Summative Evaluation of CANARIE Phase 3

Final Report

Audit and Evaluation Branch

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Canada

Executive Summary

Introduction

CANARIE is now in the fifth and final year of Phase 3 (1999-04) of its three-phase program, originally approved in 1993. Phase 3 began on April 1, 1999 and is scheduled to be completed by March 31, 2004. CANARIE received $78 million from the federal government over the five-year period on a cost shared basis. The objective of Phase 3 is:

> "…catalyze the development and diffusion of technologies, applications and services that may underpin and/or use advanced Internet infrastructure, such as CA*net 3 and CA*net 4, and are based on open-systems standards."

In support of this objective, CANARIE has one program, the Advanced Applications Development Program (AADP), which is supporting research and development by industry and the public sector in developing and deploying advanced applications in the sectors of e-business, e-learning, e-health and intelligent systems. The intelligent systems program is managed by Precarn under an arrangement with CANARIE. There are also a number of other programs operated by CANARIE outside the Phase 3 agreement.

The objective of this study is to carry out a summative evaluation focusing on the evaluation issues of relevance, success, and future directions for CANARIE after Phase 3. The element of cost effectiveness is being covered in a separate study of CANARIE. The intelligent systems program managed by Precarn was evaluated in a similar manner to the programs operated by CANARIE. The evaluation study also took into account the possible extension or reprofiling of Phase 3 to March 31, 2005.

Program Profile

The AADP represents a shift in focus away from the network infrastructure development of the previous two phases towards the development of advanced network applications and related technologies. This shift reflects both the successes of the previous two phases and the need for Canada to develop an advanced network applications industry that will help to brand Canada internationally as a high-tech advanced economy that can compete successfully with the United States, Europe, Japan and other leading countries. As noted, AADP is supporting projects in four application areas: e-business, e-learning, e-health and intelligent systems.

Phase 3 activities are oriented toward assisting key sectors of the economy to develop critical advanced applications and associated infrastructure that will improve their structural competitiveness. It was expected that the applications would utilize advanced networks including CA*net 3, and more recently CA*net 4, developed through the Next Generation Networks program, together with the regional networks that connect to it.

The AADP provides financial assistance of up to 50% of eligible project costs. Of the program's $78 million budget, $28.4 million has been allocated to the e-business program, $28.4 million to the e-learning program, $9 million to the intelligent systems program (Precarn) and $4.5 million to e-health. The remaining $7.8 million or 10% of the program's budget is earmarked for project management and administration costs of CANARIE and Precarn.

Study Approach

The evaluation study involved four lines of enquiry: document reviews, consultations, a survey, and case studies, and was guided by the evaluation framework prepared in March 2000 and the interim evaluation of November 2001. A breakdown of the consultations (49 planned/48 completed), survey (72 contacted/33 responded) and case studies (3) is provided in the following table.

Summary of Interviews, Survey and Case Studies

Enquiry Groups	Number Planned & Method of Enquiry	Number Completed / Responded
CANARIE Board	2 interviews	2 interviews
CANARIE Inc.	2 interviews	3 interviews
Sector Advisory Committees	4 interviews	4 interviews
Industry Canada	3 interviews	3 interviews
Precarn Inc.	3 interviews	3 interviews
E-business projects (participants & users)	1 case study	1 case study
	10 interviews	9 interviews
	20 surveyed	9 respondents
E-learning projects (participants & users)	1 case study	1 case study
	10 interviews	7 interviews
	22 surveyed	14 respondents
E-health projects (participants & users)	4 interviews	5 interviews
	21 surveyed	6 respondents
Intelligent Systems projects (participants & users)	1 case study	1 case study
	6 interviews	7 interviews
	9 surveyed	4 respondents
Others: Provincial, International	2 interviews	3 interviews
Others: Applicants Not Funded	3 interviews	2 interviews

Note: The number of interviews planned and the number completed were not always the same because, in some cases, interviewees were not available, and, in other cases, additional interviews were considered useful to supplement information.

