



**INTERIM EVALUATION OF GENOME
CANADA**

Prepared for: Genome Canada

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EXECUTIVE SUMMARY

This report presents the findings from the interim evaluation of Genome Canada. The interim evaluation study was carried out following Genome Canada's first three years of operation. Its objectives were to:

- Provide a timely, in-depth look at how the program is progressing relative to its objectives; and
- Examine the management and implementation of the program to determine whether any adjustments are necessary.

As an interim evaluation, the study was intended to answer the question: Generally speaking, is Genome Canada on the right track?

The answer is "yes". Genome Canada's Overall Objective is to initiate and effectively manage a major nationwide program in genomics research. The hope was that, starting from a position of lagging behind many other countries in genomics research (e.g., the United States, the United Kingdom), Genome Canada would enable Canada to catch up with these countries, at least in selected sectors. The indications from this study are that this is happening and that Canada is now recognized as a potential world leader in certain areas (i.e., GE³LS¹, agriculture, aquaculture, forestry, proteomics).

In order to accomplish this in a relatively short period of time (three to five years), Genome Canada introduced an innovative, business-oriented program model. This model is based on the funding of considerably larger research projects than are generally funded by other Canadian research programs, the identification and funding of the required scientific support infrastructure, and a major emphasis on the management of the research. The latter includes:

- Emphasis on project management at the research proposal stage;
- The establishment of regional Genome Centres that are responsible for assisting in program development, monitoring the progress of the research projects, and various coordination activities for the projects in their region;
- Quarterly financial reporting to Genome Canada for all projects, and quarterly or semi-annual scientific reporting to the Genome Centres; and
- A formal interim review of all projects.

This study concluded that the Genome Canada research projects are by far the most actively managed university research projects in Canada.²

Although the study did not include a detailed management review, the data that were collected indicate that Genome Canada's management mechanisms are effective. There have been some "growing pains" and some struggles with changing a research culture accustomed to smaller, more independently managed research projects, which usually do not have firm milestones and deliverables. But, in spite of this, the

¹ GE³LS stands for research related to ethical, environmental, economic, legal, and social issues in genomics.

² Not all Genome Canada projects are university-based, but the vast majority of them are.

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researchers involved in Genome Canada's research program believe that the program is being effectively managed.

In addition to its Overall Objective discussed above, Genome Canada has nine specific objectives. The main findings relevant to each of these objectives are summarized below.

Objective 1: Increased interactions, partnerships, and collaborations between organizations

Bringing Canada's stakeholder groups together is an important element of Genome Canada's model, and it is a definite strength of the program. There has been great progress in a relatively short period of time in creating linkages with other domestic organizations, such as research institutions and government.

Genome Canada's program was also designed to build on and complement existing genomics infrastructure and programs. It has done this – the funding of projects and platforms has enabled the enlargement and acceleration of projects previously (and currently) supported by other funding agencies.

Objective 2: Establish Genome Centres to provide leading edge technology and training

Genome Canada has established the five regional Genome Centres, as specified in the original funding agreement, and these have made some significant contributions to the program:

- They have played a major role in raising co-funding; and
- They have been instrumental in managing the technology platforms and in developing the strategic plans and policies to ensure that the platforms are capable of satisfying the needs of their genomics project base.

Specifically with regard to S&T infrastructure and training (which are mentioned in this objective), the study found that:

- The accessibility of the necessary S&T infrastructure to genomics researchers has increased dramatically as a result of Genome Canada.
- Genome Canada, the Genome Centres, and the funded projects have been highly successful in recruiting, retaining, and training the necessary workforce in all genomics-related fields, including that of project management for large-scale science.

Objective 3: Incremental research projects that are based on Canadian strengths and expertise

Genome Canada's strategy in the first two competitions was based on identifying and supporting Canada's most promising genomics research and researchers – i.e., Genome Canada emphasized the scientific merit of the research in order to “get Canada on the map” in the field of genomics. The key elements of this strategy – a responsive proposal process, and an in-depth peer review process conducted by a highly qualified international panel – were successful in identifying and supporting Canada's scientific strengths and expertise.

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There is clear evidence from the study that the research that is funded through Genome Canada is incremental, in the sense that it could not have been funded and managed at internationally competitive levels through other existing Canadian programs or organizations.

Objective 4: Adequate and effective management of S&T platforms

Ten science and technology platforms have been funded through Genome Canada and other co-funders. These were selected on the basis of satisfying the research infrastructure needs of the large-scale projects that came forward during the competitions. The accessibility in Canada of the necessary infrastructure for genomics research has increased dramatically as a result of Genome Canada, and these platforms are meeting important needs.

The platforms have all put in place reasonable policies regarding eligibility, access and priorities, pricing, and intellectual property. Most of the platforms are operating at the highest level of productivity possible.

Objective 5: Leadership in GE³LS

Genome Canada is internationally perceived as being a leader in GE³LS. A variety of strategies have been employed to support the consideration of and research regarding GE³LS issues:

- Genome Canada and co-funders have contributed over \$14M to five GE³LS-related large-scale projects.
- Additional funding has been allocated to GE³LS-related initiatives, newsletters, and workshops.
- Genome Canada has organized an Annual Genome Canada International GE³LS Symposium
- Various mechanisms have been employed to integrate GE³LS considerations into the large-scale research projects, where appropriate.

The latter is particularly impressive in light of the difficulties that have been encountered by other research funding organizations in attempting to integrate ethical, economic, environmental, legal and social considerations with biology and chemistry in complex research areas.

Objective 6: Effective communications and outreach program

Genome Canada has a well-defined communications strategy in place, with the objective of increasing its visibility and credibility and developing “brand recognition”. The organization is undertaking a wide range of communications and outreach activities. The communications outputs are recognized as being innovative and of high quality, and the data indicate that these are successful in reaching the target audiences.

The Genome Centres vary with regard to the extent they address communications issues. The emphasis of their communications strategies is generally on raising the level of stakeholder awareness for external funding and collaboration purposes.

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Objective 7: Increased participation in international genomics research

Genome Canada has steadily increased its level of international activity. It has set up the International Consortium Initiative for funding international genomics projects, has signed international MOUs with four countries and, as a result of the MOU with Spain, has launched a Joint International Competition with Genoma España.

Genome Canada has also had a significant impact on the level of international participation within its large-scale projects. There is considerable emphasis on international considerations in the peer review process (both the initial and the interim reviews), and approximately 40% of the large-scale projects have international collaborations formally built into the project plan. The study data indicate that Genome Canada has contributed to a 50% increase in the international activities of the Principal Investigators and Co-Applicants.

Objective 8: Increased investment in genomics research by others

The program has encouraged many other stakeholders to invest in genomics research, including federal agencies, most provincial governments, and industry. Genome Canada has surpassed its co-funding target of \$320 million over five years, which was required based on the first \$300M of federal government funds.

However, the co-funding issue has also been a source of considerable controversy. Many researchers and university VPs of research feel that the co-funding requirement has, in many cases, required an inordinate investment of time and been a distraction to undertaking research.

Objective 9: Socio-economic and industrial benefits to Canada

There are high expectations among the federal government and public sector co-funders regarding the realization of socio-economic benefits from this program. The program will indeed lead to significant socio-economic benefits; however, because most genomics research is long-term and relatively fundamental research, these benefits will most likely not occur as a result of research findings generated in Genome Canada projects – at least not within the next ten years. It is more likely that they will occur as a result of the research capabilities developed through the process of carrying out these projects.

It is now well known that most innovation does not follow the classic linear model (research leads to findings leads to applications leads to product/process development leads to innovation).³ This does not mean that research is not a major factor contributing to innovation. Through the process of conducting research, researchers acquire research capabilities, as well as knowledge regarding the latest research findings (worldwide), and, in addition, new researchers are trained. This higher level of research capability increases the ability of the research community to acquire relevant external knowledge, and that, in turn, contributes to socio-economic benefits. For example, studies indicate that most firms invest in R&D, not to generate research findings, but to develop the knowledge base and ability to be able to

³ See, e.g., Steven J. Kline, Innovation is not a Linear Process, *Research Management*, July-August, 1985.

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identify and assimilate external knowledge.⁴ (The impact of Genome Canada on increasing Canada's level of genomics research capability is demonstrated in this report and is quite impressive.)

That being said, the best strategy for generating socio-economic benefits from research programs is to concentrate on maximizing the potential for such benefits during the initial project selection and design. Not only does this increase the probability of benefits arising from the research findings, but also, research capabilities are developed in the most relevant areas. In particular, the project selection process is the pre-eminent strategic device for creating and realizing socio-economic benefits from research programs.

The potential for socio-economic benefits was not a dominant factor in the first two competitions. The competition guidelines included criteria related to potential socio-economic benefits⁵, but these were not given serious consideration in the peer review process, which placed the main emphasis on scientific merit.⁶ In addition, Genome Canada adopted a largely responsive approach in these competitions.⁷ Our (admittedly cursory) review of Genome Canada's large-scale projects and the reviews carried out by the Genome Centres indicate that it could take between seven to 14 years before socio-economic benefits are derived from the application of the research findings from these projects.⁸

Much of the responsibility for achieving the longer-term socio-economic benefits from Genome Canada projects has been given to the Genome Centres. The Centres have done considerable strategic planning in this area, and most of them plan to increasingly depend on the revenues derived through commercialization to fund their operations. As commercialization assumes increasing importance within the Centres, there is some potential for them to come into conflict with Genome Canada, since the Centres have, to date, had little influence on the selection process.

⁴ *W.M. Cohen and D.A. Levinthal, Innovation and Learning: the two Faces of R&D, The Economic Journal, September 1989. For an expanded discussion of this issue see D. Williams and D. Rank, Measuring the Economic Benefits of Research and Development: the Current State of the Art, Research Evaluation, April 1998.*

⁵ *For example, "benefits to Canada, including...economic, industrial, and social".*

⁶ *In particular, high scientific merit was a necessary condition for project approval; high potential for socio-economic benefits was not.*

⁷ *On the other hand, potential socio-economic benefits are obviously being given major weight in the current Applied Human Health competition.*

⁸ *For example, in its review of all genomics research projects being conducted in Ontario, OGI concluded, "the shorter-term commercialisation prospects within the current portfolio of Genome Canada funded research projects are limited".*

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1.0 INTRODUCTION

This report presents the findings from the interim evaluation of Genome Canada. This study was conducted by BearingPoint under contract to Genome Canada and was carried out over the period November 2003, through February 2004. The objectives of the study were to:

- Provide a timely, in-depth look at how the program⁹ is progressing relative to its objectives; and
- Examine the management and implementation of the program to determine whether any adjustments are necessary.

It should be emphasized that this study has not involved the evaluation of the activities of the five regional Genome Centres, nor has it involved the evaluation of individual Genome Canada-funded research projects. It is a review of Genome Canada as a whole, focusing on its structure, operation, and management.

It should also be emphasized that this is an interim evaluation, which was conducted approximately three years after Genome Canada was set up. It was not expected that this interim evaluation would attempt to draw definitive conclusions regarding the impacts of this initiative. The interim evaluation simply aims to provide a clear and comprehensive picture of how Genome Canada has been implemented, and it is intended to answer the question: Generally speaking, **is this program on the right track?**

This interim evaluation was overseen by a Steering Committee consisting of representatives of Genome Canada senior management, Genome Centre management, the Board of Directors of Genome Canada, Industry Canada, Treasury Board Secretariat, and the research community.

The following section provides a description of Genome Canada. The interim evaluation activities and methodology are summarized in section 3.0, and the study findings, by Genome Canada objective, are presented in section 4.0.

⁹ For convenience, Genome Canada is referred to as a program in this report.

2.0 DESCRIPTION OF GENOME CANADA

2.1 Overview

Genome Canada was established by the federal government in April 2000, to provide the funding and coordination for a national program in genomics and proteomics research. The overall objective of the organization is:

To coordinate genomics and proteomics research to enable Canada to become a world leader in selected sectors that are of strategic importance to this country, such as health, agriculture, environment, forestry, and fisheries.

The government has invested \$375 million in Genome Canada to date.

Genome Canada has established five Genome Centres across the country (Atlantic, Québec, Ontario, Prairies, and British Columbia), and much of the delivery of the program is administered through these Centres. Applicants for research funding apply for funding to one of the Centres, which in turn selects the proposals to put forward to Genome Canada for review. Once projects have been approved by Genome Canada's Board of Directors, the Centres are responsible for project monitoring and program administration.

Genome Canada provides up to 50% of the funding for large-scale research projects and science and technology platforms. It is the responsibility of the applicant to secure the remainder of the funds from other sources (e.g., industry, foundations or provincial governments). To date, 64 research projects and S&T platforms have been funded through four funding sources – Competition I in 2001, Competition II in 2002, the International Consortium Initiative (2002), and the Genoma España–Genome Canada Competition, for which the results were announced in January 2004. Another competition is currently underway, the Applied Genomics and Proteomics Research in Human Health Competition (results to be announced in April 2004).

In addition to the overall objective quoted above, Genome Canada has nine specific objectives:

1. *Bring together industry, governments, universities, hospitals, research institutes, and the public in support of the national genomics research program.*
2. *Establish five Genome Centres across Canada...to provide leading-edge technologies to researchers and cross-disciplinary training of the necessary workforce in all genomics-related fields.*
3. *Support large-scale genomics projects that draw on existing Canadian strengths and expertise, and whose scale and scope are such that they cannot currently be funded at internationally competitive levels through existing mechanisms.*
4. *Put in place research infrastructure to support the major science and technology platforms essential for the large-scale projects, including...functional genomics and proteomics, genomics sequencing, genotyping, bio-informatics, and new technology development.*
5. *Ensure leadership in ethical, environmental, economic, legal, and social issues related to genomics (GE³LS).*
6. *Effectively communicate the results of genomics research to the public, thereby helping Canadians to understand the relative risks and rewards of this type of research.*

7. *Foster Canadian participation in international genomics research programs.*
8. *Encourage investment in genomics research by others.*
9. *Create and realize economic, industrial, and social benefits to Canada.*

2.2 Operation of Genome Canada

2.2.1 Proposal process

There have been some differences in the proposal process for each of the four competitions, but generally the process works as follows:

- Genome Canada issues a call for proposals, which includes descriptions of the guidelines and evaluation criteria that will be used, as well as specific timelines.
- The Genome Centres publicize the competition to the research community, and researchers access applications through the Centres' websites.
- Researchers develop proposals in consultation with the Centres. This process can involve a fair degree of interaction between the researchers and the Centres, and the Centres often become involved in assisting researchers with the preparation of sections of the proposal (e.g., the financial and management sections).
- Proposals are pre-screened by the Centres, sometimes with the assistance of a scientific advisory committee, and the Centres put forward a subset of the submitted proposals to Genome Canada for consideration.
- Genome Canada conducts a "due diligence review" for each of the submitted proposals. This process involves a detailed analysis by management experts of the budgetary and management aspects of the proposals, including meetings with the proposed principal investigators (PI). Some proposals are rejected at this stage and others are sent back to the researchers for revision.
- The remaining/revised proposals are then reviewed by an international panel of scientific experts in a rigorous peer review process.¹⁰ This process involves a "reverse site visit" in which the PIs – usually accompanied by other members of the research team – travel to the location in which the panel is meeting for presentations and to answer questions of the panel.
- The panel recommends the proposals that should be funded to the Board of Directors of Genome Canada¹¹, and the Board approves the recommended proposals.

The main differences between the three competitions have been:

¹⁰ *Written reports are obtained from external reviewers for each proposal, and each proposal is assigned to a minimum of three to four panel members, who prepare detailed written reports for the proposed project. During the panel meeting the primary and secondary reviewers present their reviews, followed by comments from the other reviewers and a discussion by the entire panel. A consensus rating is mandatory.*

¹¹ *Actually, each proposal is rated either A = highly recommended, B = recommended, and C = not recommended.*

- In Competition I Genome Canada solicited “combined proposals” which included proposals for the regional Genome Centres together with associated research projects – both large-scale research projects and the S&T platforms that were viewed as necessary for carrying out the large-scale projects. (These large-scale projects and S&T platforms were viewed as the proposed research program of the Centres.)
- Genome Canada adopted a responsive position for Competitions I and II – i.e., there were no specific guidelines regarding the types of projects the organization was looking to support or the desired areas of application (health, forestry, etc.). In the current Applied Human Health Competition, however, Genome Canada stated that it was soliciting proposals “focusing on the development and application of genomics and proteomics tools to improve the prediction, prevention, and treatment of human disease...” This focus on human health was mandated by the federal government in the February 2003 budget, as one of the conditions of the funding provided for this competition.

