced concrete has the potential to considerably reduce government costs related to the repair of concrete structures.

Primary vs. secondary partners – financial impacts

Secondary partner respondents reported stronger impacts on a number of dimensions in comparison to primary partners³³. Some of these variations may be attributable to the different characteristics of primary and secondary partner respondents. Secondary partner respondents reported less capacity with respect to internal R&D facilities, and

³³ One has to exercise some caution in interpreting these findings given that the confidence intervals for these

were somewhat less likely to contract research with private industry or to conduct research with universities. The principal market of secondary partner respondents as compared to primary partners was more likely to be local (31% vs. 9%) and less likely to be international (49% vs. 64%). Reported differences in some aspects of economic impacts include:

- Twenty-nine (29) percent of secondary partners reported a moderate to strong impact with respect to increased speed of supplying and/or delivering goods as compared to 11 percent of primary partners.
- Forty-one (41) percent of secondary partners compared to 26 percent of primary partner respondents reported a moderate to strong impact with respect to increased market opportunities.
- Thirty-four (34) percent of secondary partners vs. 23 percent of primary partners reported moderate to strong impacts with respect to improved productivity; and
- Twenty-three (23) percent of secondary partners vs. 9 percent of primary partners reported moderate to strong impacts with respect to increased revenues.

3.3.2.6 Social/Environmental Benefits

According to case study evidence, some of the IRC research has significance for the protection of resources, energy efficiency, and climate change. While not the primary intended benefit of the program a few case studies highlighted social or environmental benefits achieved by the Chair such as the creation of areas for cod spawning grounds; additional capacity to restore used peat land and bogs; and the development of a provincial restoration and reclamation policy identifying appropriate after-use of harvested peat lands.

3.3.3 Impacts on University

3.3.3.1 Building Critical Mass

Overall, all lines of evidence supported the assertion that the IRC program contributes substantially to the achievement of a critical mass of faculty for major research endeavours with an industrial focus. The majority of Chairholder and university survey respondents reported strong and moderate impacts on a number of dimensions, most notably with respect to the expansion of the scope of research within the area of

two groups are large. Only differences of greater than 10% are reported.



the Chair, and the attraction of HQP to the university. Sixty-nine (69) percent of university respondents reported that the Chair had a moderate or strong impact on the university achieving critical mass for major research endeavours in key research areas.

University key informants agreed that the IRC program contributed strongly to building or enhancing key research areas through its recruitment and retention of faculty, and attraction of HQP. The enhanced leveraging effect of the Chair (as compared to project based research such as CRDs) was also emphasized: “Having the Chair program in an identified area or theme of research attracts other funding, which in turn attracts more students and more faculty”. Increased leveraging, in turn, was reported to contribute to research scope and productivity, which helped to bridge gaps in existing programs, or developed niche areas (e.g. automotive sector, environmental science, construction engineering and management).

The establishment of infrastructure itself (e.g. new equipment, additional laboratory space) can leverage additional funds and attract new faculty members. In one case, new research instrumentation enhanced the quality of the Chair’s research results and made the research more industrially relevant. This was noted to be a significant factor in the provision of supplementary funding by the industrial partner. In another case, the Chair contributed to the establishment of a university-based research centre. The centre helped to attract additional high quality researchers (i.e. a Tier I and Tier II CRC) in a complementary research area.

The salary support feature was reported to be essential to building critical mass in that it facilitates the hiring of new and replacement faculty members. Additionally, some case studies underscored that the IRC was a critical factor in retaining high calibre researchers, not only within the university, but also within Canada.

Many university key informants considered external candidates to be more incremental in the sense that the university is recruiting an additional highly qualified researcher. In reviewing 127 current IRCs it was found that in almost half (46%) of the cases, the Chairholder was recruited from outside the university (see Table 3 below). In addition, a substantial portion of external candidates come from outside Canadian academia which means that new capacity is being created within Canadian universities and not necessarily shifting capacity from one Canadian university to

another. Many university key informants reported that the IRC program was used strategically to build a key research area, providing additional support for the argument that critical mass is being built in important research areas relevant to industry.

Table 5: Origin of Chairholders

Origin of Chairholders (based on review of 127 current IRCs)	
Chairholders internal to the university	54%
Chairholders external to the university	46%
Canadian Academia (including external and internal candidates)	63%
Foreign Academia	7%
Industry	19%
Government	8%
Other (Postdoc, RA, etc.)	3%

With respect to internal candidates, university survey and key informant evidence indicate that freed up salary funds are generally being used to support replacement faculty members in the Chair's research area or complementary areas, although some delays in recruiting these faculty members were reported.

Increased teaching capacity was one of the key reported impacts with respect to the recruitment and retention of replacement faculty. The majority of university key informants reported that replacement faculty members play a role in assuming some of the Chairholder's previous teaching responsibilities. According to some university key informants this resulted in a net increase in courses (including both new and existing courses) being taught subsequent to the establishment of the Chair.

The impact of the replacement faculty with respect to building critical mass in the Chair's research area is less clear. Varying degrees of integration with the Chair's program of research were reported by university key informants, with some replacement faculty members more peripherally involved than others in the Chair's research. NSERC should continue to monitor the impacts of replacement faculty through its progress and final reports.

The long-term nature of the program was reported to be an important feature in helping to build a sustained program of research. According to a number of university key informants, the IRC facilitates long-term commitment to a research program. Once the IRC is established, the university (and the Chairholder) are committed to the research area and that commitment extends beyond the IRC term. For example, McMaster University has a continued focus on steel related and polymers research areas beyond the completions of these IRCs. The steel industry funded two endowed Chairs (McMaster University) subsequent to the completion of the IRC, helping to sustain this research area.

3.3.3.2 *Partnerships/Collaborations*

The majority of university survey respondents reported that the Program has had moderate to strong impacts with respect to increased collaborations within the university (66 percent, n=15) and with respect to increased collaboration outside the university (83 percent, n=17). University key informants noted that the long-term nature of the program encouraged leveraging, resulted in the attraction of other types of funding for research, and increased collaboration not only within the university, but also with other industrial partners beyond those initially involved with the IRC. A few university key informants indicated that they have longstanding partners that continue to collaborate with the university beyond the terms of the IRC. For example, the McMaster Advanced Control Consortium (an industry consortium) continues to collaborate with McMaster, almost ten years after completion of the Industrial Process Control Chair. A number of examples were reported where new industrial partnerships with the university/research team resulted from the enhanced visibility of the Chair.