Study Findings

Program Relevance

The objectives of Phase 3 continue to be relevant, especially given the goals and targets outlined in "Canada's Innovation Strategy". The target of moving from 15th to 5th in international rankings of R&D performance will require the infrastructure and applications development that CANARIE has been initiating and supporting in Phase 3 and previous phases. CANARIE is seen by many as an organization attuned to the needs of the time, able to evolve to meet changing needs. In Phase 1, its focus was on technology and product development; in Phase 2, attention moved to incorporate applications; and in Phase 3, the program has concentrated on sectoral applications. The importance to Canada of CANARIE's work on infrastructure development was also emphasized and, while outside the scope of this evaluation, we noted comments such as "without CANARIE, Canada would not have a high-speed research infrastructure which has been essential in keeping Canada in the forefront of research in areas like genomics, and high energy physics involving the transfer of large volumes of data".

Further, many believe that CANARIE is more necessary today than at the start of Phase 3 in 1999. With the recent dot-com crash, venture capitalists have become extremely conservative, and the ability of companies to raise financing has become tougher. Project approval from CANARIE or Precarn, however, has reduced risk and allowed companies to leverage additional sources of financing. Venture capitalists and the e-business, e-learning, e-health or intelligent systems communities know that if a project has been approved by CANARIE or Precarn, it has been subjected to rigorous review by peers, and has attained a certain standard, or "seal of approval".

Both CANARIE and Precarn indicated that both the number and quality of proposals increased over the 1999-2003 period. During this time, 517 Expressions of Interest (EOIs) were submitted to CANARIE, of which only 134 were accepted for the proposal stage. Some 87 proposals were recommended for funding, giving an approval rate of 17 percent of EOIs received, and 70 percent of subsequent proposals received. In the same period, Precarn funded 34 of 92 proposals for an approval rate of 37 percent.

Success/Objectives Achievement

The table below summarizes the number of projects by program area, total project costs, the contribution by CANARIE, and the leveraged contributions.

Summary of Phase 3 Contributions[1]

Program	No. of Projects	Project Size (000,000)	Phase 3 Contribution (000,000)	Leveraged Contributions (000,000)	Leveraged Contributions Percent
E-Business	29	$65.6	$28.3	$37.3	57%
E-Learning	33	$64.0	$30.0	$33.9	53%
E-Health	23	$11.8	$4.6	$7.2	61%
Sub-Total: CANARIE	85	$141.3	$62.9	$78.4	55%
Intelligent Systems	13	$31.8	$9.0	$22.8	72%
Total: Phase 3	98	$173.2	$71.9	$101.3	58%

Phase 3 is not at a point where it can demonstrate final results although the evidence from the interviews, survey, and case studies suggests that the program, despite initial delays, is on course to achieving the intended impacts and effects. It should be noted, however, that an audit/evaluation is conducted at the end of each project, which will provide Industry Canada with additional information on impacts. In e-business, e-health, e-learning, and intelligent systems, a major achievement of the program has been the promotion and facilitation of collaboration among organizations and individuals in creating network applications. A key impact has been the development of communities of interest, and full involvement by SMEs, particularly in e-business projects. CANARIE exercised considerable care in choosing the communities of interest to be supported and involving the appropriate industry associations. A critical challenge in the four areas has been the social and cultural issues around communities of interest.

In e-health, the major impact has been on demonstrating the unique contribution telehealth can make to improving the quality of health care services. However, until the provinces agree to implement and integrate telehealth applications into the delivery of health care, the full impact of the e-health program will not be realized. In e-learning, Canada is leading the world in learning object repositories but not in implementation of e-learning initiatives. In intelligent systems, the major impact has been to move Canada further up the innovation chain, as well as the development of communities of interest and the greater participation of SMEs. All participants in this program believe that intelligent systems will play an increasingly important role in the Canadian economy, particularly in the space, mining, biotechnology, health care, and geomatics fields.

Most project participants that were interviewed indicated they had met the objectives of their projects. Delays in the "go to market" phase were the main reason for not fully achieving objectives. The survey confirmed the high level of satisfaction of participants with the CANARIE program: meeting project needs (72.7 percent); enhancing the quality of

[1] Only ninety projects were included in the evaluation study because eight were approved after the evaluation study began. The eight included: 3 e-business projects; 4 e-learning projects; and 1 intelligent systems project.

products/services (75.8 percent); developing new products/services (67.7 percent); developing new partnerships (75.0 percent); increasing revenues (33.3 percent); increasing the number of high quality jobs (57.6 percent); increasing the uptake of network applications (45.5 percent); and, changing service delivery costs (30.3 percent).