2.2.2 Project and program monitoring

For each project that is funded by Genome Canada, the Genome Centre designates a Project Manager who monitors the project on an on-going basis from both a scientific and financial perspective and ensures that the necessary project performance information is collected. The performance information that is required is specified in Genome Canada’s overall performance measurement system.¹²

Formal project reporting is done on the following basis:

- Financial reports are submitted quarterly.
- Scientific reports are submitted either quarterly or semi-annually to the Genome Centres.

These reports are intended to document the progress and accomplishments of the project in relation to the detailed project plans laid out in the proposals.

Each project is subject to an in-depth interim review by an international panel of scientific experts after its first 18 to 24 months of operation. In preparation for this review, the PIs are required to prepare a detailed progress report addressing the progress of the research relative to planned milestones, the involvement of highly qualified personnel (training of students and recruitment of researchers), and the project’s management process and structure. The PI, generally accompanied by other members of the research team, then meets with the review committee to make a presentation and answer questions. Following this, the committee prepares a detailed report on each project summarizing their views regarding strengths, weaknesses, and any required corrective actions.

In addition, Genome Canada has a Scientific and Industry Advisory Committee (SIAC), composed of international senior scientific experts from universities and industry. The official mandate of this committee is “to provide strategic advice to the Board of Directors of Genome Canada on approaches and directions that will ensure that the corporation achieves its long-term objectives of excellence and leadership in selected areas of genomics and proteomics research”. This includes advising the Board on major research trends and emerging international opportunities. As is clear from this description, the SIAC is intended to assist Genome Canada in the area of strategic planning, and it does not have a formal

¹² This, in turn, is part of Genome Canada’s Results Based Management and Accountability Framework that was developed to satisfy Treasury Board accountability requirements.

monitoring role. However, to date Genome Canada has functioned primarily as a responsive organization, and has not engaged in strategic planning, so the SIAC has carried out a de-facto monitoring role. The Committee has met with representatives of the Genome Centres and representatives of their associated research projects and provided advice regarding these research programs.

A review of the organization and operation of Genome Canada as a whole was conducted in December 2002 by Mercer Human Resource Consulting. That study focused on organizational performance, as well as the performance of Genome Canada's Chief Executive Officer. The current mid-term evaluation is the first formal review of the entire organization. There is planned to be a full formal "summative" evaluation at the end of Genome Canada's 5-year term.

2.2.3 Communications

As noted in section 2.1, one of Genome Canada's formal objectives deals with communications: "Effectively communicate the results of genomics research to the public (...)". Genome Canada and the majority of the Genome Centres have undertaken major communications programs. These are described in more detail in section 4.7. By way of overview, it can be said that communications and outreach activities range well outside of the stated objective of communicating genomics research results. Some of the most common communications activities to date have been:

- Branding (Corporate logo, website, annual report, brochures, promotional items)
- Newsletters and other publications
- Media guide, press releases, media contacts and interviews
- Workshops, symposium
- Advertising, special features and magazine supplements
- Public education programs such as the Canada-wide Science Fair and The Gee! In Genome exhibition.

2.2.4 Investment

Another of Genome Canada's specific objectives is: "Encourage investment in genomics research by others." The main impetus for investment by others is the co-funding policy, which stipulates that up to 50% of the costs of proposed research projects are funded by Genome Canada and the remainder must be contributed by outside parties. The co-funding does not necessarily have to be secured at the time of the proposal submission, but each proposal must contain a feasible strategy for obtaining co-funding, and the practicality of this strategy is assessed during the due diligence review process.

The Genome Centres are active in assisting project personnel to seek and arrange co-funding.¹³ For example, they generally maintain close relationships with provincial government programs that provide research support, and they assist the researchers with applications to these programs.

¹³ All statements that refer to "the Genome Centres" are generalizations. For example, in the area of co-funding, some of the Centres are much more active than others.

2.2.5 GE³LS

Still another of Genome Canada's specific objectives deals with GE³LS issues: "Ensure leadership in ethical, environmental, economic, legal, and social issues related to genomics (GE³LS)". To this end Genome Canada has done two things:

- Encouraged applications for large-scale GE³LS research projects and funded a number of these.
- Set up systems at the Genome Centre level to ensuring that appropriate and adequate attention is given to GE³LS issues in the conduct of the mainstream (i.e., non-GE³LS) research projects. These mechanisms vary by Centre, but include, for example, GE³LS committees involving a representative from each project to discuss and resolve GE³LS issues, GE³LS experts on staff at the Centre to advise projects regarding GE³LS issues, periodic workshops to discuss GE³LS issues, and so on.

2.3 Projects Funded to Date

To date, Genome Canada has funded 54 large-scale projects and ten science & technology platforms. Table 1 (below), as well as figures 1 and 2, provides a breakdown of these projects, and the associated funding, by Centre, as well as by Sector. Note that these funding figures do not include additional GE³LS funding, which was provided directly to Genome British Columbia and Ontario Genomics Institute (\$640,000), as well as funding for associated development costs (\$4,208,598), which was provided to the Genome Centres to assist in the operation and management of Competition I projects.

Table 1: Allocation of Genome Canada Funding to Large-Scale Projects and Platforms

	Canada	BC	Prairies	Ontario	Québec	Atlantic
GE ³ LS	5	1	1	2	1	0
	8,155,283	632,986	1,663,450	4,551,567	1,307,280	-
Agriculture	5	1	2	1	0	1
	19,352,482	3,134,481	13,478,375	814,273	-	1,925,353
Fisheries	2	1	0	0	0	1
	5,143,568	3,101,564	-	-	-	2,042,004
Environment	3	1	0	1	1	0
	8,992,202	2,304,774	-	2,931,073	3,756,355	-
Forestry	4	1	0	1	1	1
	14,257,042	5,423,868	-	2,326,649	4,375,703	2,130,822
Health	31	6	1	9	13	2
	170,478,477	26,771,621	13,465,707	65,849,415	60,857,245	3,534,489
Bioinformatics	1	0	0	1	0	0
	12,500,000	-	-	12,500,000	-	-
Development of New Technologies	3	0	1	2	0	0
	14,499,904	-	8,564,069	5,935,835	-	-
S&T Platforms	10	5	1	2	1	1
	40,083,010	8,142,010	5,000,000	11,281,314	9,014,853	6,644,833
Totals	293,461,967	49,511,304	42,171,601	106,190,126	79,311,436	16,277,501

Figure 1

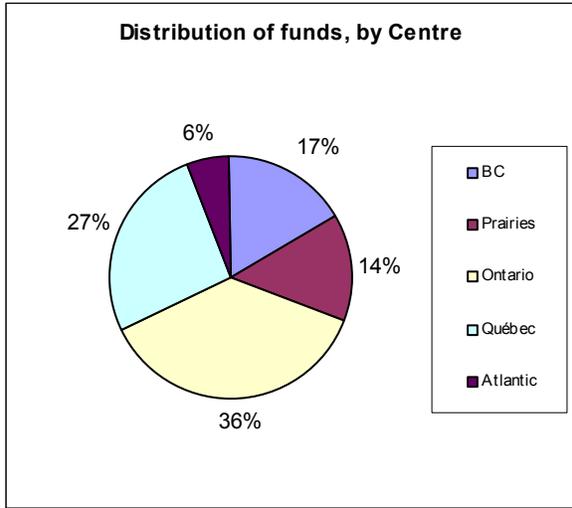
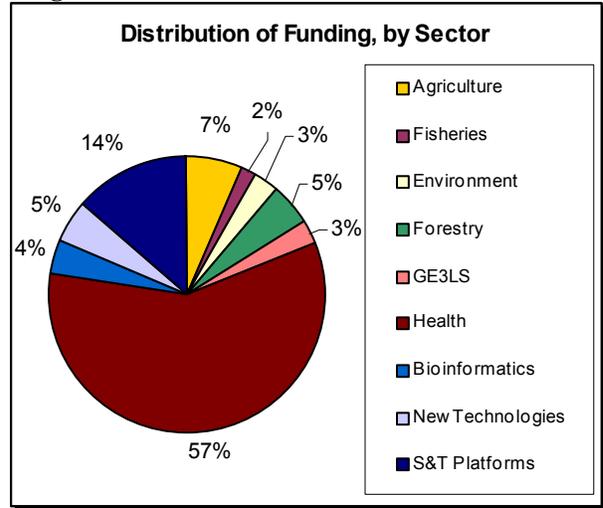


Figure 2

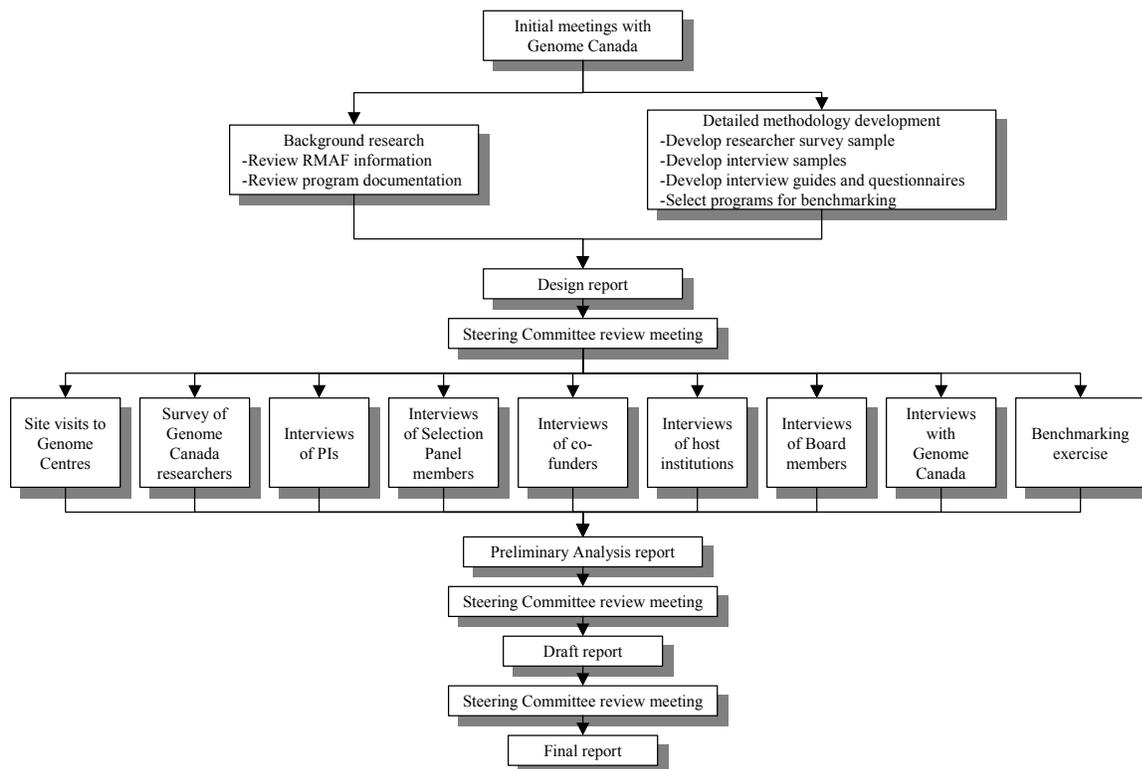


3.0 STUDY ACTIVITIES AND METHODOLOGY

The work plan that was followed in carrying out this study is illustrated in Figure 3, below. The top five activities are largely self-explanatory.¹⁴ After the Figure, we describe each of the main data collection activities.

We emphasize once again that this study was an interim evaluation, and, as such, we were not overly concerned with “academic” methodological issues such as statistical validity. On the other hand, we intentionally utilized a wide range of data sources, as evidenced by the fact that there are nine boxes along this row. The purpose of this was to ensure that any significant findings presented in this study are corroborated by a number of different data sources, thereby increasing confidence in the validity of the findings.¹⁵

Figure 3: Work Plan for the Interim Evaluation of Genome Canada



¹⁴ The acronym “RMAF” stands for results-based management and accountability framework – an on-going performance measurement system and an evaluation plan for the organization.

¹⁵ The use of multiple lines of evidence, which is sometimes referred to as “triangulation” in the evaluation literature, is one of the key principles of program evaluation.

3.1 Review of RMAF Information

Genome Canada has developed a results-based management and accountability framework (RMAF) in accordance with current Treasure Board policies. The main part of this RMAF is a plan for on-going performance measurement, and at the beginning of this study a considerable amount of information from this performance measurement system was supplied to the study team.

We reviewed this information at the beginning of the study in order to give us an understanding of the structure and operation of Genome Canada and the Genome Centres, and we reviewed the information supplied by each of the Centres again prior to each site visit. A considerable amount of information from the RMAF has been incorporated throughout this report as part of the analysis of the issues that were addressed in the study.

3.2 Site Visits to Genome Centres

A senior member of our study team visited each of the five regional Genome Centres. The main purpose of this visit was to obtain detailed information regarding how each of the Centres is managing the regional Genome Canada research program. Information was also collected regarding the S&T platforms and their management and use, the GE³LS program, communications activities, issues related to co-funding, commercialization activities, and a number of other issues.

The format of these visits varied slightly according to the availability of Genome Centre personnel and researchers, but, in general, these visits lasted two days and involved the following:

- An interview with the President of the Genome Centre
- An interview with the senior person responsible for Centre operations
- Individual meetings with 2-4 PIs for large-scale projects
- A tour of one or more of the S&T infrastructure facilities
- An interview with the Chair of the Board of the Genome Centre.

3.3 Survey of Genome Canada Researchers

This was a web-based survey of the principal investigators and co-applicants for Genome Canada's large-scale projects. The survey questionnaire is contained in Appendix A.

The initial sample for this survey consisted of all PIs and Co-Applicants for Genome Canada's large-scale projects. Each of the Genome Centres was asked to provide e-mail addresses and phone numbers for these researchers, and this contact information was obtained for almost all the researchers. PIs who were scheduled to be interviewed, either during the site visits or by telephone, were eliminated from the sample (there is considerable overlap between the survey questionnaire and the PI interview guide.)

The survey process was as follows:

- The researchers were contacted by e-mail and asked to complete the questionnaire. This contact was accompanied by a message from the President of Genome Canada encouraging them to participate.
- Over the course of the survey non-respondents were sent two e-mail reminders.

- All remaining non-respondents following these reminders were contacted by phone and encouraged to participate.

The survey populations and response rates were as follows:

Number of PIs contacted	Number of PI respondents	Number of co-applicants contacted*	Number of co-applicant respondents	Total number of researchers contacted*	Total number of responses**
58	28 (48%)	214	69 (32%)	272	101 (37%)

* An additional 21 co-applicants could not be contacted with the information provided.

** Included are three (3) Co-Applicants and one (1) PI, who were not in the original sample list, but who also responded.

3.4 Interviews of Principal Investigators

In order to obtain more detailed information regarding the management of the large-scale projects, some of the PIs were interviewed, either in-person or by telephone. The PI interview guide is contained in Appendix A.

The sample of PIs was selected roughly in proportion to the number of large-scale projects funded by each Genome Centre. A total of 17 PIs were interviewed, distributed as follows:

- BC – 3
- Prairies – 2
- Ontario – 5
- Québec – 5
- Atlantic – 2.

3.5 Interviews of Platform Leaders

In order to obtain further information regarding the management of the S&T platforms, an attempt was made to contact, by telephone, all Platform Leaders who had not been interviewed during the site visits. A total of four (4) Platform Leaders were available to be interviewed, in addition to two others who were interviewed, as Principal Investigators, during the site visits. The Platform Leader interview guide is contained in Appendix A.

3.6 Interviews of Selection Panel Members

Peer reviewers from the two competitions and the interim review of Competition I projects were interviewed by telephone, primarily regarding the project review and evaluation process, but also to obtain their opinions as senior researchers regarding some of the other evaluation questions. The interview guide is contained in Appendix A.

This sample was developed in consultation with Genome Canada and contained 22 potential interviewees. Some of these individuals were not available for the interview; therefore, a total of 13 panel members were interviewed.

3.7 Interviews of Co-Funders

Co-funders from both industry and government were interviewed by telephone regarding their investments (e.g., motivation, expected benefits), the expected socio-economic benefits from their projects generally, and the involvement of stakeholder organizations in Genome Canada activities. The two interview guides (for industry co-funders and government co-funders) are contained in Appendix A.