3.3.3.3 *Curriculum Impacts*

Seventy (70) percent of Chairholder survey respondents reported that the IRC program had moderate to strong impact on teaching activities and curricula. There were a number of case study examples illustrating particularly strong curriculum impacts when the IRC represented a niche area of relevance to industry³⁴.

³⁴ In these cases, the industrial partner was the catalyst for the creation of curriculum or a program because they were experiencing a shortage of qualified personnel (e.g. automotive industry, construction engineering).

3.3.3.4 *Universities' Long Term Strategic Plans*

According to university key informants, IRCs are typically aligned with the long-term strategic plan of the university. Some key informants noted the proactive use of IRCs to recruit or retain faculty with respect to strategic research areas. A few university key informants noted that the university modified its long term plans to reflect strong research areas developed through the IRC.

3.3.4 Impacts on HQP

3.3.4.1 *Impacts on Training*

Survey and case study evidence supported the assertion that the IRC experience provides HQP with a unique and industrially relevant training experience. Ninety-four (94) percent of Chairholder respondents reported that the Chair resulted in HQP participating in research in which they would otherwise not have been involved. Many Chairholder respondents (83 percent) also reported that the IRC had strong to moderate impacts in terms of providing HQP with training in areas (related to their field), which, in the absence of the Chair, would not be available. Professional development and career preparation was reportedly positively impacted through HQP's involvement with the Chair. Eighty-six (86) percent of Chairholder respondents reported moderate to strong impacts in terms of better qualifying HQP for employment in their area of study.

An analysis of case studies showed how involvement in the IRC influenced HQPs' research and training experience. First, interactions with industry influenced students' academic work by helping them identify research problems as a focus for academic study. Second, interactions with industry provided students with opportunities to observe how their research results are transferred to an industry setting. In one case study, HQP were exposed to a broad spectrum of research in various stages ranging from the very early generation of concepts through to the final stages of patent development. By working in a laboratory that emphasized the stages throughout the research spectrum, HQP were exposed to what was described as an "inventing environment" and participated as co-inventors (many of the students are named on patents). In another case, HQP working directly with industrial engineers observed how their research would be transferred, the considerations that need to be made in this transfer, and challenges in adapting their work to the industrial setting. In another case, HQP worked on testing prototypes and, as a result, gained an understanding of



the effort and costs involved in commercializing prototypes.

HQP respondents in the case studies generally viewed their experience with the Chair as advantageous in a variety of ways. Some of these included:

- access to the Chairholder;
- access to a broader range of academic (including international academic networks) and industry contacts;
- more opportunities to participate in conferences and other fora;
- increased understanding of the industrial context in conducting research; and
- increased understanding of the transfer of research results to an industrial setting.

3.3.4.2 *Impacts on Employment*

According to survey and key informant interviews, the Program is considered to have strong impacts with respect to the employment of HQP. Eighty-eight (88) percent of Chairholder respondents indicated that the IRC helped HQP obtain employment in an area relevant to their field of study. Thirty-two (32) percent of partner survey respondents reported that they had hired HQP associated with the IRC.

Chairholder survey respondents reported 2920³⁵ HQP³⁶ (31 percent undergraduates, 27 percent Master's level, 18 percent PhD level, 11 percent Post-doctoral, 13 percent research associates and technicians) have participated in Chair research. This averages out to about 26 HQP per Chair over a five-year period. Over one third (844 out of 2920 HQP) were reported to have obtained employment immediately following IRC involvement. Of these 844, the industrial partner employed 16 percent, and another 52 percent were employed in an industrial setting³⁷. However, it is not known the extent to which HQP obtain employment in Canadian industry. Case study evidence suggests that some portion of HQP obtain employment in the United States

³⁵ This number includes HQP that were in training as well as HQP that have completed their training

³⁶ A review of 55 randomly selected files found that 1268 HQP participated in these Chairs (averaging out to about 23 HQP per IRC, which is similar to the average of 26 derived from the survey results). Where employment results were indicated in the most recent progress report on file (n=23), it was found that 43 percent of HQP had obtained employment within industry (including employment with the industrial partner or with other industrial organizations). While this percentage is lower compared to survey findings, caution should be exercised given the small number of files that contained information regarding employment status of HQP.

³⁷ Eleven percent were reported to have obtained employment in a government laboratory and 22 percent were employed in academia.



and other countries.

Table 6: Types of HQP Employment Immediately Following IRC Involvement

% Employed by Industrial Partner	% Employed by Industry (excluding industrial partner)	% Employed in Government Laboratory	% Employed in Academia
16%	52%	11%	22%

In some cases, the Chairholder experienced considerable difficulties retaining students (to continue their graduate studies) where there was very high industrial demand and lucrative job opportunities.

3.3.4.3 *Developing HQP to Fill Gaps in Science and Engineering Expertise*

A few case studies highlighted the effectiveness of the IRC program in developing HQP in niche research areas or where significant expertise gaps were identified. For example, the University Network of Excellence in Nuclear Engineering (UNENE) established five Industrial Research Chairs to enhance the supply of highly qualified graduates in the nuclear industry. The IRCs are on track to meet their training targets thereby contributing to the development of a pool of trained graduate students and postdoctoral candidates in nuclear engineering.

A number of IRC Chairs relevant to the automotive industry are considered to be an important contributor to the creation of new graduate courses in automotive engineering and to the development of a pool of automotive engineers. However, the demand was such that these Chairs experienced challenges in retaining students to continue their graduate degrees. According to one industrial partner key informant the contribution of the IRC program to developing a pool of HQP in automotive engineering and research means that their company does not have to recruit from outside Canada. The IRC program is also considered to have played an important role in developing HQP in the area of construction engineering, a niche area that has recently experienced strong growth.

3.3.5 Incrementality

Overall, all lines of evidence support the linkages between the unique design elements of the IRC program and the achievement of results. The majority of Chairholder and partner respondents reported that in the absence of the IRC program, the research would not have been conducted, or would not have been conducted to the same extent.

Survey respondents indicated a number of possible outcomes if they had not received the IRC:

- Research not conducted at all: Forty-five (45) percent of Chairholder respondents and 44 percent of partner survey respondents reported that the research would not have been conducted without the existence of the IRC.
- Research scope reduced: Fifty (50) percent of Chairholder and 47 percent of partner respondents indicated that the scope of research would have been significantly reduced.
- Research delayed: Twenty-seven (27) percent of Chairholder and 32 percent of partner respondents indicated that the research would have been significantly delayed in the absence of the IRC program.