Network Usage by Projects

CA*net 4, as did its predecessor CA*net 3, interconnects the provincial research networks, and through them universities, research centres, government research laboratories, schools, and other eligible sites, both with each other and with international peer networks. The use of CA*net by the application programs (e-business, e-learning, e-health) corresponds closely to access. Under Phase 3, 55 percent (18 of 33) of e-learning projects, and 22 percent (5 of 23 projects) of e-health projects used CA*net to carry out their research, while none of the e-business projects used CA*net. E-learning and e-health projects where the lead participant was a private firm, also did not use CA*net, the main reason being lack of, or difficulty in getting, access to CA*net by the private sector partners. In e-business, another reason for not using CA*net has been that the applications being developed have not required the large bandwidth of CA*net; they have required innovative network management but have been readily accommodated within the capacity of the publicly available Internet. It is interesting to note that in e-business, while none are using CA*net, 24 percent (7 of 29) of the projects are using wireless networks.

Future Directions

All respondents to the survey and interviews indicated that federal support of advanced network applications and content development (e-business, e-learning, e-health, and intelligent systems) should continue. Momentum has been created over the ten years of CANARIE - the results of investment in Phases 1 and 2 are beginning to be evident in the work of Phase 3 - but the task is not considered to be complete. A general consensus in our data gathering is that CANARIE and Precarn have been key factors in helping Canada to maintain its competitive edge in network applications with our major trading partners, e.g., USA, Europe, Japan, Australia. In the absence of these programs, most believe industry in those countries would move ahead of Canada, especially given the relative generosity of their R&D programs compared to Canada.

A common view held by industry is that a future focus has to be the mid-market, that is SMEs. The software approach to e-business has not worked for SMEs as indicated in Chapter 5 because SMEs haven't the necessary skills to adopt the solutions or are slow to adopt, and, furthermore, they can't afford them. The respondents advocated an honest broker role working with industry associations and suppliers to develop a 'communities of interest' approach. It was felt that CANARIE had made a start in this direction in Phase 3 and had the knowledge, experience and credibility to continue on this path.

Also of interest in considering future directions is the issue of Canada's innovation challenge. Part of this challenge is seen as the acceleration of research collaboration, for example between research laboratories, between industry, university or government. "Data sharing is now pushing the frontiers of science. Collaboration is needed but it poses a challenge – all sectors are saying

we need facilitation, cross fertilization, informed advice and leadership." Again, this was seen as a role that CANARIE has played and could play to a greater degree in the future.

The approach to collaboration and to programming in network applications could, however, change in the future. In order to gain access to global markets, collaboration will need to be international in scope. A comment by an industry interviewee summarized the future situation: "Collaboration, consultation and facilitation will continue to be needed in the future supported by public funding, whether or not CANARIE is there as a performer of these functions". As network processes become more integrated, there would also be benefit, according to some interviewees, for the now separate areas of e-business, e-health, and e-learning to be brought together into one program.

The results of the survey provide a breakdown of support (primary, secondary) for various possible roles for CANARIE. Continued funding of advanced network applications and maintenance of CANARIE's coordinating/facilitation (honest broker) role received strong endorsement (primary and secondary). Across the application areas, the top preference among respondents for funding was basic R&D, with the development of prototypes a close second.

Most respondents noted that if there is a Phase 4, part of the funds should be used to finance demonstrations for the purpose of showcasing the advantages and benefits of CANARIE and Precarn. Many thought that a big challenge facing both CANARIE and Precarn is raising awareness, not only to potential project participants but also to the Canadian public. The general consensus was that stronger promotional efforts might have made the future of CANARIE and Precarn more certain. Several applicants (particularly in e-learning and e-health) whose proposals were not funded, expressed a desire to see detailed results of completed projects. They noted that the information provided in the newsletters is of a general nature, and although very useful for informing people on the types of projects completed, does not provide the detailed information that they would need to utilize and apply the results of CANARIE-funded research to their R&D efforts.