The sample of co-funders consisted of all the co-funding organizations that the Genome Centres felt were appropriate to interview; that is, there were no major sensitivities that needed to be avoided and the organization was reasonably knowledgeable about the project they are co-funding. Fourteen co-funders were suggested, and eight of these organizations were available to be interviewed.

Number of industry co-funders suggested	Number of industry co-funders interviewed	Number of government co-funders suggested	Number of government co-funders interviewed	Total number of co-funders suggested	Total number of co-funders interviewed
8	5	6	3	14	8

3.8 Interviews of host institutions

Representatives of seven host institutions for Genome Canada projects were interviewed by telephone, primarily regarding the suitability of arrangements that had been made with their institutions (e.g., regarding use of infrastructure, IP), and benefits/detriments of hosting the Genome Canada projects. A copy of the interview guide is contained in Appendix A.

These interviews included the Vice Presidents or Associate Vice Presidents of Research at six universities:

- University of Toronto
- McGill
- Dalhousie
- University of Calgary
- University of Alberta
- University of British Columbia.

The Director General of one NRC research institute was also interviewed.

3.9 Interviews of Board members

As noted above, the Chair of the Board of each Genome Centre was interviewed during the site visit (or, if not available during the site visit, in a subsequent telephone interview). In addition, six members of the Genome Canada Board, including the Chair, were interviewed. These interviews primarily dealt with Genome Canada program management and governance issues. The interview guide is contained in Appendix A.

3.10 Interviews with Genome Canada

The study team had numerous interactions with Genome Canada officials over the course of the project, primarily to obtain information regarding the structure, operation, and outputs of the organization. In addition, individual meetings were held with all but one of the Genome Canada Vice-Presidents toward the end of the data collection period in order to fill information gaps.

4.0 FINDINGS BY OBJECTIVE

4.1 Overriding Objective

To co-ordinate genomics research to enable Canada to become a world leader in selected sectors that are of strategic importance to this country, such as health, agriculture, environment, forestry and fisheries.

Summary of Findings

- In view of becoming a world leader, the initial efforts of the program were to quickly establish an infrastructure and catch up to the established leaders in the international community in genomics research.
- To do this in a relatively short period of time (three to five year horizon) a new, innovative and more business oriented program model was introduced.
- The model has incorporated measures that have captured a balance between administrative structure and research flexibility.
- Program managers are recognized for responding quickly to problems that were quickly identified.
- An effective management framework with a variety of mechanisms has been imposed. Critical mass of this structure was achieved relatively quickly.
- There has been an unqualified success in selecting projects of high scientific merit.
- There have been growing pains and some struggles with changing a research culture accustomed to smaller, more independently managed, research projects.
- The program, and the way it has been structured and implemented, has been successful in helping Canada catch up to most of the leading countries in genomics research and is recognized as a potential world leader in certain areas (i.e. GE³LS, agriculture, aquaculture, forestry, proteomics).

Discussion

The program has been successful in helping Canada catch up to most of the international leaders in genomics research. The vast majority of international peer reviewers had a strong opinion about how Canada's genomics research efforts were considered almost inexistent from an international perspective three years ago and how, today, Canada has not only "emerged as an international player" but has surpassed some of the established leaders, which "in such a short period of time", is recognized as a major achievement.

Many of the peer reviewers, who enjoy the most unbiased view of Canada's recent accomplishments, have provided many concrete illustrations of this success including how uncommon it was three years ago to find Canadian researchers at any of the major international symposiums, forums or conferences on genomics. On the other hand, today, "Canadians are a major player" at many of these events.

Genome Canada is increasingly being recognized internationally as a “flagship program ... by far the most creative genomics program in the world”. Others have described it as a program that “is looking at genomics in all its dimensions; an iconic organization for Canadian science, consistent with Canada’s vision of becoming a second strongest biotech nation.”

A majority of other respondents as well, including researchers, board members and Genome Canada/ Centre staff, acknowledge that the program’s international vision and successes are among the its most important strengths.

Many of these opinions are echoed by findings of a recent study by Earncliffe Research and Communications (2004), such that;

“It is widely believed that before 2000, there was no significant genomics sector in Canada to speak of, certainly none of the kind of scale and scope that was being developed internationally in the US and the UK. Now, three years later, these opinion leaders generally believe that Canada has taken some important steps in the right direction.”

It is evident that Canada’s genomics program has improved substantially; however, to determine whether it has become a world leader in all sectors is too difficult to determine at this time, with the information available. Some of the sectors identified where Canada is recognized as a world leader are in fisheries and forestry. Health on the other hand is a sector where Canada is still viewed as lagging far behind the leaders, and in particular the United States. However, with the recent competition in applied health research, is felt that Canada should be able to quickly make some in-road.

New Model

The success of the program, in terms of effectively coordinating genomics research in Canada and rapidly catching up to the international genomics community, is mainly attributable to the structure and approach that was devised by Genome Canada’s Board of Directors and staff.

This “new model” has been extolled by many as being innovative and pioneering and quite different than any other that had been previously adopted by a Canadian research and development program.

The main, differentiating characteristics of the new model include:

- Substantially larger projects, with average investments ranging between \$8 million and \$12 million.
- More project management mechanisms.
- More of a “business approach” (resembling venture capital funding approaches rather than traditional public sector funding approaches).
- Increased collaborations - between Canadian researchers, institutions and corporations as well as with international partners.
- Ensuring cost-effective access to required technologies and tools.
- Providing a hybrid approach between corporate and public research - allowing researchers to continue to be guided by their interests, while imposing a more rigorous accountability and monitoring structure.
- Ensuring that stated objectives are being met but allowing for some flexibility in order to quickly make changes when objectives are not being met.

- Using the program to leverage co-funding from various private and public sector stakeholders.
- Requiring transparency, accountability and communication regarding all elements of the program.

Another important business-oriented mantra that has been infused into this new program is “speed wins”. Many Board members and Genome Canada/Centre staff view this model, and particularly the speed with which it was implemented, as being the main reason for the program’s initial successes and believe that, with some adjustments along the way, “it will prove to be the catalyst for future success as well”.

Management Mechanisms

For this model to work, it requires an intensive emphasis on management. The main management mechanisms built into the program are the following:

- **Heavy emphasis on project management at the research proposal stage.** Genome Canada requires that proposals provide detailed management plans, which are addressed in a due diligence review process that occurs prior to the peer review process. The due diligence review looks at such things as budget/control processes, co-funding strategy, management process, decision making process, recruitment/training strategies, timelines/milestones, links to S&T platforms, and attention to GE³LS, public outreach and communications. Proposals are required to pass this due diligence stage before reaching the peer review stage (which deals with scientific merit, capability of the proposed team, etc.)
- **The establishment of regional Genome Centres** and, within each Centre, the designation of a Project Manager for each project. This Project Manager is responsible for monitoring the project on an on-going basis from both a scientific and financial perspective.
- **Quarterly financial reports and annual scientific progress reports** are required for all projects (the latter by the Genome Centres), with formal internal reviews by various Centre committees.
- **A formal interim review of all projects** to assess whether they are on-track, and whether there is a need for mid-course corrections. This review incorporates not only assessment of scientific progress, but also collaborations, use of platforms, training, commercialization activities, etc.

Management practices undertaken at the Centre level also include¹⁶:

- Initially reviewing project applications and selecting those to be put forward
- Collaborating with the PIs, in order to modify proposals, as required
- Monitoring and reporting on project progress, financial management, etc.
- Working with the PIs to help them prepare for the interim reviews
- Assisting with commercialization issues by identifying, protecting, and exploiting IP
- Assisting with GE³LS issues.

It has also been recognized that co-funding, particularly through the involvement of private sector companies, has “added a level of scrutiny and management accountability that enhances the model” and adds to the intensity of the overall management structure.

¹⁶ Please see Objective 2 for a more detailed discussion of the management mechanism associated with the centres

Researchers recognize that there are distinct management mechanisms in place with respect to their Genome Canada project. Of the Principal Investigators and Co-Applicants who responded to the survey:

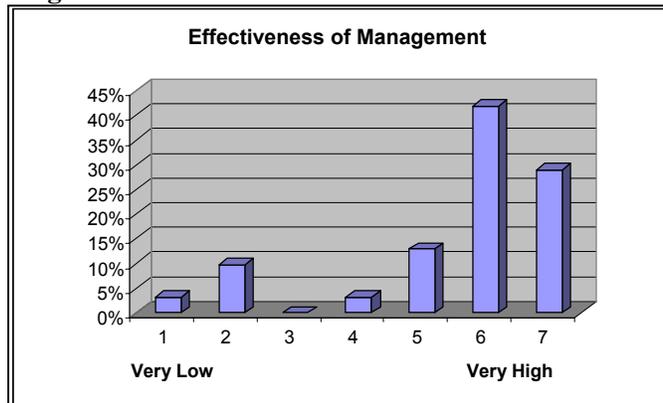
- 93% said there is a research plan in place with clear objectives, deliverables, and timelines
- 79% have mechanisms to ensure adequate information exchange and collaboration between project researchers
- 86% have adopted mechanisms for project monitoring and measuring progress against objectives
- 85% say there are mechanisms for adjusting the research program when necessary.

Effectiveness of Management

A large majority of respondents, particularly Board members, staff and Principal Investigators, believe that the mechanisms in place to manage the program are effective.

Of all the researchers interviewed, 71% rated the effectiveness of the management of the Genome Canada research program as being high to very high, with an average of 6.0 on a scale of 1 to 7 (where 1=very low effectiveness and 7=very high effectiveness). Principal Investigators rated the effectiveness higher than co-applicants, with 76% rating it high to very high (with a 5.9 average) compared to 63% of Co-Applicants giving management a high to very high rating.

Figure 4



Management Problems and Issues

As with all new models, the Genome Canada program has required an adaptation period, in which some growing pains have been identified. As one Board member remarked, it “required making repairs to the airplane while we were in the air”. Most of the growing pains were felt and identified by the researchers, who have been required to make substantial adjustments to their traditional way of operating. Many Board directors, staff and even researchers themselves, noted that this program “has required a tremendous cultural shift for researchers in Canada”.

Many researchers feel strongly that the various management layers, reporting responsibilities and requirements for securing co-funding are burdensome and frequently distract them from their research. A large number of researchers interviewed identified reporting burdens as a major weakness of the program. A majority of researchers also feel that there should be more flexibility shown with respect to co-funding, with some of the original researchers from Competition I stating that the requirement for co-funding was actually imposed subsequent to their signing an initial agreement to undertake the project. (This appears to have been at least partly a communications issue – the Guidelines for Competition I indicate that co-

funding is expected. However, the Guidelines are not very specific¹⁷, and, in any case, since Competition I was structured as a competition to establish Genome Centres, some of the individual PIs could easily have been unaware of this.) Many of the researchers also feel that they are forced to deal with redundant layers of management, particularly relating to the Genome Centres, which are perceived to add even greater reporting burdens and consume resources that could be more productively utilized for research.

In contrast to these statements, many Board Members and Genome Canada staff have indicated that, in order to implement a new model, which increased project size, scope and funding, “a more robust management system needed to be installed”. “If things are to be done quickly... you need accountability and control.” It is felt that most researchers will eventually understand that “the benefits of working with these considerably larger sums... far outweigh the extra paper work.”

Comparison With Other Programs

Genome Canada research projects are by far the most actively managed university research projects in Canada¹⁸.

Most university research in Canada is funded by the university research granting councils – the Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR), and the Social Sciences and Humanities Research Council (SSHRC). In general, these councils place very little emphasis on the management of the research (although it should be noted that most of the projects funded by the councils are considerably smaller than Genome Canada’s large-scale projects). Almost all the programs of the councils require only a summary financial report (outlining how the money was spent) at the end of the project – project plans and progress reports are not required, there is no project monitoring, and, in many cases, researchers are free to pursue the research subjects they feel are important (in fact, most council-supported projects are for “curiosity-driven” research, for which management is usually considered detrimental). In a few of the more applied programs, such as programs that support university-industry collaborative research, progress reports are required, and researchers are not supposed to change the focus of their research from what was proposed. However, these programs are relatively small compared to the councils’ programs that support “free research”¹⁹.

The study team would like to emphasize that, in our opinion, there is nothing wrong with this – in fact, this is perfectly appropriate for this type of research. These projects do not require a high level of management, and that would often be detrimental to the conduct of the research. We are simply describing the situation.

¹⁷ The Guidelines state that “...every effort must be made by the Genome Centre to secure contributions from other funding organizations...to fund part of the cost of the research that it will propose in the application to Genome Canada”; and one of the evaluation criteria for the Genome Centres was “the nature, structure, and amount of financial commitments...received by the Genome Centre from other sources...” However, there is no mention that Genome Canada will fund only up to 50% of the cost of each project.

¹⁸ Not all Genome Canada projects are university-based, but the vast majority are.

¹⁹ The terms “free”, “curiosity-driven”, “investigator-driven”, and “fundamental” research are often used more or less synonymously.

It is believed that the first university research program in Canada to require that the funded research projects (and especially projects which were often fairly fundamental in nature) be managed to any significant degree (i.e., planned, monitored, revised in mid-course if necessary, reported on, etc.) was the Networks of Centres of Excellence (NCE) program, introduced by the federal government in 1988. For that program, the administrative and management capability of the proposed team was given explicit weight in the proposal evaluation process. Each funded network was required to have both a Scientific Leader and a Network Manager, as well as a Board of Directors. The latter two were quite new requirements for all but the largest of university research projects or programs. Annual reports were required, and each network was subjected to a midterm review that reviewed management as well as science.

This was such a revolutionary concept at the time that the major issue addressed in the 1993 interim evaluation of the NCE program was the question of whether the networks were being actively managed (or, indeed, managed at all²⁰) – in particular, the extent to which their operations differed from “business as usual”, in which researchers would pursue their own individual research interests.²¹ It was concluded that approximately two-thirds of the networks were, in fact, being actively managed and that, in general, this is a viable concept for university research programs.²² Active management of research programs has remained a salient feature of the NCE program.²³ Note, however, that the Genome Canada large-scale projects involve even more active management than the networks:

- In the NCE proposal process there is no separate assessment of the management plan by management experts.
- There is less focus on targets, deliverables, and milestones in the NCE program.
- NCE reporting is done on an annual basis – Genome Canada requires quarterly financial reporting.

Furthermore (since the research team has been familiar with NCE since its inception), it is possible to say with certainty that Genome Canada and the Centres exhibit higher focus on, and active pursuit of, management than NCE and NCE networks did at the equivalent stage in their lifetimes.

Until Genome Canada, there have been few other attempts to require a high degree of project management in university research programs. The 13 Institutes of the Canadian Institutes of Health Research, which have some structural similarities to the NCE networks, are required to have some level

²⁰ This was not at all certain at the time, since there was considerable resistance to the idea of research management.

²¹ Interim Evaluation of the Networks of Centres of Excellence Program, *The ARA Consulting Group (now part of BearingPoint)*, February 1993.

²² *Ibid*, Section 4.3.

²³ A second NCE evaluation also addressed management issues, although from a different perspective. This study focused on the degree to which networks were successful in managing multidisciplinary, multi-sectoral research (among other issues), the impact of different management styles, and the impact of federal management through the NCE Directorate, the councils, and Industry Canada. Evaluation of the Networks of Centres of Excellence Program, *The ARA Consulting Group (now BearingPoint)*, December 1996. The third NCE evaluation did not explicitly address management issues, although it did consider the value-added impacts of this continuing management. Evaluation of the Networks of Centres of Excellence Final Report, *KPMG Consulting (now BearingPoint)*, June 16, 2002.

of management, but these institutes have only been in existence for a few years, and it is too early to assess the degree to which they are actively managed. The institutes are required to submit annual reports that discuss achievements against goals. To date, however, they do not appear to be as actively managed as NCE networks. The programs of the Canada Foundation for Innovation and the Canada Research Chairs program also require some degree of planning, collaboration, management, and reporting – considerably more than is required for “normal” granting council programs. However, this level of management and reporting is still a far cry from the degree of active management required of Genome Canada research projects.

With respect to the survey findings in this study, researchers definitely gave management effectiveness a higher rating for the Genome Canada research program as compared to their experience and knowledge of other programs. For example, they rated the management of the Genome Canada program approximately 13% more effective than the management within another “well-established research program”. Principal Investigators rated management effectiveness almost 18% higher. Researchers also rated the effectiveness of the management to be almost 12% higher than if the same research was funded by “Some other Source”. PIs rated it more than 33% higher.

Researchers also consider the research they are doing with Genome Canada to be of high importance and high quality. As demonstrated in Figure 5, below, 89% rated the importance of their research as being high to very high (6 or 7 on a 7-point scale, where 1=very low and 7=very high). Likewise (Figure 6), 91% rated the quality of their research to be high to very high.