This line of evidence is corroborated with university key informant interview: All university key informants reported that the scope of the research would have been significantly reduced, or research would have been delayed in the absence of the IRC program.

Important attribution issues arise as to whether industrial partners, particularly those belonging to larger organizations, would proceed with similar research without the IRC program, and whether participation in the Chair provides incremental benefits as compared to other alternatives. A number of industrial partners in the case studies reported that the program's long-term nature and cost sharing benefits were primary incentives for participating in long-term fundamental research or more speculative technology based research. They reported that without the benefit of the Chair program, they would not have conducted this type of research through other mechanisms. The fact that investment in basic research represents only a small

portion of overall industrial R&D effort in Canada³⁸, as in most other OECD countries, suggests that this type of research would not likely be conducted by industry, or not conducted to the same extent, if the costs of research were not shared with government. It should also be noted that the amount of research done by industry is poor in Canada compared with other countries³⁹. Finally, the Chair program was reported to better provide partners with close access to high quality academic researchers; this ongoing and close contact with the Chairholder was considered not to be available (or not available to the same extent) through other mechanisms.

When asked about the consequence of not obtaining an IRC on their research, many unsuccessful Chair applicant key informants (Chairholders and partner candidates) reported that the research and the partnerships continued subsequent to the application process. However, some unsuccessful Chair applicant key informants noted that the research was not as extensive or as timely as anticipated under the Chair. Specifically, these key informants noted impacts such as reduced scope of research, less capacity to focus on research (due to full teaching load), research delays, and inability to leverage sufficient funds to conduct the research at the same level. Two key informants (out of nine) reported that the proposed research proceeded as planned.

Case study and survey evidence show that the majority of IRCs arise from a pre-existing relationship between the Chairholder and the partner(s). Therefore, the program cannot be attributed to having a substantial impact on the creation of new partnerships between the Chairholder and industrial partner. However, survey results and case study evidence support the contention that IRC program helps to strengthen the partnerships by virtue of the long-term funding commitment, and the more unfettered, closer relationship to the Chairholder afforded by the IRC program.

³⁸ OECD. The Knowledge-Based Economy: The Role of the Science System in the Knowledge-Based Economy. <http://members.shaw.ca/competitivenessofnations.htm>

³⁹ e.g., The expenditure on R&D in the Business Enterprise Sector (BERD) as a percentage of GDP in 2004 for Canada was 1.07%, vs. 1.53% for the overall OECD. Source: OECD Main Science and Technology Indicators, June 2006.

3.4 Cost Effectiveness

Section Summary:

Overall, the Chair model was regarded as the most effective means to assist universities in building critical mass in industrially relevant areas. The unique design elements of the program enhanced its leveraging effect. The IRC program leverages industrial partner funds that contribute both to the costs of research and to the Chairholder's salary. Total NSERC contributions from 2000/2001 to 2005/2006 amounted to approximately \$72M. Private sector and other partner cash contributions totalled approximately \$107M. In-kind contributions from all partners totalled about \$36M. Hence, the IRC program leverages 2 private and public sector dollars (including cash and in-kind contributions) to every 1 dollar it funds/provides (i.e., at a ratio of about 2 to 1).

The Chair was reported to be an effective model in generating momentum beyond that created by other types of funding mechanisms. The long term funding commitment, flexibility, and prestige associated with the IRC are considered to contribute substantially to the increased leveraging effect of the program.

Overall, key informants viewed the Chair model as the most cost effective means to assist universities in building critical mass in industrially relevant areas. NSERC, Committee and expert key informants cited the Program's leveraging effect and the substantial cash and in kind contributions by the private sector as evidence of its cost-effectiveness.

The IRC program leverages industrial partner funds that contribute both to the costs of research and to the Chairholder's salary. Total NSERC contributions from 2000/2001 to 2005/2006 amounted to approximately \$72M while private sector cash contributions were about \$65M. Private sector contributions (including in kind contributions) totalled approximately \$89M. The ratio of private sector contributions is about 1.25.

Total cash contributions from both private sector and other partners (federal, provincial and local levels of government agencies and departments) amounted to



about \$107M during this time period. In-kind contributions from both the private sector and other partners totalled approximately \$36M. Hence, the IRC program leverages 2 private and public sector dollars (including cash and in-kind contributions) to every 1 dollar it funds/provides (i.e., at a ratio of about 2 to 1).

The private sector contributions are likely to be an underestimate as case study evidence highlights examples of additional private sector funding being generated to complementary research areas (e.g. contract research, CRD grants) which were attributed, at least in part, to the IRC program. Some university key informants also provided examples of private sector donations / endowments to the university as a result of an IRC. For example, Atmospheric Environmental Sciences (AES) has participated in supporting a total of six Chairs. It was estimated that the first four Chairs leveraged 3.5 times the AES funds from the partners. The fifth Chair⁴⁰, at the University of Toronto, leveraged 2.5 times the original amount in direct funds, “and many times the original amount as “in-kind” support, such as access to satellites”⁴¹.

Many key informants noted that the Chair was an effective model in creating momentum beyond that produced by other types of funding mechanisms such as the CRD program. “The Chair model has a great multiplier effect compared to other types of research funding programs”. The unique design elements (i.e. salary support, cost-sharing, long-term funding commitment) and benefits (e.g. enhanced visibility, increased collaborations outside the university) were linked to the Program’s enhanced leveraging effect.

There is a general consensus among all groups of key informants that the IRC program is a more cost-effective model (as compared to project based research) for leveraging funds for several reasons. The IRC program is considered by some university key informants to be particularly important in building niche areas as its salary support feature (and prestige associated with the program) enables recruitment of highly qualified researchers to work in these key research areas.

⁴⁰ The sixth Chair was still in the earlier stages at the time of the report.