Conclusions and Recommendations

The following section summarizes the major conclusions that we have drawn from our research, and are grouped into two main categories: first, the possible extension of Phase 3 for one year, including the issues of relevance and success; and second, possible future directions for CANARIE after Phase 3. It should be noted that the scope of the evaluation was restricted to the Advanced Applications Development Program (AADP) and specifically the application programs of e-business, e-health, e-learning and intelligent systems (managed by Precarn). The study's mandate did not include CA*net or other application programs, such as e-content, that are supported by other departments and royalties from Phase 2.

Extension of Phase 3

CANARIE has requested an extension of Phase 3 to March 31, 2005. The study was asked to include this request in its review of Phase 3.

Conclusions

We conclude, based on our research, that there is merit in extending Phase 3 to permit all AADP projects to be completed. Supporting this position is our conclusion that the objectives of Phase 3 continue to be relevant, especially given the goals and targets outlined in "Canada's Innovation Strategy", and that CANARIE is meeting the high-speed infrastructure and advanced network application R&D needs of educators, health practitioners and private firms. Although Phase 3 is not at a point where it can demonstrate final results, due in part to the delay in getting the AADP started, evidence from completed and ongoing projects indicates that the AADP is on course to achieving the intended impacts and effects. Industry Canada's support for AADP has put many of the participants at the forefront in their respective sectors.

Only 38/85[2] projects are or will be completed by March 31, 2004, with the remaining 47 projects being completed six months later by September 30, 2004. All 13 of the intelligent systems projects under AADP managed by Precarn are or will be completed by March 31, 2004. The termination of the AADP on March 31, 2004 would mean, therefore, that 47 projects would remain unfinished or possibly continue at a reduced pace without CANARIE funding. Project objectives would not be reached and potential follow-on service implementation on an operational scale or product commercialization would likely not happen.

Recommendation

CANARIE's request to extend the AADP to March 31, 2005 should be approved so that the remaining 47 AADP projects can be completed, and the intended impacts fully realized.

Future Directions

CANARIE is now in its fifth and final year (1999-04) of its three-phase program. Industry Canada will need to decide if it wishes to keep to the original Phase 3 sunset, or to support a subsequent phase. A factor will be the perceived need for continued federal funding and the future role that might be played by CANARIE. We outline below a number of conclusions from the study and options for the future.

Conclusions

The technologies that have been supported in the AADP projects continue to evolve and are providing opportunities for applications that will involve new uses of advanced networks. The key change taking place will be the integration of the Internet into applications such that the applications can take advantage of other data and computational resources that they can directly access over the network. CANARIE, Precarn and others recognize that significant technological barriers need to be overcome as well as organizational and cultural barriers to allow this transformation to happen.

[2] Two e-business projects were approved after CANARIE's request for Phase 3 extension was submitted, bringing the total number of projects to 85. It was assumed, therefore, that these two projects would not be completed until the next fiscal year, 2004/05.

Our evidence is that a facilitator at a national level will be needed if Canada is to be able to take full advantage of these new applications that could have a profound influence on business practices, the Canadian health care system, the learning environment, and the manufacturing and resource industries. CANARIE has performed this function in the past, particularly in Phase 3, and has been credited with overcoming institutional and cross-jurisdictional impediments in a way that government agencies would have found difficult to do. All participants and other interviewees (including one rejected applicant) were in favour of a subsequent phase. Consultation with a provincial and US representative familiar with CANARIE also recognized the key contribution being made by CANARIE in advanced network development and utilization.

The leverage of funding from other sources that the AADP has achieved in Phase 3 is notable, particularly for the Precarn managed component. This reveals a strong commitment by firms and other organizations in the private and public sectors to work with CANARIE and Precarn in a coordinated effort to capitalize on the potential of new network and system technologies and applications. The evolution of CANARIE's programs and the broadening of its stakeholder base through Phases 1-3 also has demonstrated a capacity on the part of CANARIE to change to ensure Canada stays on the leading edge of network technology advances and the opportunities afforded to raise the productivity and competitiveness of Canadian companies and public services.