Figure 5

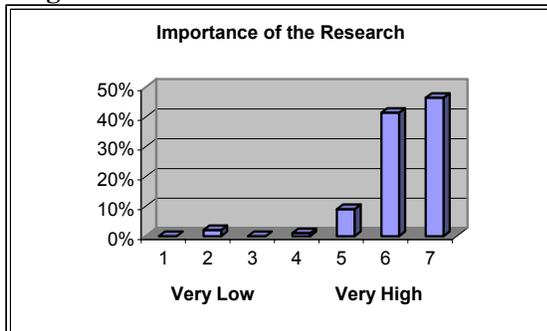
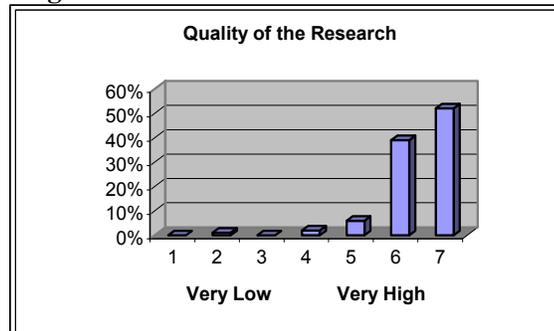


Figure 6



4.2 Objective 1

Bring together industry, governments, universities, hospitals, research institutes and the public in support of the national genomics research program,

Summary of Findings

- Bringing Canada’s stakeholders groups together is an important element of the new model and is a definite strength of the Genome Canada Program.

- A large number of interactions between researchers in all stakeholder groups have been made possible due to this program.
- Genome Canada understands the diverse and, at times, divergent interests of all its stakeholders.
- Links to other R&D funding programs have also been initiated however there is still an element of competition being felt between funding organizations.

Discussion

Most respondents identified the high level of collaboration as a major strength of the Genome Canada program. There has been great progress in a relatively short period of time in creating linkages with other domestic organizations such as research institutions and government. These linkages have been enhanced by the high level of collaboration between researchers from various organizations, particularly from industry and universities.

Genome Canada's program was also designed to build upon and complement existing genomics strengths, infrastructures and programs. It has, for example, provided funding for projects that rely on infrastructure and equipment funded by other programs (such as the Canada Foundation for Innovation). The funding of projects and platforms has enabled the enlargement and acceleration of projects previously supported by other funding agencies. Research funded by other agencies also has benefited from access to some of the S&T platforms.

The specific mechanisms to promote inclusion and collaboration were identified by board members and Genome Canada staff. This is done through;

- the selected projects,
- representation on the Board of Directors,
- representation on the Science and Industry Advisory Committee (SIAC),
- the Centres, as well as their Boards,
- the co-funding initiatives.

Projects themselves exemplify this approach of inclusion as:

- 51 projects include major collaboration agreements with institutions
- 16 projects include collaborations with private sector/industry
- 12 projects include collaborations with hospitals
- 9 projects include collaborations with government agencies/depts
- 7 projects include collaborations between centres .

In the RMAF documentation, the Centres have identified 182 instances of domestic collaboration, including all individual agreements with partners, as well as collaborations with other Genome Canada projects, platforms and Centres.

Of the 15 members who sit on the Genome Canada Board of Directors, six are representatives from research funding agencies, three represent the university community, four are from the venture capital community, one is from the legal community and one is from Health Canada.

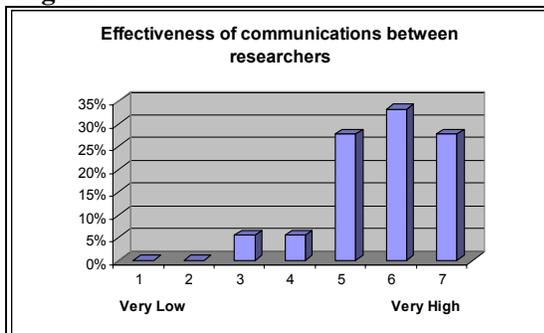
Of the 15 member Science and Industry Advisory Committee (SIAC), 11 members are from universities (including one member who is also affiliated with the Hospital for Sick Children), three are from industry and one is from the federal government (NRC).

The Centres are designed to spearhead collaboration with the provincial governments. Each of the Centres' Board of Directors are also comprised of representatives from industry, financial institutions, governments, universities, hospitals and research institutions.

The general public is not represented officially through any of the above-mentioned mechanisms. The link to the general public is being initiated through the communications and outreach program (see section 4.7).

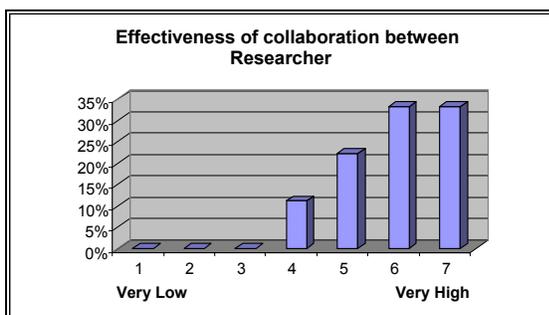
Although much has been done to include the private sector into the program, some researchers and most of the Centres feel that more effort is required to encourage industry and commercial involvement in the process, for example through a higher level of participation in the various Boards. Some researchers have indicated that, as they get closer to potential commercialization, they would like to turn directly to industry for advice, seeing as they have the specific experience in relevant commercial areas.

Figure 7



Overall, most of the researchers are of the opinion that the effectiveness of communications and collaboration between researchers themselves is very high as a result of the Genome Canada program.

As evidenced by the graph in Figure 7, 69% of PIs rated the effectiveness of the communications between researchers, as a result of the Genome Canada program as being high to very high (with an average of 5.7 on a scale of 1 to 7, where 1=very low and 7=very high).



The effectiveness of the collaboration between researchers (figure 8) was also rated as being high to very high by 66% of PIs, with an average of 5.9 on a scale of 1 to 7 (where 1=very low and 7=very high).

In addition, Principal Investigators generally felt that collaboration and communications between researchers was higher under the Genome Canada program than under other programs.

It was also mentioned by many researchers, as well as by several members of the Board of Directors and Genome Canada/Centre staff, that the Genome Canada projects have considerably expanded the genomics research community, having brought together researchers and technicians from a variety of disciplines, including statistics, computer science, biology, economics, law and ethics.

4.3 Objective 2

Establish five Genome Centres across Canada, one each in British Columbia, the Prairies, Ontario, Québec and the Atlantic provinces, to provide leading-edge technologies to researchers and cross-disciplinary training of the necessary workforce in all genomics-related fields.

Summary of Findings

- Five Genome Centres were established across Canada within each of the provinces/regions specified
- There has been much success with the provision of leading-edge technologies and with Centres attempting to determine where technology gaps might exist for improving the effectiveness of the research projects.
- There has been success in ensuring that regional interests and characteristics are reflected through each of the Centres.
- The Centres have been effective in improving the ability of the program to raise funds (through co-funding), although there has not been uniform success across all Centres.
- The funding of some Centres is fragile. Not all of the centres enjoy the same opportunities for co-funding some of their administrative endeavors, and these inequities have raised certain controversies of their own.
- There has been some controversy as to the overall benefits of Centres. Some believe they are a redundant layer of program administration that impose extra reporting burden on researchers and consume financial resources that could otherwise be utilized for research.
- The Centres' responsibility regarding cross-disciplinary training of the necessary workforce has been indirectly met through the projects they are responsible for, although some centres have also devised strategic initiatives to identify and fill gaps in skills training.

Discussion

Five Genome Centres have been established and are fully operational. They operate with a total staff of 49 and have an annual budget of about \$6 million. Since the program was initiated, \$19.6 million has been allocated to Centre operations.²⁴

The wording of this objective is slightly confusing and is open to interpretation regarding the scope of responsibilities of the Centres relative to the Genome Canada and the research projects. It is unclear if the Centres were set up to facilitate training and the supply of required technologies or if they are ultimately responsible for these. There are conflicting interpretations and perceptions as to the Centres' responsibilities as well as their expected strategic direction for future growth, in particular whether the centres are expected to evolve into defacto mini-programs or act as regional representatives of Genome Canada.

²⁴ This figure does not include the co-funding received by some Centres to cover administrative budget as well as for the administration of science & technology platforms. S&T platform administration costs are included in funded projects, for the purpose of this report.

According to some Board members, the Centres have been provided “a certain flexibility with respect to how they have been allowed to evolve”. However, according to other Board members, “there are specific guidelines for how a Centre is supposed to be structured and managed” and “they are expected to become more autonomous”. There also appear to be conflicting objectives with respect to the project selection process and commercialization objectives (which are addressed in more detail in section 4.10).

Regardless of interpretation and perceptions, the five Genome Centres have evolved differently since the program’s inception in a non-uniform fashion, with some operating as a middle-layer to Genome Canada and others as genomics programs onto their own. Some have a plan to become completely autonomous within another ten years.

Comparison to Other Programs

In comparison to other Canadian R&D funding programs, the establishment of these provincial/regional Centres can be considered unique. Only one other program, the Networks of Centres of Excellence have adopted a similar centre-based structure, where each Network is similar to a mini-granting council. Therefore, Genome Canada can be considered an experimental concept with few established functional examples to borrow from.²⁵

Strengths and Weaknesses

Many Board members and Genome Canada staff feel that the establishment of Genome Centres has derived substantially more advantages than disadvantages for the program. Primarily, they have facilitated the raising of co-funding worth over \$340 million from provincial governments, industry, and other sources. It was stated that the provincial co-funding (almost \$160 million) would definitely not have been possible without the Centres. There are however differing opinions as to whether the remaining \$180 million of co-funding could have been raised without having regionally based Centres in place.

The Genome Centres have also been instrumental in managing the S&T platforms and in developing the strategic plans to ensure that the platforms are capable of satisfying the needs and demands of their project base. They are not perceived however as having been solely responsible for providing leading-edge technologies to researchers. Some researchers feel that they have only taken on an indirect role in providing the technology, as well as any of the cross-disciplinary training that has resulted from the program. Training is an important benefit; however, researchers do not perceive the Centres as having a significant influence on training.

Most Genome Canada researchers (particularly co-applicants), host institutions, industry co-funders and partners, as well as some Board members, feel that the Centres in fact add an unnecessary middle layer of bureaucracy to the program and consume financial resources that could otherwise be utilized for research. Many researchers also feel that some Centres simply provide rubber stamping services to the process of project selection, although many recognize the Centres’ assistance in preparing the applications.

²⁵ Comparisons with international programs will be addressed in the Benchmarking report.

Role of the Genome Centres

Based on early program documentation, it appears that the envisioned role of the Genome Centres was to establish and manage regional genomics research programs, i.e., the Centres were intended to:

- Identify large-scale research projects that should be funded in the Centre's region (subject to peer review);
- Identify the science and technology infrastructure (platforms) necessary to support these research projects;
- Establish a GE³LS research program;
- Ensure the development of programs to develop the necessary highly qualified personnel; and
- Monitor and manage this integrated research program.

Thus, the guidelines requesting proposals for the Genome Centres dealt not only with the establishment of the Centres, but also with their associated large-scale projects, the required science and technology platforms, their GE³LS program, and so on. The criteria for evaluating the Centres included items such as:

- The scientific excellence of the Centre's research program;
- The quality and experience of the researchers associated with the Centre;
- The quality of the Centre's GE³LS research program;
- The potential of the Centre for research training;
- Quality of the plans for making critical decisions or choices about the overall research direction.

Along the same lines, Objective 2 of Genome Canada reads as follows: "Establish five Genome Centres across Canada...to provide leading-edge technologies to researchers and cross-disciplinary training of the necessary workforce in all genomics-related fields".

Based on our observations, it appears that two of the Genome Centres operate more-or-less in this way, i.e., the Centre actively develops the regional research program and identifies research areas and researchers it wishes to support. However, in the other three regions, the Centre operates mainly as an administrative arm of Genome Canada and tends to assume the role of "middle-person". This is not to say that these three Centres do not make an important contribution to the process. They may assist projects with the search for co-funding, provide valuable assistance to researchers in preparing proposal to Genome Canada, and so on. Still, they are not defining and managing a research program. The view of most researchers in these regions is that they are applying to Genome Canada, and it is Genome Canada – not the Centres – that is managing the genomics research program.

As expected, the research community in these three regions has a less positive view of the Genome Centres. Following are two representative quotes from Vice Presidents of Research at major research-intensive universities (one of whom polled the Genome Canada PIs at his university prior to the interview):

“The Genome Centre is an unnecessary and burdensome middle layer of bureaucracy. They’re an extra layer in the review process, and they don’t add any value. Why couldn’t what they do be done centrally? There should be a requirement for the Genome Centres to demonstrate value added to the researchers.”

“The Genome Centre is...simply an overlapping level of administration. This is very inefficient.”

Science & Technology Platforms

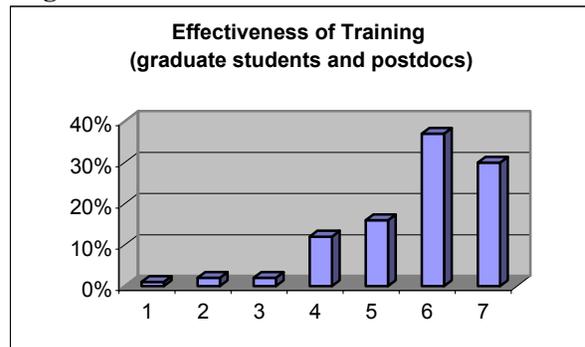
This objective specifically deals with the issue of availability of science and technology infrastructure. Through the funding of S&T platforms, the program has contributed in providing the Genome Centres and the genomics research community with leading-edge technologies. A more detailed appreciation for the platforms themselves and how they are managed will be addressed in section 4.5.

The S&T platforms are also increasingly being viewed, by the Centres, as a potential source of revenue to fund their operations over the longer term. As the platforms increase their productivity levels, some Centres have identified strategies for increasing the availability of the platforms in order to benefit from the fees charged to users outside of the program, while continuing to maintain the high levels of service satisfaction to their projects.

Cross-Disciplinary Training

Genome Canada and the Genome Centres have been successful in recruiting, retaining and training the necessary workforce in all genomics-related fields. Although recruitment and retention of workforce will be dealt in more detail as part of Objective 9, cross disciplinary training has been a successful component of the program.

Figure 9



As demonstrated in Figure 9, sixty-seven percent (67%) of researchers (including 71% of PIs) rated the effectiveness of training of graduate students and postdoctoral fellows as “high” to “very high” (6 or 7 on a 7-point scale, where 1=very low and 7=very high), with an average of 5.7. As discussed in more detail in section 4.10, this program has substantially contributed to the development of relevant and important highly qualified personnel, including increasing Canadian capabilities in project management for large scale-scale science²⁶.

Researchers rated the training received through their projects as being more effective than their genomics research not funded by Genome Canada (with a difference of over 7%), and also more effective than it would be if their same research had been funded by some other source. The difference between the

²⁶ As noted under our discussion of the Overall Objective (program management), the Networks of Centres of Excellence program is the only other Canadian research program with a comparable emphasis on project management.

effectiveness of training through their Genome Canada projects, as opposed to training provided by another well-established research program was approximately 2%.

Although many believe that the training is highly effective, many also stated that the Centres' role in this training is "non-applicable". Some of the representatives of host institutions were of the same opinion. Researchers stated that some Centres have made definite attempts to identify gaps and put together programs to promote training, such as Genome Québec's Network for Bio-Informatics. Other researchers stated that their Centre had organized training awards. However, based on the responses of PIs and researchers overall, the Centres have not done very much to directly train project or platform personnel. It is the perception of many of the researchers that effective training has resulted through the projects themselves, and their larger budgets, with little, if any, programs or even guidance regarding training coming from the Centres. As one researcher noted:

"Significant funding allows us to offer reasonable salaries to research associates and provides long-term funding for various research activities, including educational activities, scholarships for students, etc... The funding of programs offering a mixture of education, research, training, ... it is interesting and valuable."

4.4 Objective 3

Support large-scale genomics projects that draw on existing Canadian strengths and expertise, and whose scale and scope are such that they cannot currently be funded at internationally competitive levels, through existing mechanisms.