⁴¹ <http://www.ec.gc.ca/scitech/default.asp?lang=En&n=58366663-1#note>. Science & Technology Management Committee
Report No. 3 - Science and Technology Partnering: Principles and Practices

The flexibility of IRC funding as compared to a CRD grant (i.e. the IRC funding is not tied to specific milestones, but rather to a defined program of research) was noted by some Chairholders to increase the Program's leveraging capacity. The long-term funding commitment was also reported to facilitate leveraging compared to project based funding which involves coordinating different funding applications according to specified time frames. Additionally, the higher degree of visibility afforded the Chair in an identified area or theme of research serves to attract other funding. Highly successful IRCs, as supported by case study evidence, demonstrate the multiplier effect where the initial growth of the Chair stimulates further growth by attracting additional funding, HQP and faculty members. For example, new equipment or laboratory space serves to attract new funding and new faculty, leading to further growth in the Chair's research area or complementary areas.

There were a number of reported efficiencies of the IRC program. Overall the Research Partnerships Program, of which the IRC program is a part, functions with a streamlined administration budget (4.4 percent)⁴². University site visits, involving travel of peer review committee members (during the selection process) represents one of the highest expenditures of the program, but this is considered worth the investment as the site visit adds value to the decision making process. Recent changes have resulted in a more efficient review process for renewal applications: the evaluation is based on a paper review by external referees; and site visits are only conducted in exceptional cases. The fact that CRD and IRC proposals are reviewed together at the final stage of proposal assessment was provided as further evidence of efficiencies.

⁴² According to NSERC documentation





4.0 Summary and Conclusions

4.1 Relevance

Summary

The program is viewed as highly congruent with both government-wide and NSERC priorities. According to key informants, the IRC program is aligned with government priorities relating to innovation and support for a knowledge based economy. With respect to NSERC priorities, the IRC program is considered to align with investing in people and innovation. This alignment is achieved with the program's aim to build a critical mass of Canadian university expertise in industrially relevant areas, and foster long-term partnerships with industry. By encouraging the productive use of research, the IRC program supports knowledge and technology transfer to Canadian industry.

The IRC program is viewed as a highly relevant program. The IRC program was generally regarded as an important model for strengthening linkages between universities and industry by encouraging universities to conduct industrially relevant research and by providing industry with access to expertise and high quality research. Salary support, shared costs, and the long-term funding commitment were generally considered critical and desirable features of the program.

Stakeholder respondents generally viewed the IRC program as distinct from other university research funding programs such as NSERC's Collaborative Research and Development (CRD) grant program and the Canada Research Chairs (CRC) program. In comparison to the CRD program, the IRC program was perceived to be a better vehicle for focussing on a program of research. It was generally held that the IRC program objectives could not be achieved through the CRC program. The holding of joint IRCs / CRCs was primarily regarded as advantageous. However, concerns were raised that the Canada Research Chairs program could potentially overshadow the IRC program in terms of visibility.

The program is important from a number of vantage points. Chairholders particularly valued the longer-term financial commitment and the prestige associated with the

Chair. Universities typically valued the program's salary support feature and viewed the Program as an effective means to retain or recruit high calibre researchers to focus on a key industrially relevant research area.

From an industrial perspective, the program was highly valued for its long-term funding commitment, close relationship with the Chairholder, shared costs and increased access to specialized research expertise, particularly with respect to access to early stage research or research involving more speculative technologies which tend to involve a greater amount of risk on the part of the investor.

A few partner and Chairholder case study respondents expressed the view that the appropriate role of universities is to conduct early stage research while industries conduct research in the intermediate or commercialization stages. However, some case studies highlighted the benefits derived from IRC involvement in both early stage research and more applied research projects. In these instances industrial partner participation in early stage research helped to facilitate technological development. Moreover, the Chair's fundamental research efforts also benefited from exposure to the industrial context and more applied research projects.

Conclusions

Concerning relevance, this evaluation set out to determine the extent to which the IRC program continues to be consistent with the federal government's and NSERC's priorities, and whether or not the program addresses the needs and priorities of both industry and universities – the key partners in a successful Industrial Research Chair. The evidence gathered throughout this evaluation, and summarized above demonstrates that NSERC's IRC program is highly relevant.

The thrusts in Canada's Innovation Strategy to leverage the commercialization potential of publicly funded academic research, and to support the forging of partnerships between universities and the private sector to achieve commercialization, are both clearly being targeted through the IRC program. With the long term partnerships that are formed through many Chairs, industrially relevant research is carried out within the university sector, while private industry benefits from having access to this research – providing both input and receiving the benefits of transferred research results.



Within NSERC's suite of Research Partnerships Programs, the IRC is clearly distinct and does not have unnecessary overlap with other programs. As pointed out above, the NSERC CRD program (which is most often cited as the program closest in design to that of the IRC) is better designed for carrying out an industrially relevant research project, while the IRC is best suited for tackling a longer term and wider-scope *program* of research. Arguably the closest program to the IRC is the Canada Research Chairs, which also provides salary support and assists universities in funding new or established professors. While superficially they may both appear to be similar, an analysis of each demonstrates them to be distinctive from one another, with the IRC program being uniquely focused on industrial research. Unfortunately, it appears that the CRC program overshadows the IRC program in terms of visibility and consequently prestige; a recommendation is put forth below to address this issue.

While not a panacea to university and industry alike, it can be concluded that the Industrial Research Chair program is one important method of addressing the complementary needs and priorities of the two sectors. From the university perspective, the Chair model forms an appropriate means to build linkages with industry and engage in needed industrially relevant research. Moreover, considering the salary support provided by the program, universities are furnished with a means to build critical mass in these industrially relevant domains. These benefits flow fittingly from the main objectives of the IRC program.

The activities and partnerships that result from the IRC program also meet industrial needs, in particular facilitating access to research conducted at an earlier stage than that which is typically done within the commercial sector. The cost sharing in the program that is borne by NSERC, the university, and the private sector company helps to ensure that risk on the part of the partner is significantly mitigated, thus stimulating industry involvement in, and benefit from, university-led research.

As was mentioned in the methodology section, one limitation of this evaluation, and thus upon the conclusions that can be drawn, is the evaluation's focus on only those industrial partners who *already* subscribe to the program. This approach does not address the extent to which the program is relevant and can meet the needs of *other* potential industrial partners. Therefore, a more thorough assessment of relevance would require an environmental scan or further consultation with non-participating



industrial organizations and universities.