The four application areas of the AADP can be divided into those with a public sector focus, e-learning and e-health, and those with a private sector focus, e-business and intelligent systems, both having distinct characteristics that call for a differentiation in their requirements for support. This we believe to be a significant finding in considering future support in these areas.

- The study results indicate that the key determinants in supporting public sector application areas are: 1) projects would not proceed without public support; 2) cost sharing of the project creates significant difficulties; 3) participants' main interest is financial support for basic R&D; 4) most participants have access to CA*net and are using the network to carry out their research; 5) most do not expect to commercialize and/or pay royalties; 6) projects are dependent on the provinces for deploying the results of their project; and 7) large broadband connectivity such as CA*net remains an issue for the K-12 levels in e-learning and for rural and remote communities in e-health.

- By contrast, participants in the private sector programs noted that: 1) a primary need is financial support for pre-commercial testing activities and development of prototypes; 2) sharing of project costs with CANARIE/Precarn is fair, and in some cases desirable in facilitating the commercialization of results; 3) acceptance that failure to come up with their contribution means the project should not be funded; 4) without CANARIE/Precarn funds, projects would proceed at a slower pace and with a smaller scope; 5) none have access to CA*net and are relying on publicly available internet to carry out their research; 6) most expect to commercialize the results of their project and/or pay royalties; 7) projects are dependent on venture capitalists and other private funding organizations for deploying the results of their project; 8) their applications do not require the large broadband of CA*net; and 9) for e-business projects, the development of communities of

interest is significantly more critical to the success of the venture than in the case of intelligent systems projects. .

Recommendation

Consideration should be given to providing federal funding for a subsequent phase of CANARIE, subject to an acceptable proposal from CANARIE that reflected the key findings of this study, namely, that:

- The communities of interest and communities of practice approach initiated in Phase 3 projects be continued and enhanced, thereby expanding CANARIE's stakeholder base;
- The involvement of SMEs continue to be a focus of attention;
- The different funding, commercialization, royalty payment, and network requirements of public and private sector application programs be recognized in program design and management; and
- Resources be allocated to publicizing through demonstrations the applications under development in order to broaden awareness of the potential benefits of the applications and facilitate their implementation.

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1. Introduction

1.1 Background

In March 1999, Industry Canada announced $78 million in support for CANARIE Inc. to deliver the Advanced Applications Development Program (AADP), which constitutes Phase 3 of the CANARIE Program. The AADP is a five-year program, ending on March 31, 2004. The objective of the program is to remove structural barriers to, and stimulate accelerated R&D in, four priority areas: e-business ($28.3M), e-learning ($28.3M), e-health ($4.5M), and intelligent systems ($9.0M). The intelligent systems program is managed by Precarn.

In the earlier two Phases of the CANARIE Program, from 1993/4 to 1998/9, the strategic focus had been on encouraging innovative R&D by SMEs looking to compete in global markets. The focus of AADP represented a shift in direction to collaborative applications intended to stimulate growth in the Canadian economy and improve sector productivity.

A number of factors have led to delays in implementing the AADP. These include a restructuring of the organization to be able to deliver the new program, the time needed (up to 12 months) to negotiate contracts for the complex, multi-partner projects, and the reduced availability of cost shared funding from project partners adversely affected by the business downturn. Subsequently, a request by CANARIE for an extension or reprofiling of Phase 3 to March 31, 2005 has been submitted to Industry Canada.

An evaluation of Phase 3 is required this fiscal year (2003/4). The evaluation will take into account the possible extension of Phase 3 for one year as well as consider future directions for CANARIE after Phase 3. CANARIE has proposed a revised vision for its operations beyond Phase 3; this vision is focused on placing CANARIE at the forefront of the so-called third wave of the Internet, that is, the integration of applications and high speed networks to permit interoperability among different application areas. New standards, protocols, and specialized web services would be required. Some current projects of CANARIE already support the new vision such as the Learning Object Repositories, and ECCNet which is creating a standard-based platform for supply management systems.