Summary of Findings

- Genome Canada's international peer review panel is widely viewed as possessing a high level of scientific expertise in a range of genomics-related areas.
- The "bottom-up" strategy has allowed for identification of Canadian strengths and expertise from a scientific point of view.
- The selected projects are closely monitored by the Genome Centres and by the International Science Review Committee (interim review).
- The research that is funded through Genome Canada has been incremental and could not be funded at internationally competitive levels, through existing mechanisms.

Discussion

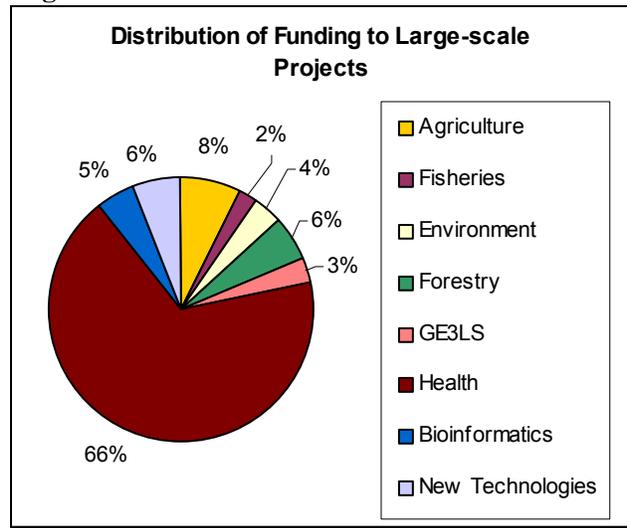
Project Selection

To date, 54 projects have been funded through Genome Canada. Figure 10 shows the distribution of Genome Canada funding among areas of application. Note that this Figure is based on funding for the large-scale projects only; therefore, it differs from Figure 2 which is based on total Genome Canada funding.

All stakeholders are generally impressed by the quality and effectiveness of the peer review process and the expertise of the panel in selecting projects of high scientific merit. Although, three of the thirteen panel members interviewed questioned whether there were some expectations that there should be a “reasonable” distribution of funded projects among the regions.

In the first two competitions, Genome Canada relied on a mostly “bottom-up” strategy, which allowed for the identification of Canadian expertise and strength from a scientific point of view – i.e., in these two competitions there was no specification of the required areas of application (health, fisheries, etc.). However, four of the 13 international panel members have expressed the opinion that, going forward, Genome Canada must capitalize on these strengths and examine the fundamental areas Canadian scientists are best equipped to work in, in order to elucidate a direction for future research.

Figure 10



Project Progress

The projects are being closely monitored by the Centres, and the International Science Review Committee has performed an Interim Review of the 17 projects from Competition I, in order to: i) assess the progress; ii) determine whether funding should be continued, reduced or cancelled; and iii) to provide advice as to avenues to strengthen successful projects.

The following table (Table 2) provides an indication of the scientific output that has resulted from Genome Canada projects.

Table 2: Scientific Output

	Canada	Atlantic	Québec	Ontario	Prairie	BC
Publications (arising from GC projects)	464	17	135	172	34	106
Major Conference Presentations	970	33	390	284	103	160
Awards	81	14	37	5	24	1
Patent Applications Filed	30	0	4	9	10	7
Patents Issued	2	0	0	1	1	0
Invention Declarations on File	43	0	11	22	0	10

Incrementality of Genome Canada Research

All stakeholder groups interviewed (especially researchers, university vice presidents of research, and panel members) generally agree that the research that is funded through Genome Canada has been

incremental and could not be funded at internationally competitive levels through existing mechanisms. The main reasons are as follows.

Scale and Scope of the Projects: The reason that was mentioned most often by those interviewed is the ability for Genome Canada to award larger funding and to manage this funding (see next point). Through normal granting council programs, the funds would be disbursed into smaller projects and would not allow for large-scale projects, which are critical to the advancement of genome science. Researchers would thus be limited in the questions they could ask. The large funding awarded by Genome Canada allows researchers to carry out more ambitious projects – projects that tend to encompass more risk, but that can ultimately lead to more innovative results.

Management: A solid management structure is essential to the successful execution of large-scale projects. According to one panel member, the management of Genome Canada is “the glue that links the different groups of investigators and holds the projects together”. If the funding for these genomics projects were awarded through other granting councils and agencies, the management structure would be much less rigorous and would not allow for the same level of proactive intervention.

Coordinated Approach: Genome Canada has enabled a wider range of groupings and collaborations than would have otherwise been possible. It has stimulated collaborative research, bringing together groups of researchers from different universities, institutions, and from industry, and has also fostered a number of international linkages, all of which would not be possible through other granting councils. The partnerships that are created offer a greater potential for synergy and information sharing. As one panel member noted, “(through other mechanisms), there could be 20 projects at a time, all studying the same thing. The researchers would end up stumbling upon each other”.

Support to Core Centres/Platforms: Another benefit of Genome Canada has been the ability to develop centres with the appropriate infrastructure and expertise to engage in major genomics projects. In genome science, a considerable amount of sophisticated and very expensive research equipment is required in order to compete on an international level. Prior to three years ago, much of this technology did not exist in Canada, but now, researchers are adequately equipped to conduct this level of research. The scale and cost of this platform capacity is beyond the scope of the granting councils.

4.5 Objective 4

Put in place research infrastructure to support the major S&T platforms essential for the large-scale projects including, but not limited to, functional genomics and proteomics, genomics sequencing, genotyping, bioinformatics and new technology development.

Summary of Findings

- Ten science and technology platforms have been funded through Genome Canada.
- The selection of the platforms was driven by the projects that came forward during the competition, as well as by the proposed management and throughput of the platform.
- The availability of necessary genomics research infrastructure has dramatically increased since the creation of Genome Canada.

- Most of the platforms are operating at the highest level of productivity possible.
- The platforms all appear to have put in place reasonable policies regarding eligibility, access, pricing and intellectual property.

Discussion

Through Competition I, Genome Canada funded ten science and technology platforms, with at least one platform in each of the Genome Centres:

1. **Arrays Facility**, Genome British Columbia
2. **Bioinformatics Facility**, Genome British Columbia
3. **Proteomics Facility**, Genome British Columbia
4. **Sequencing Facility**, Genome British Columbia
5. **Technology Development Facility**, Genome British Columbia
6. **Bioinformatics Platform**, Genome Prairie
7. **Proteomics Technology Core Facility**, Ontario Genomics Institute
8. **Genome Resource Core Facility**, Ontario Genomics Institute
9. **McGill University and Genome Québec Innovation Centre**, Genome Québec
10. **DNA Sequencing Facility**, Genome Atlantic

In many cases, the platforms existed, in part, prior to Genome Canada, and the Genome Canada funding was used to expand and improve the facilities. The need for, and selection of the platforms was driven by the projects that came forward during the competition. The peer review panel also assessed the management of the platform and, in the case of some of the larger core facilities, its ability to produce high-quality data with high throughput. However, much like with the selection of large-scale projects, three of the 13 panel members interviewed were of the opinion that geographical considerations also came into play (“every province had to have its own platform”).

According to the survey data, the Genome Canada platforms appear to be fulfilling an important need in genomics research. Seventy-seven percent (77%) of Genome Canada Principal Investigators and Co-Applicants who responded to the survey indicated that their research requires access to major research infrastructure such as sequencing and mapping instrumentation, mass spectrometry technologies, and informatics services. As well, 95% of respondents feel that the infrastructure required to conduct their research is currently readily available (rated 5 or higher on a 7-point scale, where 1=not at all available and 7=readily available), as opposed to 29% of respondents, who felt that this infrastructure was readily available, prior to two years ago (see Figures 9 and 10).

Figure 11

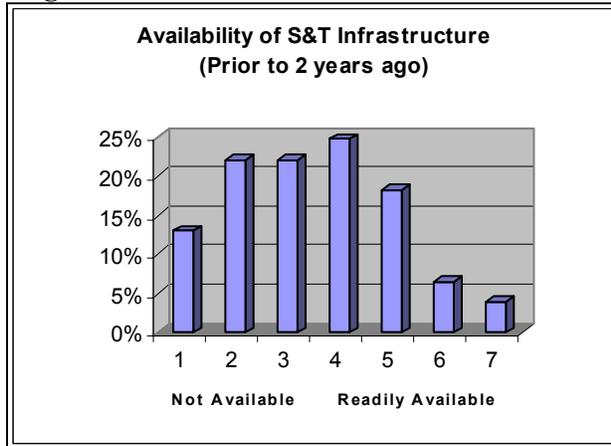


Figure 12

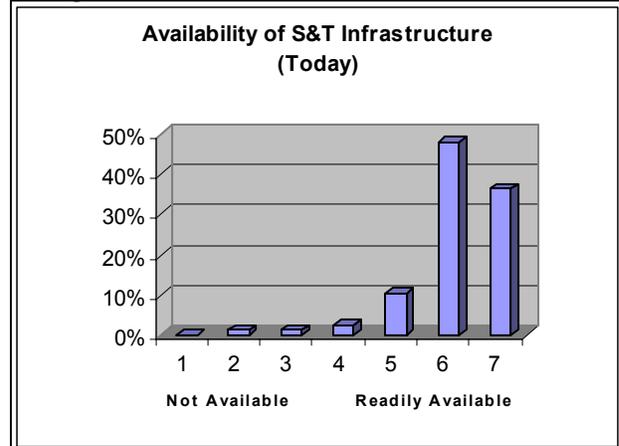


Table 3 provides a breakdown of organizations/projects serviced by the platforms (as at June 30, 2003), by type of organization/project and by Genome Centre:

Table 3

	GBC	GP	OGI	GQ	GA	Total
Genome Canada funded projects	20	12	8	13	4	57
Other Canadian research organizations	15	22	62	39	2	140
Canadian companies	10	2	4	6	0	22
Foreign research organizations	20	3	30	7	0	60
Foreign companies	6	0	9	1	0	16

Most of the platform leaders indicated that their platforms are operating at the highest level of productivity possible. They mentioned that measures have been taken to control costs and many are now actively marketing the platform through presentations and training sessions, in order to increase throughput. According to one platform leader, “The people that can benefit from the platform are well aware of what we are doing.”

The platforms all appear to have put in place reasonable policies regarding access, pricing and intellectual property, although these vary depending on the nature of the platform. In most cases, access to the platforms is open to all research groups; however, priority is given to Genome Canada-funded projects. In some cases (for example, the DNA Sequencing platform in Genome Atlantic), the platform operates on a fee for service basis, while other platforms (for example, the Technology Development Platform in Genome BC) receive operational funding from the Genome Centre. The platform leaders interviewed had mixed reactions when asked about the Genome Centre’s involvement in platform management. The management of the platform generally represents a joint effort between the Genome Centre and the researcher; however some have questioned whether the Centre-based management approach leads to unnecessary overhead and administrative burden.

The survey data indicates that, in general, Principal Investigators and Co-Applicants are happy with the availability of information regarding platform policies and guidelines (64% of respondents rated the availability of this information as 5 or higher on a 7-point scale where 1= poor and 7= excellent), as well as the effectiveness of these policies and guidelines.

4.6 Objective 5

Ensure leadership in ethical, environmental, legal and social issues related to genomics (GE³LS).

Summary of Findings

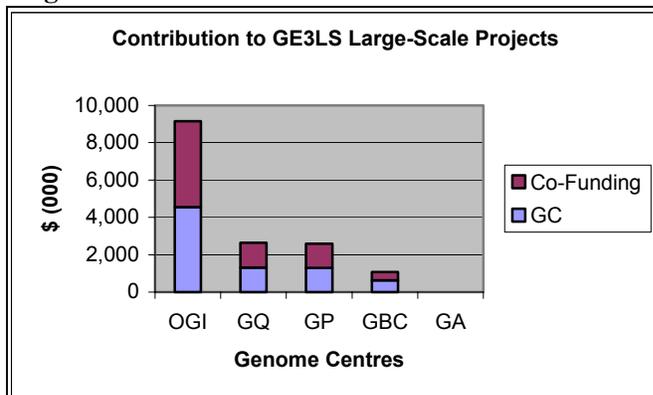
- Genome Canada is highly committed to addressing GE³LS issues.
- Genome Canada and Genome Canada co-funders have contributed over \$14M to five GE³LS-related projects.
- Genome Canada is internationally perceived as being a leader in the area of GE³LS.

Discussion

To fulfill its fifth objective, Genome Canada has worked to develop an integrated Genomics, Ethics, Environment, Economy, Law and Society (GE³LS) initiative. GE³LS research is funded in two ways:

- i. through the Genome Centres, in the form of a large-scale GE³LS project; and
- ii. through the Genome Centres, as a component of one or more large-scale genomics research projects.

Figure 13



To date, over \$15M has gone towards funding five large-scale GE³LS-related projects. This figure includes a contribution of over \$8M by Genome Canada. Note that the co-funding portion includes only funding that has been either received or committed.

The funding allocated to GE³LS large-scale projects, by Centre, is presented in Figure 11, at left.

GE³LS-related projects were funded through almost all of the Genome Centres, with the exception of Genome Atlantic:

1. **Commercialization and Society and its Policy and Strategic Implications.** Genome Prairie.
2. **Canadian Program on Genomics and Global Health.** Ontario Genomics Institute.
3. **Genomics in Society: Responsibility and Rights.** Genome Québec.
4. **Democracy, Ethics and Genomics: Consultation, Deliberation and Modeling.** Genome British Columbia.
5. **Bridging the Emerging Genomics Divide.** Ontario Genomics Institute.

The primary organizations that fund GE³LS research in Canada, apart from Genome Canada, are SSHRC and CIHR, although there are some research funds available through the CHSRF. Note that neither of these organizations actually has a particular GE³LS stream or focus. They do support GE³LS research, but they do not have the means to carry out research of the scale that is being carried out at Genome Canada. Groups such as the Canadian Biotechnology Advisory Committee (CBAC) and Industry Canada have also commissioned position papers and small grants. Further, a variety of charitable organizations and disease support groups, e.g., Associated Medical Services, Canadian Breast Cancer Foundation, etc., support GE³LS research.

In addition to the funding provided to GE³LS large-scale projects, Genome Canada has allocated \$500,000 per year towards GE³LS-related initiatives, newsletters and workshops. The Genome Canada three-day GE³LS Symposium in Montreal in February 2003 attracted over 220 attendees, including many international speakers. A second GE³LS Symposium was held in Vancouver in February 2004, and attracted 180 attendees.

To date, Genome Canada appears to be succeeding in demonstrating leadership with respect to GE³LS issues. Most of the panel members that were interviewed, some of them GE³LS experts, were impressed by the quality of the GE³LS research that has come out of Canada. As one panel member put it,

“GE³LS research is one aspect of genome research where Canada has always been a force to reckon with. There have been good researchers in Canada who’ve had very sensible comments to make on the global stage. This is one of Canada’s strengths.”

Another panel member mentioned that other countries, and particularly the United Kingdom (U.K.), are now learning from the Canadian model. A Genome Canada PI added that the Wellcome Trust in the U.K., as well as the Human Genome Project in the United States mostly fund “small projects”, but are lacking the large-scale, interdisciplinary GE³LS research projects, as well as the mechanisms to link GE³LS to the scientific research.

One concern that was mentioned by two of the 13 panel members interviewed relates to the projects that have a GE³LS component. Because GE³LS is a relatively new area, scientists working on discovery projects are sometimes unfamiliar with GE³LS issues, and their projects have few direct GE³LS implications. However, it is the perception of these panel members that, to satisfy Genome Canada requirements, PIs must “force” a GE³LS component into their proposal²⁷, which is not always applicable or properly dealt with, given their area of expertise. One panel member suggested that the most effective approach would be for Genome Canada to encourage greater interaction with the actual GE³LS research teams (see the OGI example, below). One PI suggested that Genome Canada also provide funding for smaller-scale independent GE³LS research projects rather than solely awarding grants to large groups.

In fact, one Genome Centre that has attempted to better integrate GE³LS with its other large-scale projects is the Ontario Genomics Institute (OGI). OGI has established a GE³LS Support Program, which is aimed at ensuring that there is sufficient capacity in the system to address GE³LS issues. This includes:

- A separate budget set up by OGI for consideration of GE³LS issues.

²⁷ In fact, this is not at requirement of Genome Canada.

- An ethics committee with a GE³LS representative from each large-scale project. The committee meets quarterly to identify initiatives to support scientists and other stakeholders in addressing GE³LS issues.
- A research fellow hired by OGI, who is responsible for assessing GE³LS issues associated with the large-scale projects and liaising with the projects regarding these issues. The fellow assists in resolving GE³LS issues (including carrying out issue-specific research where necessary) and, when necessary, brings GE³LS issues to the attention of the ethics committee.