4.2 Design and Delivery

Summary

Level of Satisfaction and Delivery Challenges

All stakeholder groups were highly satisfied with the program and with most dimensions of the program. While not pervasive, administrative and infrastructure inadequacies for their IRC research programs were more commonly reported challenges and in some cases impeded the Chair's research capacity and progress. From the university perspective, meeting costs associated with the Chair was difficult and was heightened with subsequent IRC renewals where salary support from NSERC is provided on a declining scale. Some universities experienced difficulties securing resources for salary replacement within the five year time frame. Finding funding within the partner organization to sponsor the Chair program was the most commonly reported challenge by industrial partners.

According to case study evidence, administrative challenges were greater in circumstances where there were multiple industrial partners; where the Chair maintained a large laboratory and research team; where university financial accounting requirements were substantially divergent from NSERC requirements; and where the Chair maintained a large number of collaborations outside the university.

Inadequate laboratory space and delays in securing lab space were two specific challenges identified by some Chairholder respondents. Despite additional funding for infrastructure through programs such as the Indirect Costs program, inadequate laboratory space is considered a key challenge by some Chairholders. Additionally, over one third of Chairholder respondents reported little or no impact with respect to new or renovated laboratory space. Evidence suggests that infrastructure challenges may be greater for those universities that are smaller; have considerable deferred maintenance costs; have experienced provincial funding cutbacks; and have experienced increased demands for space.

The time frame for the application and approval process (between 1 and 2 years) was



not a major source of dissatisfaction for either industrial partners or Chairholder survey respondents. Unsuccessful candidate key informants noted, however, that a pre-screening process would help to minimize unnecessary investments of time and resources. More than one third of applicants are not approved for IRC funding.

Collaborations between Industrial Partners and the Chair

According to the survey results and case study evidence, the majority of IRC partnerships arose from existing collaborations between the Chairholder and the industrial partner. Involvement in the IRC tended to be initiated by either the Chairholder candidate or the university. In only 17 percent of cases did Chairholder survey respondents report that they were approached by industry for an IRC.

The majority of industrial partners have regular and direct involvement with the Chair. Primary partners reported somewhat higher levels of interaction with the Chair as compared to secondary partners. The majority of partner survey respondents reported that they regularly discuss research findings with the research team (72 percent). Sixty-one (61) percent of partner respondents indicated that they have provided direction for the research process. Only 8 percent of industrial partner respondents reported that they are not involved in the IRC apart from the financial contribution.

Conclusions

In order for any program to achieve desirable levels of relevance, impact, and cost effectiveness, its design and delivery must be appropriate. This evaluation has been able to bring forth the conclusion that, in fact, the design and delivery aspects of the IRC program are very strong. As stated above, all stakeholder groups are highly satisfied with the program, and with most dimensions of its design and delivery. Nonetheless, despite this, several of the recommendations put forward below in section 5.0, relate to the delivery of the program.

The most cited and most apparent deficiencies in the program's design relate to a need for administrative and infrastructure support for the Chairs – deficiencies that can have a direct impact on the quality and pace of research outcomes. Not surprisingly, administrative problems were most prevalent under somewhat predictable circumstances, such as when an IRC has numerous partners,



collaborators, and a large research team. Furthermore, infrastructure difficulties are most likely within smaller institutions, or those under financial constraint. It is these findings that lead to the recommendation, described below, to consider a special funding mechanism to provide administrative and capital support under specific circumstances.

The salary support provided to support the Chairholder is obviously one of the strongest elements in the design of the IRC program, and forms one of the prime advantages for the universities' participation. Nonetheless, for some universities, because of the diminishing salary support during subsequent IRC terms, the five year time frame during which full support is furnished is insufficient to secure sustained and adequate funding to take over responsibility for the Chairholder's salary. As such, the recommendation of extending full salary support for an additional two years, for those institutions with demonstrated need, is provided in further detail in section 5.0.

Relating to design and delivery, the largest difficulty that has been observed to be experienced by the industrial partners is finding the funding within their own organizations. This challenge relates to factors external to the program's design and therefore addressing this issue may be more the role of industry or other programs aimed directly at helping Canadian industry build R&D capacity. The extent to which insufficient funding creates a barrier to industry participation in the IRC program should be further assessed in an environmental scan that includes consultation with non-participating industrial organizations.

The IRC program has a success rate of 62%, perhaps a relatively low number considering the investment of time and resources required to participate in what is a rather in-depth application process. Given the success rate, a more formalized pre-screening process would minimize unnecessary investments of time and resources for applicant, partner and Chairholder candidates.

Finally, the collaboration between industrial partners and Chairs is appropriate. The nature of the collaboration is somewhat dependent on the type of research conducted, the relationship between the Chairholder and the industrial partner prior to the formation of the IRC, and partner and Chairholder experiences with respect to industry and university contexts. Overall, these relationships have characteristics of



being direct, transparent and ongoing.

4.3 Impacts

Summary

Creation/Strengthening of Partnerships

The IRC program plays a strong role in strengthening existing partnerships and in creating new partnerships between industrial partners and universities. Sixty-seven (67) percent of industrial partner respondents reported that the existing partnerships with universities have been strengthened as a result of the IRC. Forty-two (42) percent of all partner respondents reported that their organization had formed new partnerships with university researchers and 31 percent reported that they had formed new partnerships with other organizations as a result of the IRC.

Partnerships between Chairholders and industrial partners are strengthened through the IRC. Survey evidence indicated that most current Chairholders and partners intend to maintain their collaboration with each other upon completion of the IRC term (primarily through an anticipated renewal of the Chair), and that former Chairholders and industrial partners tend to continue collaborations through a number of mechanisms (e.g. another NSERC program; contract research; and formal /informal network) after the completion of the Chair.

The Program was considered to increase collaborations within and outside the Chairholder's university. Sixty-nine (69) percent of Chairholder respondents reported that the Program had strong to moderate impacts with respect to enhancing collaborations within their university. Eighty-five (85) percent of Chairholder respondents reported moderate to strong impacts with respect to increased collaborations outside the university.

Impacts on Chairholder Research/Research Capacity

All lines of evidence supported the assertion that the Chair program contributed substantially to the Chairholder's research capacity in terms of increased size of research team, increased ability to attract more qualified personnel, enhanced reputation within the research community, and increased visibility of the research program with industry in general. Reported impacts with respect to reduced

administrative load and enhanced laboratory space were milder. Some case studies illustrated that a considerable portion of the first term can be dedicated to building research capacity.