According to OGI and the Ontario PIs who were interviewed, this approach encourages researchers to pay attention to GE³LS issues, where they may not have otherwise.

4.7 Objective 6

Effectively communicate the results of genomics research to the public, thereby helping Canadians to understand the relative risks and rewards of this type of research.

Summary of Findings

- Genome Canada has a well-defined communications strategy in place and is undertaking a wide range of communications and outreach activities. These range well beyond the stated objective of communicating “the results of genomics research”.
- The Genome Centres vary in terms of the effort and resources they devote to communications and outreach.
- The emphasis of communications strategies at the Genome Centres is generally on raising the level of stakeholder awareness for external funding and collaboration purposes.
- The activities put forth by Genome Canada appear to be far-reaching; however, there have been no studies or surveys carried out to assess their effectiveness in increasing public awareness.

Discussion

Genome Canada Communications and Outreach

As part of its mandate, Genome Canada is responsible for developing and implementing a communications and outreach program to help Canadians understand the important issues surrounding genomics research. In addition, Genome Canada has identified its own goals and priorities with respect to communications and outreach, the main ones being to gain visibility and credibility, and to develop brand recognition. That is, Genome Canada aims to be perceived as Canada’s primary source for genomics information. This recognition could, not only strengthen public support for Genome Canada, but also lead to increased collaborations between researchers, industry and government and help to secure further financing. To achieve these goals, Genome Canada has developed a very explicit communications plan, which includes specific objectives and strategies, as well as a series of tactics for each targeted audience.

To date, Genome Canada’s communications efforts have primarily targeted the general public, governments and the scientific community, as well as internal stakeholders such as the five Genome

Centres and their staff. Table 4 provides an overview of the communications activities that have been undertaken by Genome Canada:

Table 4

Communications at Genome Canada (March 2004)					
1. Media Relations	2. Public & Educational Programs / Special Events	3. Multimedia (Website/ Electronic Communications)	4. Publications and Advertising	5. External Relations (Government Affairs, Business and International Development)	6. Support to Centres and GC Team/ Administrative
<ul style="list-style-type: none"> ■ One-on-one meetings with media ■ News releases ■ Coordination of Op-Eds and other articles ■ News conferences ■ Media monitoring ■ Speaker's Bureau 	<ul style="list-style-type: none"> ■ Gee! In Genome ■ Science Fairs ■ Genomics Summer Camps ■ CBC production ■ National Genomics Symposium 	<ul style="list-style-type: none"> ■ Corporate website ■ Education website ■ Content development ■ Graphic/creative design ■ Information email address ■ Genome Canada Newsletter 	<ul style="list-style-type: none"> ■ Annual Report ■ GE³LS Newsletter ■ Brochures ■ Backgrounders ■ Media guide ■ Advertisements/supplements ■ Promotional items 	<ul style="list-style-type: none"> ■ Support to the Executive VP ■ Postdocs strategy and events ■ International events ■ National events ■ Workshops/symposia 	<ul style="list-style-type: none"> ■ Mailings ■ Correspondence ■ Presentations ■ Database ■ Coordination of translations ■ Genome Centre liaison

Genome Centres Communications and Outreach

Genome Canada closely collaborates with the five Genome Centres regarding communications plans, possible links and gaps. Representatives from each Centre attend a conference call with Genome Canada every three weeks and the group also meets in person three times a year. However, the Centres vary in the extent to which they address communications issues. Although some of the Centres rely heavily on Genome Canada for communications activities, others have their own communications staff in place.

In particular, Genome British Columbia has two full-time staff members in place who are dedicated to the Centre's communications efforts. Genome BC has developed a very explicit external stakeholder communications plan, using a detailed matrix showing target groups, the message to send, and an implementation plan. According to Genome Canada's Vice-President of Communications, this commitment by Genome British Columbia has made a considerable difference in increasing the visibility and credibility of the Centre in British Columbia.

As for the other Genome Centres, Genome Québec also has a full-time resource dedicated to managing the Centre's communications and outreach activities²⁸, while Genome Atlantic and Genome Prairie each have one resource working part-time on communications issues (for Genome Atlantic, this position has only recently been filled). The Ontario Genomics Institute (OGI), one of the largest Centres in terms of number of projects funded, has no staff dedicated to the Centre's communications. Rather, communications activities fall under the responsibility of the Centre's operations staff.

²⁸ This position has been vacant since the summer of 2003, although interviews are currently underway to have it filled. In the interim, Genome Canada has taken part responsibility for the Centre's day-to-day communications activities.

For the Genome Centres, the emphasis of their communications strategies is generally on raising the level of stakeholder awareness for external funding and collaboration purposes. Efforts and resources are primarily focused on educating government and other funding agencies, the scientific community, and industry. This is achieved through media relations (press releases and interviews), publications (newsletters, brochures, annual reports), advertisements, website, email updates, event sponsorship, congresses, presentations and forums.

Still, all Centres also engage in a significant level of public education and outreach. Specific activities include many of the same tactics used to attract co-funding, in addition to panels, sponsorship of regional science fairs, and public forums (see box, at right). At Genome British Columbia, an Education Committee has been formed, and has collaborated with Science World and the University of British Columbia Biomedical Laboratory to provide information to students and science educators. Among other things, this has included the launch of an education website for teachers, students and the generally curious. The site features support for education programs, in-class exercises, quizzes, games and a comprehensive glossary of genomic terms.

The Gene Scene Comes to Science World

Genome BC's free public forum series explores a host of issues from gene patenting, the role of microbes and the implications of genomics to the media's portrayal of science, the risks and benefits of GMOs and the nature vs. nurture debate. Run in conjunction with the GEEE! in Genome exhibition at Science World, forums to date have attracted over 100 people per session. Attendees are people from all walks of life who are interested in finding out more about this field and discussing both the wonders and worries. The forums are moderated by professional broadcast journalists Hal Wake and Sid Katz, and feature scientists, ethicists, policy makers and community leaders.

Signals Newsletter, Genome British Columbia

Finally, it is important to note that Genome Canada researchers have played an important role in communications activities, primarily through the dissemination of their findings. Many have been invited to speak at industry and scientific conferences, to clinical and patient groups and to the media – especially upon publication of key scientific papers (see Table 2, page 28). As well, some of the S&T platform leaders actively market their platform to other Genome Canada researchers and other potential users of the platforms. Some of the tactics that were mentioned include web portals, newsletters, presentations, meetings and training sessions with researcher groups.

Effectiveness of the Communications and Outreach by Genome Canada

In terms of reaching the target audiences, the activities put forth by Genome Canada appear to be successful:²⁹

- The Genome Canada website received 2,957,896 hits in 2003 (this figure includes 44,981 distinct users and the average length of the visit was 9 minutes and 55 seconds). The site has already received 915,819 hits to date in 2004 (as of Feb 19).
- Of the 24 press releases that were issued by Genome Canada in 2003, 22 were picked up. In 2002, of the 21 press releases that were issued, 20 were picked up.

²⁹ The figures and comments listed do not reflect communications activities of the Genome Centres, as these figures were not available at the time of the study.

- 5000 copies of the 2002-2003 Genome Canada Annual Report were distributed to stakeholders, including government officials, funding organizations, genome centres, biotechnology, genomic and pharmaceutical companies, international partners, journalists, international review panel members, project leaders, universities and members of the public (by request).
- The Genome Canada electronic newsletter is issued every two weeks to over 1000 stakeholders and monthly to approximately 500 members of the general public (by request).
- The GE³LS newsletter is published three times a year and is distributed to approximately 2500 individuals and organizations, including researchers, government officials, universities and Genome Centres.
- There were 113,994 visitors to The Gee! In Genome exhibition, held at the Canadian Museum of Nature in Ottawa between April 25 and September 1 2003. This exhibition will be travelling to ten other Canadian cities between now and 2006.

In addition, a number of the Board members interviewed were impressed by the reach, effectiveness and innovation of the communications efforts being carried out by Genome Canada.

A study released in January 2004³⁰ discusses, among other things, the awareness of genomics and of Genome Canada by government opinion leaders. The study indicates that, over the past three years, the fields of genomics and biotechnology have become more widely understood among government opinion leaders. As well, middle and upper managers within the public service, whose specific function relate to biotechnology across government, are highly knowledgeable about Genome Canada. Among senior public servants who are significant decision-making influencers (Deputy Ministers, Assistant Deputy Ministers, and key Directors General), Genome Canada is certainly known, but does not stand out significantly from other councils and agencies, while, as might be expected, Members of Parliament generally possess only a vague understanding of the organization and its mandate.

With respect to communications and outreach targeting the public at large, it is difficult to assess whether the activities carried out by Genome Canada and the Genome Centres are succeeding in raising Canadians' level of awareness and understanding of genomics issues or whether Genome Canada is regarded as a credible source for genomics information. An initial baseline survey was conducted by Genome Canada when the program was first introduced to gauge public awareness, knowledge and perception of genomics. However, so far, neither Genome Canada nor any of the Centres have carried out any follow-up studies or surveys to determine the actual impact of Genome Canada communications and outreach on public opinion.

4.8 Objective 7

Foster Canadian participation in international genomics research programs.

³⁰ *Earnscliffe Research and Communications*

Summary of Findings

- Over time, Genome Canada has steadily increased its interest in international activities (Joint Competition with Genoma España, International Consortium Initiative, international MOUs).
- Over a third of the large-scale projects have formal international collaborations built into the project plan.
- Genome Canada has had a significant impact on the international activities of Principal Investigators and Co-Applicants who are participating in Genome Canada projects.

Discussion

In order to succeed in developing world-class leadership in genomics and proteomics research, Genome Canada recognizes the need to invest in and collaborate with other genomics research programs around the world. To this end, Genome Canada has undertaken a number of international initiatives.

International Consortium Initiative

In October 2002 Genome Canada announced the International Consortium Initiative (ICI). The ICI provides an opportunity to fund unique international projects that will have significant impacts on Canadian science and further enhance the status of Canada and Canadian scientists in the global community. To date, the ICI has funded the Structural Genomics Consortium (see box, at right), as well as four international workshops:

Structural Genomics Consortium

The Structural Genomics Consortium is a three-year initiative led by Canadian scientist Dr. Aled Edwards, a world-leading expert in proteomics and structural genomics research. The Consortium, which seeks to determine the three-dimensional structure of more than 350 human proteins, operates from research laboratories at the University of Toronto and the University of Oxford in the United Kingdom. It represents the first funding partnership among the U.K.-based research charity the Wellcome Trust, four Canadian research-funding organizations (Ontario government's Ontario Research and Development Challenge fund and the Ontario Innovation Trust, Genome Canada and the Canadian Institutes of Health Research) and the global pharmaceutical company GlaxoSmithKline.

Genome Canada News Release, April 3 2003

- a) The first International Workshop on Bovine Genomics was held in Montreal on June 17, 18 and 19, 2003. Genome Canada financially supported and facilitated this workshop, which gathered more than 80 international scientists and experts of the bovine community with the goal of defining a global research strategy for bovine genomics.
- b) The Public Population Project in Genomics includes scientists from Québec, Finland, Estonia and the United Kingdom. A workshop was organized by Genome Canada in Montreal on July 3, 2003 and a follow-up meeting was held August 26th, 2003.
- c) The Poplar Tree Genomics workshop was held in Toronto September 27-28, 2003.
- d) The International Lepidopteran Genome Consortium, a one-day workshop sponsored by Genome Canada, was held in Toronto on January 19th, 2003.

International MOUs and Agreements

Genome Canada has signed international memoranda of understanding with Sweden, Spain, Denmark and the Netherlands.

As a result of the memorandum of understanding between Genome Canada and Genoma España, a Joint International Competition was launched. This competition has resulted in the approval of three new large-scale genomics projects, for a total value of \$17 million over three years. Half of the funding for these projects will be provided by Genome Canada and the other half by Genoma España.

International Components in Large-Scale Projects

Of the 51 large-scale projects that were funded in Competitions I and II, 39% of these include international collaborations (eight of 17 projects in Competition I and 12 of 34 projects in Competition II).

According to the panel members interviewed, a great deal of care was taken in assessing whether international considerations had been included in the proposals for large-scale projects. The international experts on the panel were familiar with genome research around the world, which allowed for an in-depth discussion of these issues. In some cases, discussion centred around heightening Canadian competitiveness on an international scale, avoiding overlap or duplication between international projects, identifying potential collaborations and ensuring the dissemination of the findings to a broader international audience. As well, the panel was generally more supportive of projects that did have strong international linkages and those that would be imbedded into larger international projects.

Still, two of the 13 panel members interviewed noted that there could be more productive efforts on the part of Genome Canada to link projects with international efforts and share the findings with the rest of the world. One panel member pointed out that, although Genome Canada had a substantial amount of money, Canada itself had “more to gain by sharing, rather than by going about it alone”.

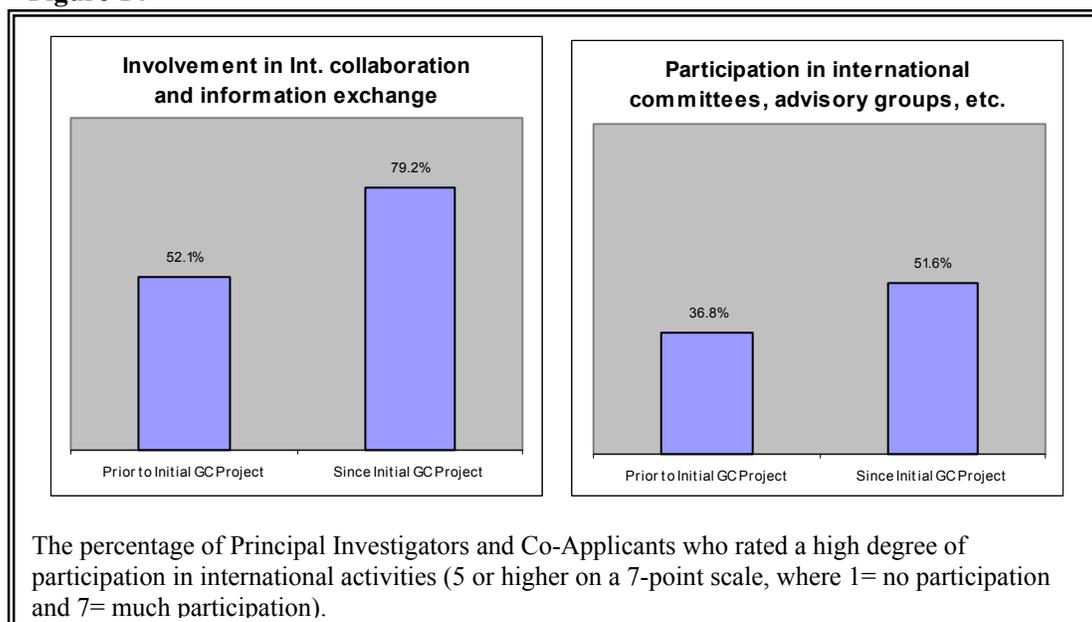
International Involvement of Canadian Scientists Funded by Genome Canada

The data collected by the Genome Centres indicate that:

- 90 Canadian researchers have participated in international committees
- 16 Canadian researchers have received international awards
- 31 Canadian researchers have participated in international projects

The survey results indicate that Genome Canada has had a significant impact on the international activities of Principal Investigators and Co-Applicants who have participated in Genome Canada projects. Of the 101 researchers who were surveyed, 52.1% rated their degree of participation in international research collaborations **prior to** their initial Genome Canada project as being high (5 or higher on a 7-point scale, where 1= no participation and 7= much participation), while 79.2% noted a high degree of participation in international research collaborations **since** their initial Genome Canada project. Likewise, the percentages of researchers who rated their degree of participation in international committees and advisory groups prior to their initial Genome Canada project and since their initial Genome Canada project were 36.8% and 51.6%, respectively.

Figure 14



4.9 Objective 8

Encourage investment in genomics research by others.

Summary of Findings

- The program has encouraged many other stakeholders to invest in genomics research, including most Canadian provincial governments, industry, other federal agencies, institutions, as well as foreign industry and institutions.
- The program has acted as a tremendous leveraging device, which has allowed Genome Canada to surpass its target of \$320 million in co-funding.
- Co-funding has increased the total number of projects and has ensured the operation of many of the Centres.
- Co-funding has also created a great deal controversy. Some say it is a distraction to undertaking research, and others question whether it is fair that all projects must raise co-funding, especially given the perception that it was imposed after some Competition I projects had already been approved.

Discussion

To date, over \$342 million in funding for genomics research has been leveraged from co-funding requirements, based on the \$300 million that has been invested by Genome Canada. This figure surpasses the \$320 million originally set as a co-funding target in the funding agreement with Genome Canada. Another \$75 million, which is earmarked for projects from the recent Applied Health competition, will

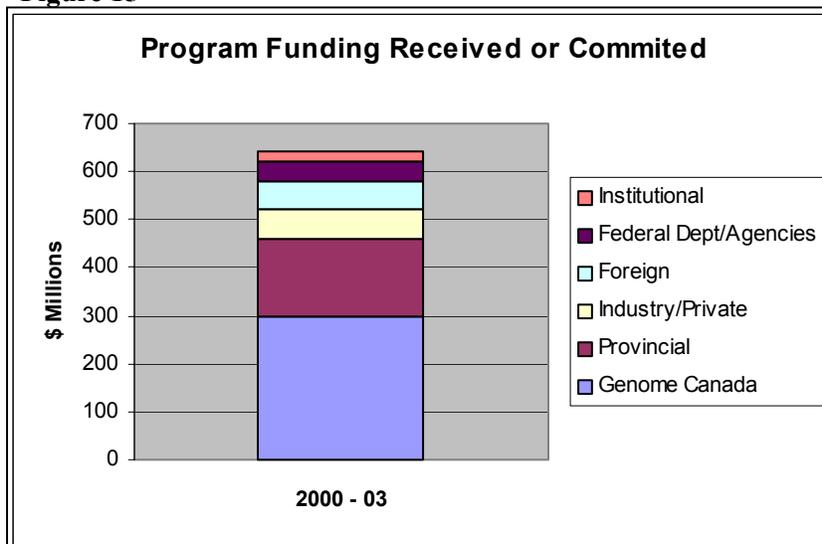
raise additional co-funding. The specified target for co-funding in the agreement with Genome Canada relating to this competition is \$80 million.

The breakdown of the \$342 million in co-funding received or committed so far (as at March 2004) can be broken down as follows:

- \$158M Provincial governments
- \$67M Private sector
- \$56M Foreign
- \$42M by Other federal agencies
- \$19M Institutions

Figure 15 (below) illustrates the importance of each contribution and how they are supported by the \$300 million invested by the Crown, through Industry Canada.

Figure 15



The following table (Table 5) also outlines a more detailed, regional breakdown of co-funding received or committed to date.

Table 5: Co-funding Received or Committed

	Canada	Atlantic	Québec	Ontario	Prairie	BC
Co-Funding (000\$)						
Federal Dept/Agency	41,625	11,182	1,527	19,001	8,834	1,081
Foreign	55,692			54,302		1,390
Industry/Private	66,614	132	18,667	35,480	12,080	255
Institutional	19,113	53		15,501	1,346	2,213
Provincial	157,975	4,477	70,664	38,579	10,305	33,950
Total Funding Raised	341,019	15,844	90,858	162,863	32,565	38,889

The program has been successful in encouraging the private sector to invest considerably in genomics research. As some Board members and Genome Canada staff have mentioned, the amount of corporate co-funding is becoming increasingly significant, due to the “branding” of Genome Canada projects as involving “internationally recognized, world class science”. This, it is claimed, inherently assists the private sector to more easily secure funding themselves from traditional private sector and venture capital markets. In addition, one industry co-funder pointed out that, in some cases, it is “too early in the development stage for the projects to be fully funded by industry because of the risks involved. But, because the investment made by government reduces the risk to a tolerable level, and because of potential outcomes, industry is willing to participate.”

As for government funders, most representatives interviewed indicated that co-funding is secured as part of their mandate. For example, the Atlantic Canada Opportunities Agency (ACOA) co-funds Genome Canada projects because its mandate is to contribute to the “development of the economic sector in Atlantic Canada.” Likewise, Valorisation-Recherche Québec (VRQ) seeks to strengthen university research, while at the same time leading to increased positive outcomes for Québec. All co-funders, both from industry and from government, are pleased with the rigour of Genome Canada’s peer review process and appear to be satisfied that they are receiving good value for their money.

As stated under section 4.3, many Board and staff members feel that the Centres have played a positive role in securing co-funding, particularly with regards to raising provincial co-funding and assisting projects in raising local private sector co-funding. However, it was also pointed out that although \$65 million of co-funding has been leveraged from industry, so far, there are relatively few industry participants in co-funding activities.

Although co-funding is recognized by a majority of respondents as being a successful component of the program, it was also one of the elements which excited the greatest amount of criticism from the researchers.

For example, a number of PIs said that co-funding for Competition I projects and platforms was imposed by Genome Canada after projects had been selected and contracts had been signed. As discussed in section 4.1, this appears to have been, at least in part, a communications issue. The Guidelines for Competition I – which, recall, was a competition for Genome Centres (and their associated projects), not a competition for projects – indicate that Genome Canada expected funding contributions from other sources. However, they do not state that Genome Canada would only fund up to 50% of the cost of each project, and even the more general discussion of Genome Canada’s co-funding expectations may not have been communicated to these PIs.

Many PIs also stated that for both competitions, the co-funding requirement did not include clear definitions or criteria regarding what was to be considered as eligible co-funding. Consequently, there are a few somewhat unusual sources of co-funding. For example, some projects are using pre-existing grants from other programs.

For Competition II projects, some Centres submitted proposals, which included co-funding, which they considered as eligible, based on the information that was provided by Genome Canada. Each proposal was then reviewed by a due diligence committee to assess the budget, co-funding sources and strategies, and project management, and some of the co-funding was determined to be unacceptable. The Centre has been working with the research teams to identify and secure additional funds to meet the co-funding requirement.

Co-funding is clearly an issue for many Centres, but even more so for researchers. Many researchers see co-funding requirements as a definite detriment to the research process and the programs research objectives as a whole.

“Strategy of relying on matching funds wastes energies of talented scientists, which are spent on arranging matching funds rather than doing the work.”

“[Researchers] need to write multiple proposals to arrange funding. When co-funding is successful, timeframes are usually incompatible with Genome Canada. Sole reliance on co-funding strategies tends to bias work in the direction of low-risk low-return projects to the detriment of high risk high yield projects”

Another issue that was highlighted by a number of researchers, particularly those conducting GE³LS research, is that they believe not all projects should be treated in the same way when it comes to requiring co-funding. Since GE³LS projects face more difficulty in demonstrating commercial or other economic benefits resulting from their research, they have more difficulty raising funds from traditional provincial or private-sector funding programs.

4.10 Objective 9

Create and realise economic, industrial and social benefits to Canada.

Summary of Findings

- There are high expectations, on the part of the federal government and the public sector co-funders regarding the attainment of “significant” socio-economic and industrial benefits from this program over the long-term.
- The program has realized some short-term, quantifiable, social and economic benefits to date.
- There have been few specific industrial benefits derived, as yet, from this program, although it is too early to expect significant industrial benefits.
- The selection process is the pre-eminent strategic device for creating and realizing economic and industrial benefits, and the potential for socio-economic benefits and commercialization were not major factors in project selection for the first two competitions.
- The Centres are expected to play major role in strategically directing commercialization policies and benefits, but have little direct effect on the selection process. There are several long-terms strategic management implications to this situation.
- There is a lack of an economic/industrial benefit strategic planning based on competitive advantage to optimize socio-economic benefits for Canada as a whole, and no specific clustering strategy (as stated in the initial business plan for the program)

Discussion

Given the fact that Genome Canada projects have been operational for no more than two and a half years – and many projects for only one and a half years – it is not reasonable to expect the program to have

generated a “significant” number of socio-economic or industrial benefits to date. It is, as many Board members and Genome Canada staff have stated, far too early to expect to harvest all of the rewards that are anticipated from this program. With the over \$640 million invested to date in projects, there has obviously been some impact in terms of job creation and training. However, any significant socio-economic and industrial benefits will be derived through the eventual application and commercialization of the research being funded and the application of the research capabilities that are being developed.

One of the most important strategic devices to ensure the creation and realization of socio-economic benefits for the medium to long-term is through the project selection process. As part of each of the two competitions, it has been a requirement for all projects to outline the objectives and plan for achieving socio-economic benefits. However, based on interviews with peer-reviewers, as well as Genome Canada and Centre staff, these objectives did not play a major role in the project selection process. The overriding selection criterion was always the scientific merit of the proposal. As exemplified by one peer-reviewer - “Good economic potential coupled with mediocre sciences simply did not, and should not, make the cut”.

To make perfectly clear what is being said here – it goes without saying that Genome Canada should require all research it supports to be of high scientific merit. It could **also** require, however, that the research have the potential for significant socio-economic benefits. This was not done in the first two competitions. It was done in the current competition on Applied Human Health.

From a strategic perspective many Board members and Genome Canada staff have qualified this “bottom-up” or “downstream strategy” as a temporary by-product of their business model and an attempt to quickly catch-up to other major international players. Most Board members and staff, who provided an opinion on this, felt that a bottom-up/downstream strategy was essential in properly identifying where the strengths in Canada actually lay. However, many of the other respondents also added, and this was voiced with particular emphasis by the Centres, that it is time that more of a top-down/upstream strategy be adopted in order to achieved more quickly the anticipated socio-economic/commercial benefits.

As part of the new model, whether implicitly planned or not, much of the responsibility for achieving the longer-term socio-economic and industrial benefits has been either given to or adopted by each of the Centres. The Centres have done considerable strategic planning in this area and have included more industry experts in their project assessment process. It was also specifically mentioned by many of the PIs that they were being held to task by the Centres regarding all of the socio-economic benefits they alluded to in their applications for funding. The co-funders, who fall under the responsibility of the centres from a management point of view, also require that all expected socio-economic benefits be identified and that a detailed plan be in place to ensure that these benefits are realized. The Centres also plan to increasingly depend on the expected revenues derived through commercialization to not only cover their administrative budget, but also fund projects of regional economic importance or to fund skill development or technologies and tools in areas they identify as being strategic “gaps”. Some Centres expect to become totally self-sufficient within a six to twelve-year horizon, dependent entirely on the proceeds from commercialization. With respect to the management of IP and commercialization issues, each Centre has devised its own unique mix of policies, approaches and procedures. One of the responsibilities of the Centres has been the education of scientists regarding what IP consisted of, how to protect it, how to publish without compromising future rights, etc. This process has been facilitated by Genome Canada, which shared IP policies and agreements among the Centres.

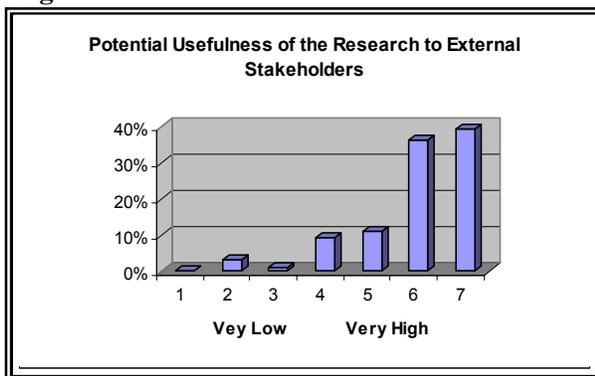
A potential for managerial conflict could arise, both in the short and long term, in that the Centres have had little influence on the selection process itself (other than undertaking a “triage”-type pre-assessment of projects), which is a main trigger for generating commercialization, but they have substantial

responsibility with respect to commercialization and hence the more “significant” socio-economic and industrial benefits.

Social Benefits

It is evident that the research being done will benefit Canadian society in terms of promoting an understanding of genomics issues, particularly as exposed through the program’s communications and outreach initiatives and focus on GE³LS issues. As one Board member put it, “as art is required in buildings, so too is ethics in science”. There will also be considerable influence on future research into a number of related scientific disciplines that will benefit Canadian society in numerable and immeasurable ways, including environmental remediation and improved health.

Figure 16



It is widely recognized by all respondents that the research will be useful to all Canadian partners and stakeholders of this program. Based on the web survey, 76% of researchers rated as high or very high the potential usefulness of the research to external stakeholders, with an average rating of 5.9 for all researchers on a scale of 1 to 7 (where 1=very low and 7=very high). PIs who responded to the web survey rated the potential usefulness of the research to external stakeholders at approximately 16% higher than if the same research had been funded by another program (such as under the federal granting councils or Networks of Centres of

Excellence).

Short-Term Economic Benefits - Job Creation, Skills Training Development and Brain Gain

In keeping with the implicit business model characterized by “speed wins”, the number of short-term economic benefits that have been derived to date, after only after a few years, is important, if not impressive.

Based on data accumulated through the RMAF process, a number of short-term benefits can be identified. This includes having close to 2,000 direct jobs created or maintained, over 90% of which are considered HQP (Highly Qualified Professional) positions. As can be seen from Table 6, the majority of these positions involve relatively high paying researcher, technical and project management responsibilities. It is estimated that since Genome Canada’s inception, between 5,000 and 5,500 person years of employment have been created. Also, based on the total \$650 million dollar values invested in R&D to date, it has been estimated (based on appropriate Statistics Canada multipliers) that between 3,200 and 3,700 person years of indirect employment have also been created as a result of this program.

Table 6: Training and Job Creation

	Canada	Atlantic	Québec	Ontario	Prairie	BC
Direct Jobs Created and/or Maintained (estimated headcount Dec '03)	1997	88	689	546	379	295
Investigators	387	13	121	124	85	44
Other researchers	277	1	165	35	37	39
Technical personnel	411	22	118	131	72	68
Post-doctoral fellows	210	13	79	61	38	19
Graduate students	178	18	67	33	48	12
Bioinformaticians, programmers	163	6	27	60	24	46
Project managers/coordinators	65	1	17	27	11	9
Undergraduate/Co-op Students	142	1	58	38	25	20
Administrative staff	65	3	23	26	4	9
Consultants	14	2	4	2	1	5
Other	48	6		1	29	12
Genome Canada and Centre Staff	37	2	10	8	5	12

As noted in section 4.3, in terms of training, this program has substantially contributed to the Canadian base of expertise in a number of relevant disciplines, including that of project management for large-scale science³¹, which is a relatively new but strategically important discipline from an international competitiveness point of view.

Brain Gain

The program has also had a measurable influence on both attracting and retaining world-class researchers, including Canadian researchers who were influenced to return to Canada. Based on RMAF data collected by some of the Centres and on information collected from a sample principle investigators, over 60 world class researchers were identified as having been attracted to work in Canada because of the opportunities the program has offered. There are undoubtedly many more however it would be too difficult to estimate total numbers based on the information that has been collected.

It should be emphasized that the training and attraction/retention impacts of Genome Canada discussed in this section are significant, because the genomics research community in Canada was relatively small compared to other countries at the inception of Genome Canada, and one of the major aims of this

³¹ As noted under our discussion of the Overall Objective (program management), the Networks of Centres of Excellence program is the only other Canadian research program with a comparable emphasis on project management.

initiative (implicit in several of the objectives) has been to build up Canada's genomics research capability.

BC Opportunities Bring Local Scientist Home

Rob Holt knew when he left Canada for further studies that he would return, one day. He continued to follow Canadian developments in genomics with interest, from his position as a founding member and senior scientific operations manager at Celera Genomics in Maryland. With Celera he was the principal investigator on several major projects, including large-scale sequencing of the malaria mosquito genome and of the rat genome.

He credits funding now available in Canada for basic research, from organizations such as Genome Canada and Genome British Columbia, as the reason for his return, somewhat ahead of his own schedule, and for his new position at the Genome Sciences Centre (GSC) and the BC Cancer Agency.

Marco Marra, Director of the GSC and co-leader of three Genome BC-funded projects, noted, "We are indeed very fortunate to attract Rob to the Genome Sciences Centre, as there are many opportunities for one with his knowledge and skills. His contribution will be a key aspect of our on-going success."

Excerpts from
Signals Newsletter, Genome British Columbia

Retention of World-Class Researchers is a strength of Genome Canada

Prior to Genome Canada, several members of one of the current Genome Canada large-scale project research teams were working together on their research at a small Canadian biotech company. However, due to financial difficulties, the company was forced to discontinue this research project and lay off the research team.

Following this, the researchers found other jobs (not all in research), but continued to pursue this research "in their spare time". They met every Friday night in the kitchen of the lead researcher (now the PI for the large-scale project) to discuss their progress and next steps. Nevertheless, the continuing viability of this arrangement was tenuous; and, in fact, prior to the Genome Canada funding, one member of the research team had tentatively accepted a job at DuPont in the United States.