There was a strong consensus that research was strongly impacted by the IRC program in terms of increased productivity, and in terms of an expansion of the research scope. According to case study evidence, collaborations with industry also benefit the Chair and its research in the following ways: by helping to keep informed of industrial needs and context; by helping to identify fundamental, long-term research objectives; by providing data for future research and development; by providing a “testing-ground” for tools and knowledge; and by providing feedback on the results of the research.

Similar to Senior Chairholders, Associate Chairholders experienced strong impacts with respect to a number of dimensions relevant to enhanced research capacity and increased research productivity. However, Associate Chairholders reported somewhat more moderate impacts with respect to reduced teaching and administrative loads, increased collaboration within the university and access to confidential data provided by the industrial partner.

Industrial Partner Impacts

With respect to partner impacts, the majority of partner respondents reported the strongest impacts with respect to increased access to specialized expertise and research results. These impacts are consistent with the partners’ expectations of the IRC program. Ongoing access to the Chairholder’s expertise was considered to benefit the partner organizations by facilitating the transfer of knowledge/technology with respect to cutting edge research, and potential new processes, products and methodologies for exploring research problems. Moreover, the Chair, through its network of collaborations, provides the partner organization with access to expertise beyond the Chair. According to survey evidence, about half of the partner organizations experienced moderate to strong impacts with respect to increased R&D capacity.

Survey evidence shows that IRC research is being used by industry, most commonly to improve or develop processes and products. Additionally, other receptor organizations typically use research results. A comparison of earlier and more recent Chairs revealed that, with the exception of prototype or pilot development, a greater percentage of the earlier Chairs showed evidence of transfer of knowledge/technology (e.g. increases in the number of patents issued, numbers of technologies



licensed, and improved and new processes and products), indicating that commercialization of results is being realized over time.

Overall, partner organizations experienced milder impacts with respect to a number of dimensions relevant to financial impacts such as improved revenues or cost reductions of the partner organization. According to partner survey evidence, the IRC program contributed considerably to the improved competitive position of partner organizations in 44 percent of reported IRC cases. For about one-third of the reported cases, the IRC program contributed substantially to increased market opportunities, improved productivity, and increased market opportunities of partner organizations. In about 20 percent of the reported cases, the IRC contributed substantially to the creation of new jobs; increased speed of supplying and/or delivering of goods; and increased cost-reductions. In just under 15 percent of the cases, the IRC contributed considerably to increased revenue and increased profitability.

Secondary partners experienced stronger financial impacts as compared to primary partners on a number of dimensions including increased speed of supplying and/or delivering goods; increased market opportunities; improved productivity; and increased revenues. These variations may be attributable to the different profile of primary and secondary partner respondents. The principal market of secondary partner respondents was more likely to be local and less likely to be international.

Case studies show that the economic results can be achieved through various pathways: through the direct application of research results; through increased partner R&D capacity leading to improved financial outcomes; and through factors other than research (e.g. enhanced visibility/prestige associated with the Chair). Although not directly part of the IRC expected results, the IRC program contributes, to some extent, to the realization of outcomes pertinent to environmental and social issues.

University Level Impacts

The IRC program was reported to contribute significantly to the achievement of critical mass and helped to bridge gaps in existing programs or developed niche areas (e.g. automotive sector, environmental science, construction engineering and management). The building of critical mass in industrially relevant areas was linked to a number of the program's features and benefits such as its leveraging effect, its effectiveness as a tool to recruit and retain faculty (through salary support and

increased prestige), and its ability to attract HQP.

The salary support feature was considered to be particularly important in building critical mass, in that it enabled the university to attract external expertise and in the case of Chairholders selected from within the university, use the freed up salary funds for replacement faculty members in complementary areas of research. Just under half of the current active Chairs are external candidates; a good indication that the IRC program plays a substantial role in helping create critical mass in new research areas for those universities.

The recruitment of replacement faculty typically results in increased teaching and research capacity at the university. The impact of the replacement faculty on the Chair's research area is less clear as varying degrees of integration with the Chair's program of research were reported, with some replacement faculty members more peripherally involved than others in the Chair's research.

HQP Impacts

According to survey evidence, most HQP interact with industrial partners. The most common types of interactions between HQP and partners are the presentation of research results and the discussion of research projects. The interactions were considered to provide training enhancements by improving knowledge of the industrial context and by developing an understanding of how research results are transferred to industry. About one-third of industrial partner respondents indicated that they have hired HQP. Survey results indicated that more than two-thirds of HQP who obtain employment are employed by industrial partners and industry upon completion of their involvement with the IRC. However, it is not clear from the evidence as to the extent of HQP that are employed with Canadian industry.

Conclusions

When considering the impacts of the IRC program, this evaluation was designed to determine the extent to which the program has been successful in meeting its program objectives and its intended reach. At this point it is worthwhile to review these objectives: to assist universities in building on existing strengths to achieve the critical mass required for a major research endeavour in science and engineering of interest to industry; and/or to assist in the development of research efforts in fields



that have not yet been developed in Canadian universities but for which there is an important industrial need.

It should be pointed out that, in general, the impacts achieved by the IRC program are stronger with respect to more immediate outcomes, and are moderate or milder where longer time horizons are necessary to achieve results. This is not surprising considering the evaluation's focus on more recent Chairs.

The results of the evaluation demonstrate that the IRC program is having significant impact in terms of meeting its objectives – as well as in areas beyond these precise bounds. The program directly contributes to building critical mass in universities in research areas relevant to industry, especially through the design element of salary support, which leads directly to the creation of new positions. Furthermore, taking into account that almost half of the current IRCs have been formed with external candidates, and that a substantial portion of these candidates come from outside Canadian academia, demonstrates the incremental impact the program is having.

The IRC program also has a strong impact with respect to building the research capacity of the Chairholder. The increased research capacity facilitated by the IRC program, coupled with an enhanced focus on a *program* of research contributes to increased research productivity and a broadening of research scope. Moreover, the distinct, longer term features of the IRC program encourage not only industrial partnership with universities, but also engagement in fundamental or more speculative research.

Related to the development of research capacity, the IRC program plays a strong role in strengthening existing partnerships between Chairholders/universities and industrial partners. The program also has a strong impact with respect to increased Chairholder research collaborations outside the university, along with a more moderate impact on increased collaborations within the university. Furthermore, with respect to partnering, IRC Chairs moderately contribute to the creation of new partnerships between universities and industrial partners, as well as between other organizations and industrial partners.

In terms of the impact of the program on the industrial partners, most generally, they benefit from increased access to specialized expertise. This increased access



contributes substantially to building the R&D capacity of partner organizations and to the transfer of knowledge/technology to industry. With the formation and existence of an IRC Chair, many conditions exist for the transfer of knowledge and technology to industry. Direct and regular interactions between industry and the Chair do, for the most part, take place. HQP involved in the Chairs typically interact with industry and in many cases are eventually employed by industry. The knowledge from an IRC that is transferred is typically used to improve or develop processes and products. Moreover, research results are frequently used by organizations other than the specific industrial partners.

Not surprisingly, the extent to which IRC research is transferred to partner organizations and to other receptor organizations, generally increases over time. However, it should be noted that the extent to which an individual Chair is involved in knowledge and technology dissemination activities varies considerably. It is not clear whether Chairholders have the appropriate resources and capacity to perform necessary dissemination activities or whether other mechanisms for knowledge and technology transfer are needed.

For a small portion of partner organizations, involvement in an IRC has had a substantial impact with respect to the enhancement of commercial and financial outcomes. Given the evaluation's focus on recent Chairs and the evidence for achievement of more immediate outcomes, the IRC program likely results in more extensive economic and commercial impacts for partner organizations over longer timeframes. Secondary partners, as opposed to primary partners, are more likely to realize stronger commercial impacts as a result of the IRC program. This result is likely due to the different profiles of secondary partners: their principal markets are more likely to be local and less likely to be international – and therefore impacts may be more likely to be immediate. Although not one of the intended outcomes of the IRC program, the program contributes, to some extent, to the realization of outcomes pertinent to environmental and social issues, benefiting Canadians. However, current performance reporting does not fully track environmental and social outcomes derived from the IRC program⁴³.

⁴³ While the final report tracks contributions to policy or regulations, the progress report does not track indicators relevant to environmental and social outcomes

Finally, in terms of the impact on the development of HQP, the IRC program augments the training of HQP by providing them with access to a broader range of collaborators and partners, and by enhancing the HQPs' understanding of how technology and knowledge are transferred to industry. The incremental impact of the IRC program on HQP employment is less clear, except in those cases where the IRC has contributed significantly to the development of curriculum in niche areas where there is high industry demand. While a substantial portion of HQP are employed by industry immediately following their IRC involvement, the extent to which HQP are employed by Canadian industry is not known.

4.4 Cost-effectiveness

Summary

Overall, the Chair model was viewed as the most cost effective means to assist universities in building critical mass in industrially relevant areas. NSERC, Committee and expert key informants cited the Program's leveraging effect and the substantial cash and in kind contributions by the private sector as evidence of its cost-effectiveness.

The IRC program leverages industrial partner funds that contribute both to the costs of research and to the Chairholder's salary. Total NSERC contributions from 2000/2001 to 2005/2006 amounted to approximately \$72M. Private sector and other partner cash contributions totalled approximately \$107M. Private sector and other partner in-kind contributions totalled \$36M for that same time period. Hence, the IRC program leverages 2 private and public sector dollars (including cash and in-kind contributions) to every 1 dollar it funds/provides (i.e., at a ratio of about 2 to 1).

The Chair was reported to be a more effective model, as compared to other funding mechanisms such as the CRD and the CRC programs, in generating leveraging momentum. The long term funding commitment, flexibility, and prestige associated with the IRC were considered to contribute substantially to the enhanced leveraging effect of the program. The long-term funding commitment was also reported to facilitate leveraging compared to project based funding which involves coordinating different funding applications according to specified time frames. Additionally, the

higher degree of visibility afforded the Chair in an identified area or theme of research serves to attract other funding. According to many Chairholder and university key informants, the focus of the program on industry-university alliances also serves to differentiate it from the CRC program, enhancing its visibility to industry.

Conclusions

As stated in the methodology section, the analysis of cost effectiveness that has been carried out for this evaluation is limited to the leveraging aspect of the IRC program, and the perspective of stakeholders as to whether the IRC objectives can be achieved more cost-effectively through other alternatives. Nonetheless, the evaluation has yielded varied evidence that the Chair model is a cost effective means to assist universities in building critical mass in industrially relevant areas. Moreover, the objectives of the IRC program could not be achieved to the same extent through other funding mechanisms such as the CRD or CRC programs.

A key advantage of the IRC program's design is that it leverages private sector funds that contribute both to the costs of research and to the Chairholder's salary. Moreover, the long term funding commitment, flexibility, and prestige associated with the IRC contribute to the enhanced leveraging effect of the program. Finally, the IRC differentiates itself from the CRC program by focusing on industry-university partnerships, enhancing its visibility within the private sector.



5.0 Recommendations

Overall the evaluation provided strong evidence that the program meets overall expectations and needs of universities, researchers and industrial partners. Moreover, there is reasonable and varied evidence to support that many of the impacts, particularly with respect to enhanced research capacity and building of critical mass in industrially relevant areas, can be attributed to the unique design elements of the IRC program. While no pervasive challenges were found, there were some aspects of the program that merit further assessment and modifications. The following recommendations address some of the key issues identified in the findings and conclusions.

1. Identify and implement additional efforts to further augment the visibility and prestige of the IRC program. The prestige and visibility associated with the IRC is of value to researchers and is viewed as an important factor in leveraging additional funding. The Canada Research Chairs program has the potential to overshadow the IRC program in terms of visibility and prestige, and thus there is a risk that this could negatively impact on the IRC program. Therefore, it is important to ensure that the visibility of the IRC program is maintained or enhanced. Efforts to enhance visibility could be targeted towards researchers, industrial partners, and industry in general. Additional efforts to recognize the endeavours of the Chair are worth further consideration. Increased awareness of IRC benefits to industry would enhance the industrial partners' level of commitment and support for the Chair. The prestige of the IRC could be further enhanced through more formal gatherings or events to recognize the Chairs' achievements.

2. Consult with non-participating universities and industrial organizations to assess opportunities and challenges with respect to IRC involvement. One limitation of this evaluation is its focus on those partners who subscribed to the program. Some universities may face more challenges in establishing and supporting a Chair. Additionally, there may be potential industrial partners that face barriers that could be addressed through adjustments to the program or improved marketing and outreach. Therefore, to better assess possible barriers and challenges to participation in the program, consultation with non-participating universities and industrial organizations is recommended. Specifically, NSERC could also assess whether

smaller companies, or companies involved in emerging technologies or in more vulnerable sectors would benefit from the IRC program or whether other funding mechanisms can best address their needs. The evaluation found that finding funding within the partner organization to sponsor the Chair was challenging for many industrial partner organizations. Therefore, the environmental scan should also assess the extent to which finding funding within the partner organization is a barrier to participation in the IRC program as well as possible strategies to address this challenge.