However, as a result of Genome Canada support, they have now all been retained as Canadian genomics researchers.

A majority of researchers, Board members and Genome Canada/Centre staff stated that the ability to attract and retain world-class researchers is one of the program's main strengths. A high percentage of researchers (60%) rated high to very high (6 or 7 on a 7-point scale, where 1=very low and 7=very high) the ability of the research program to attract and retain world-class researchers, with a rating average of 5.5 for all researchers. This was approximately 10% higher than the perceived ability of other programs to do the same.

Figure 17

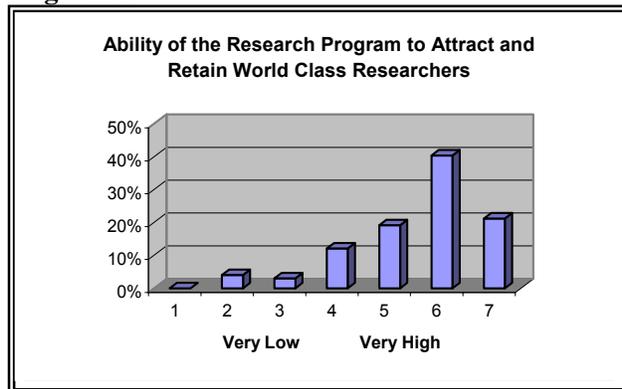
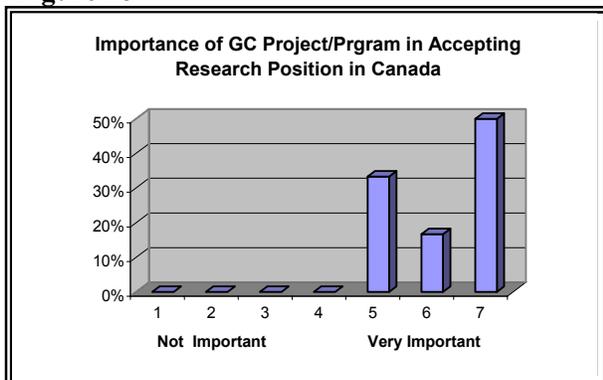


Figure 18



Of those researchers who responded to the web survey, 7% indicated that in the past three years they did leave a research position in another country in order to accept a research position in Canada. Of these, 67% rated High to Very High (6 or 7 on a 7-point scale, where 1=very low and 7=very high) the importance of the Genome Canada project or program in accepting their research

position in Canada, with a rating average of 6.2 (see Figure 18).

Of the researchers surveyed, approximately 30% stated that they had seriously considered a research position in another country over the past three years. As demonstrated in Figure 19, of those who have seriously considered leaving, 59% indicated that participation in their Genome Canada project or Genome Canada generally played an Important to Very Important role in deciding to remain in Canada (that is they rated the importance as 6 or 7 on a 7-point scale, where 1=not important and 7=very important).

Figure 19

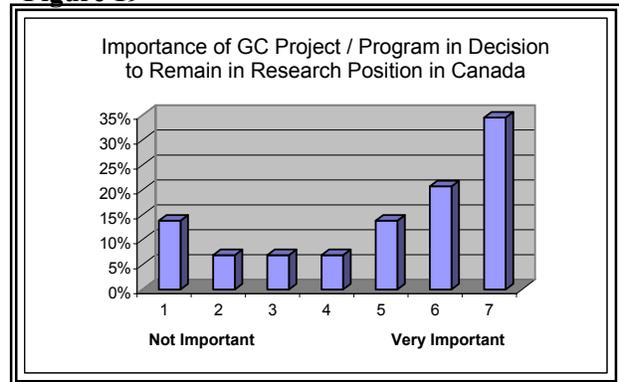
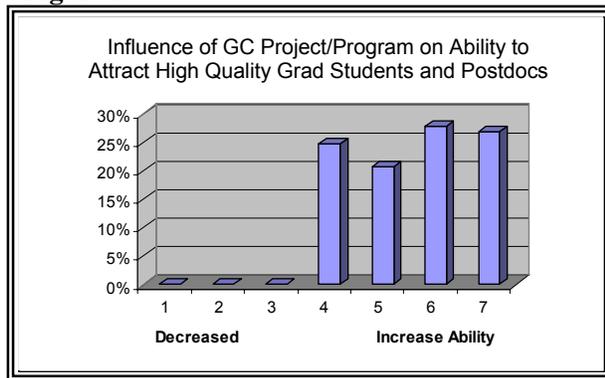


Figure 20



As well, as shown in Figure 20, 57% of researchers surveyed indicated that the specific Genome Canada project they are involved with, as well as Genome Canada generally, has increased or significantly increased their ability to attract high quality grad students and postdocs (that is, they selected 6 or 7 on a 7-point scale, where 1=significantly decreased ability and 7=significantly increased ability).

Medium to Longer-Term Economic and Industrial Benefits

Although short-term economic impacts are considerable, there are even higher expectations regarding the volume and importance of the long-term economic and industrial benefits. It could be easily argued that spending this amount of money in a number of other economic sectors would produce some comparable impacts, particularly if one looks at job creation. However it is the potential for this sector to be much more, that captures the imagination of economic planners, and, as one of the co-funders stated, “The big payoff will be when commercial activity starts to kick-in”. With the great potential for non-linear increases in not only job creation, but also in skills training, import substitution and export generation, it is commercialization that is considered the true facilitator for “significant” economic and industrial benefits.

The expectations are high and recent policy statements by the new government have been overwhelmingly clear regarding the expected results of publicly funded research and the need for commercialization strategies. Also as the Earncliffe Research and Communications Study (2004) has strongly identified, the mood among politicians and senior federal program administrators is,

“one of a mix of hope and fear about the sector; hope in that it can achieve its promises in terms of health and economic benefits, but fear in the sense that government has made

a substantial investment in this field and is exposed to significant political and media pressure if results do not show themselves.”

“Commercialization is the current mantra in Ottawa. There was a very strong belief in most quarters that if government is going to fund research, that some portion of that research has to yield commercially viable applications within a reasonable period of time. Research in and of itself is not enough to satisfy the demands.”

To date there has been little evidence of derived commercial benefits, but that is to be expected in such a new program. Based on the several initial indicators of potential commercial activity however there is some evidence to show that the program has something to point to, as shown in the following table.

Table 7: Indicators of Potential Commercial Activity

	Canada	Atlantic	Québec	Ontario	Prairie	BC
Interactions with Industry						
Industry Co-App / Co-Funders	43	1	5	27	8	2
New Start up Companies Created	7	0	2	3	2	0
Intellectual Property						
Patent Applications Filed	30	0	4	9	10	7
Patents Issued	2	0	0	1	1	0
Invention Declarations on File	43	0	11	22	0	10
New/Improved Products, Services and Processes	28	0	9	0	4	15

- 43 companies have been active participants in the program so far, either through co-funding or being a co-applicant on a research project that was successfully selected. There was also a large number of private sector co-applicants that were involved in competitions I and II but were not selected.
- In terms of new company formation, to date there have been seven new companies that have been identified.
- Entrepreneurial formation is very difficult to measure, but will come from the pool of trained highly qualified researchers and technicians.
- Patent applications filed (30), patents issued (2), invention declarations on file (43) and new or improved products/services/processes (28), are all important indicators of potential program-related commercial benefits.
- There have also been 464 publications linked to the program as well as over 950 major conference presentations.

Project Selection Process

The guidelines related to socio-economic benefits in the three competitions that have been held to date are summarized below.

Competitions I and II

The evaluation criteria for both these competitions included several criteria related to socio-economic benefits:

- (1) “Benefits to Canada, including...economic, industrial, and social”;
- (2) “Extent to which the scientific component [of the project] will ...enhance the development of new technology”; and
- (3) “Where applicable³²:
 - the expected commercial potential
 - a strategy for commercialization, technology transfer, and handling of IP issues.

However, it is widely felt, particularly by peer review panel members, Genome Canada staff, and many researchers that these criteria were not given serious consideration by the selection panels and that the evaluation of proposals was based primarily on the scientific merit of the proposed research.

Interim Review of Competition I Projects

In their presentations to the review panel, applicants were required to describe:

- “Achievements in creating new products, processes, or services that have been or could be commercialized”, as well as technology transfer that has occurred, spin-offs, etc.
- “How the research team has applied, or plans to apply, the research results to social, economic, or industrial benefits to Canada, including technology advancement and public policy development”,
- For projects with commercial potential, the strategy for commercialization.

Based on the response of peer review panel members, these items were not given as much serious consideration as some of the other review criteria.

Applied Research in Human Health Competition

This competition clearly focuses much more on socio-economic impacts. The guidelines to applicants include the following:

- The purpose of the competition is to solicit proposals “focusing on the development and application of genomics and proteomics tools to improve the prediction, prevention, and treatment of human disease...”
- “The successful research proposals must be directly linked to the delivery of predictive, preventive, and/or personalized healthcare...”
- “Preference will be given to those proposals likely to impact human health in the near-term, generally within five years.”
- “Emphasis will be placed on the ease with which newly developed tools can be made accessible to clinicians and other healthcare providers.”

³² This wording appears to be intended to recognize that not all projects have commercial potential and GC is not requiring this

The guidelines provide examples of research areas and types of “tools” [used in the broad sense to include methodologies, etc.] that Genome Canada wants to support in this competition (e.g., biochips, medical and diagnostic applications of microarrays, molecular diagnostics). The guidelines also require that each proposal include “a clear commercialization process, which includes IP management and ownership, technology transfer, and benefit sharing”.

The evaluation criteria mirror these guidelines. They include:

- Direct impact on human health
- Timeliness of the impact of the research on human health or the Canadian healthcare system
- The benefits to the health of Canadians or the Canadian healthcare system, “which may include economic, industrial, and social”.
- [For projects where there is commercial potential] the quality of the strategy for commercialization, technology transfer, and handling of IP issues.

Commercialization at the Centres

Taking into consideration the divergent approaches to commercialization, including how IP issues are dealt with, a comparison of the approaches adopted by each of the Genome Centres is provided below.

A number of elements are similar for all centres, many of which are elements of the new program model.

- Intellectual property ownership belongs to the researchers unless otherwise negotiated; some rights are shared with corporate co-applicants and/or the Centres.
- The Centres can negotiate a percentage of the revenue or profit-generating potential of each project. Although there are no fixed rules, there has been a guiding principal of 30% established.
- Universities as host-institutions and private sector co-funders/co-applicants usually have the first rights to pursue commercialization opportunities, which is usually done through their technology transfer offices; if they do not pursue them, the centre then has the right to do so.
- Full self-funding of Centre operations is a medium to long-term goal of all Centres.
- All Centres wish to have strategic funds in order to pursue other genomics/proteomics projects that are judged important to their region, mainly due to their commercialization potential.
- Most use their in-house science and business experts to review a project in terms of its socio-economic potential – some have developed an external expert panel.
- Most Centres have developed a commercialization strategy.
- The RMAF (recommended guidelines) are quite linear ...publications to disclosures to IP to patents to products.

Genome Atlantic

- Genome Atlantic is working hard to improve the productivity and revenue generating capability of its technology platform in order to make it a major component of its self-funding strategy. This includes restructuring agreements to take over management of the platform, in partnership with NRC and the Universities, to support all genomics research in the region, in accordance with Genome Canada guidelines. Genome Atlantic is also looking to leverage the platform to form partnerships with industry, in order to promote industrial research and shared benefits.

- Genome Atlantic is the only Centre that has negotiated a 30% ownership of the intellectual property rights to each of their projects.
- The Centre wishes to increase and diversify its funding base.
- During the first competition the Centre developed a project evaluation structure with its own peer review process. This process was very costly and perceived by the Centre as being redundant. During the 2nd competition, every project that passed the letter of intent stage was presented to Genome Canada for peer review. Genome Atlantic is now looking to return to in-house review of letters of intent and projects before sending them to Genome Canada, the key criteria being relevance to the Atlantic region.
- Genome Atlantic's commercialization strategy is based on sharing the risks and rewards with corporate partners. However, when these partners are not available, Genome Atlantic will have to turn to an incubation strategy, where there will be a definite need for seed funding from venture capitals or government programs.

Genome Québec

- Genome Québec has negotiated a different status than other Centres, mainly surrounding their agreement with universities, where around one-third of the commercial fall-out of projects will be returned to Génome Québec.
- Genome Québec has been able to attract additional funding (VRQ, FRSQ, FQRNT) to launch an additional initiative in Bioinformatic (focused on skill development and networking). Genome Québec is pursuing a long term (ten to twelve years) self-funding strategy. The basis of this strategy is the development of technology transfer capabilities and an equity investment in the private organizations that are being funded. Genome Québec has implemented a different platform concept, which is essentially being managed and operated by Génome Québec personnel. The platforms are developing business plans with a focus on business development.
- Genome Québec has also been very active in recruiting the participation of the private sector as partners and collaborators.
- Genome Québec also publishes a running tabulation of the comparative success of all its projects, based on whether or not they are meeting socio-economic objectives.

Ontario Genomics Institute (OGI)

- OGI is very active in trying to bring in private sector partners. For example, they invited United Kingdom and United States venture capital groups to take a look at the commercial opportunities OGI has identified.
- OGI wants to be seen as an avenue for commercialization.
- OGI has an in-house scientific/business expert who is constantly reviewing all promising genomics/proteomics research projects taking place in Ontario (including projects not funded by Genome Canada) for potential commercialization. Also, every project has a commercialization committee.
- OGI intends to focus on "products and services that have positive commercialization potential but are unlikely to be developed without additional resources" [and even then for at least five to ten years]. The majority of these are products of applied research such as diagnostic tools and agricultural

products with moderate potential financial value and reasonable probability of successful development and commercialization.³³ For example:

- Diagnostic tools or services for prevalent human medical conditions
 - Development of new research equipment and formats
 - Agricultural applications of genomics and proteomics
 - Therapeutic targets [i.e., drugs].
- OGI will assist in the development of these products by drawing from its scientific and business base, and legal networks, to provide expertise required for business planning and pre-commercialization development. OGI will also bring additional investors and industry partners to the table.

Genome Prairie

- Genome Prairie has devised detailed “new start-up strategy”, from where it feels most commercialization/economic benefits will come from.
- Genome Prairie foresees that returns from commercialization will be insufficient to fund the administration of the Centre, over the long term.
- The commercialization return sought by Genome Prairie will be placed in a Genomics Advancement Fund, a portion of which will be made available for new rounds of project funding as a reinvestment with the Centre’s various partners (always through a competitive process).
- Because the Centre represents three provinces, none of these provinces have a feeling of “ownership” and none consider the Centre as being an engine of economic growth for “their” province. This makes it very difficult for the Centre to secure co-funding to cover their operations budget. Centre officials feel that if Alberta cannot be convinced of the benefits of having the Centre strategically located in Calgary, they will have to consider moving.

Genome British Columbia (GBC)

- GBC is regarded by some (Genome Canada staff) as potentially a good model for dealing effectively with intellectual property issues.
- GBC has an entrepreneurial attitude with respect to socio-economic benefits, and has several explicit features to try for early commercialization benefits.
- The GBC Board has organized a commercialisation committee, whose members have extensive experience in early-stage development. This committee identifies potential, interesting IP, commercial opportunities, and commercialisation strategies to bridge the gap from universities to venture capitalists.
- GBC has first rights for 90 days with the institutions to pursue identified commercialization opportunities. In the case of the British Columbia Cancer Agency, GBC has 30% of the net proceeds.
- There has been a very extensive consultation to identify appropriate projects that are more aligned with the D part of R&D. GBC has organized approximately 15 Business Advisory Committees (BAC), one for each project and each platform. These BACs include individuals skilled in

³³ However, some of the products do have market sizes of billions of dollars.

institutional IP and R&D issues, legal/patent issues, VC issues, and private sector issues. The CSO also is a member. The BACs meet regularly, as required by individual projects; typically one to two times a month to once every 2-3 months. They have a portfolio of projects, some more based on fundamental science (especially from the first competition), others on more applied science (especially from the Applied Health competition).

- In the Applied Health Competition, GBC went through a lot of effort to propose projects to Genome Canada that fully reflected Genome Canada's goals and selection criteria; e.g., discussed this a lot with the scientists ahead of time, and told them not to apply if they couldn't live with the focus on social and (especially) economic benefits. GBC told scientists that there had to be some sort of practical applications *within five years*. This was at first very threatening to the scientists, and essentially ruled out applications such as drug development, since the time frame would be 15-20 years. Instead it focused effort on applications such as diagnostic and prognostic tools, instruments, methods, etc.