3. Consider making available a special funding mechanism, linked to the IRC program, to provide for administrative and capital costs of research in specific circumstances. The evaluation showed that in certain circumstances, administrative and infrastructure support was inadequate. A special fund could be made available for those IRCs demonstrating the need for additional administrative or infrastructure support. Application for additional funding would be made at the same time as application for the Chair or application for renewal. The applicant would have to clearly demonstrate the special circumstances that necessitate additional funding. Additionally, to help address administrative challenges faced by some Chairholders, NSERC should also consider the development and dissemination of best practice information to Chairholders with respect to the management and administration of IRCs.

4. In the case of second term renewals, NSERC should consider providing full salary support for the first two years with salary support provided on a declining scale the remaining three years of the renewal, for those universities who can adequately demonstrate need. The evaluation showed that the five-year time frame is insufficient for some universities to find adequate resources for salary replacement. Full support for salary during the first two years of renewal would engender more university support for IRC renewals.

5. NSERC should consider adopting a two-step application process. The application and approval process necessitates a considerable investment of time and resources. A more formalized pre-screening process would help to reduce unnecessary investment of time and resources for those IRC applicants not likely to be successful in the competition. A two-stage proposal process would be one option to address this challenge. The first stage would involve a précis proposal. A full

proposal submission would be accepted only upon pre-approval of the précis. Pre-approval by all three parties (University/ Industry/ ACUIG) of the Chair and Chairholder candidate would be required. The industrial partner candidate(s) should be identified in the précis.

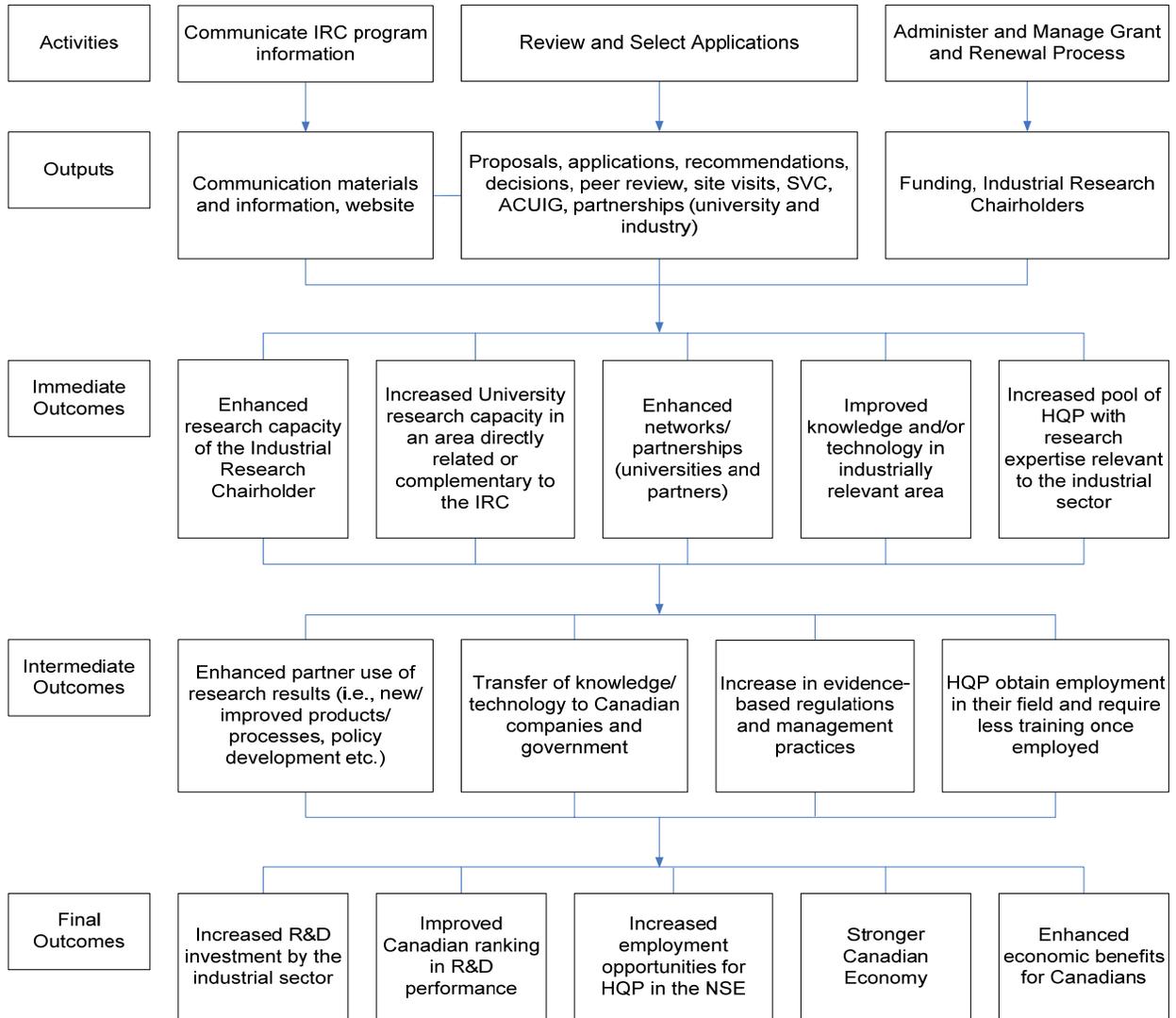
6. Modify performance reporting tools to ensure that environmental and social outcomes of the IRC program are adequately monitored. Although not directly part of the IRC mandate, the IRC program contributes, to some extent, to the realization of outcomes pertinent to environmental and social issues. However, current performance reporting does not fully track environmental and social outcomes derived from the IRC program. By improving tracking of these outcomes, data collected over time, could provide some guidance as to whether environmental and social results should be more clearly articulated in the program logic.





Appendix A: IRC Program Logic Model

The following logic model illustrates the key activities, outputs and expected outcomes of the IRC program.





Appendix B: Survey Results