1.2 Study Purpose

The study provides a summative evaluation of CANARIE Phase 3 that focuses on the evaluation issues of relevance, success, and future directions. The element of cost effectiveness is being covered in a separate study of CANARIE. The intelligent systems program managed by Precarn will be evaluated in a similar manner to the programs operated by CANARIE.

The study was conducted in consultation with the Information and Communications Technology Branch, Industry Canada, and under the aegis of a Steering Committee whose membership is given in Appendix A.

1.3 Organization of the Report

The report is organized as follows:

Chapter 2 describes the program profile for Phase 3.

Chapter 3 outlines our approach to the study and the evaluation methodologies.

Chapter 4 reviews the relevance of Phase 3.

Chapter 5 reviews the success of the program in achieving Phase 3 objectives.

Chapter 6 discusses future directions for the support of advanced network applications after Phase 3.

Chapter 7 presents the study conclusions and recommendations.

2. Program Profile

2.1 Phase 3 Objectives

The Advanced Applications Development Program (AADP) is designed to:

> "…catalyze the development and diffusion of technologies, applications and services that may underpin and/or use advanced Internet infrastructure, such as CA*net 3 and CA*net 4, and are based on open-systems standards."

As stated in the Contribution Agreement, the seven sub-objectives of the AADP are to:

- facilitate the development, testing and demonstrating of advanced networking applications and related technologies and services;
- support the development by Canadian industry of software, infrastructure and other products, solutions and services relating to advanced networks and advanced applications;
- support the development of emerging sectors including intelligent systems technologies and telehealth that may underpin advanced network infrastructure and/or applications;
- support diffusion and deployment of advanced networks and advanced applications, including the results of projects undertaken through the AADP;
- promote awareness of advanced networks and related applications, technologies and services, including the results of projects undertaken through the AADP;
- promote improved access to and use of advanced networks; and,
- collaborate with industry, universities and colleges schools, and school boards, libraries, government research centres and agencies, provincial governments and departments, aligned federal initiatives and other stakeholders.

2.2 Phase 3: Advanced Applications Development Program

As stated in Chapter 1, the Advanced Applications Development Program constitutes a shift in focus away from the network infrastructure development of the previous two phases towards the

development of advanced network applications and related technologies. This shift reflects both the successes of the previous two phases and the need for Canada to develop an advanced network applications industry that will help to brand Canada internationally as a high-tech advanced economy that can compete successfully with the United States, Europe, Japan and other leading countries. As noted in Chapter 1, AADP is supporting industry-led projects in four areas: e-business, e-learning, intelligent systems, and e-health. The program began in September 1999 and is planned to end on March 31, 2004. An extension of Phase 3 to March 31, 2005 has been submitted to the government to allow additional time for all projects to be completed.

Phase 3 activities are oriented toward assisting key sectors of the economy to develop critical advanced applications and associated infrastructure that will improve their structural competitiveness. It was expected that the applications would utilize advanced networks including CA*net 3, and more recently CA*net 4, developed through the Next Generation Networks program, together with the regional networks that connect to it. Phase 3 is also supporting the government's broader strategies and initiatives relating to the development of Canada's knowledge based society and economy, such as the National Broadband Task Force[3] which made recommendations enabling Canada to reap the benefits of high-speed Internet access and innovations in applications and technology.

Program Advisory Committees, which are committees of the CANARIE Board of Directors, allocate CANARIE's financial resources to the component activities in e-business, e-learning and e-health, and make recommendations to the Board for project approval.[4] Intelligent systems is managed by Precarn; proposals are evaluated by Precarn's Research Management Committee whose recommendations are then passed to the Boards of Precarn and CANARIE for decision.

Program Areas

E-business: The goal of the e-business program is to help Canadian industry develop competitive positions in electronic business with a particular reference to broadband networks. To achieve this goal, CANARIE acted as a catalyst in the development, demonstration, promotion and diffusion of advanced e-business applications, services and framework policies, helping remove or diminish barriers to e-business applications adoption and further increase the potential for electronic business in Canada.

The CANARIE Board allocated $28.35 million over the period 1999-2004 to support e-business initiatives. CANARIE has supported up to 50 percent of eligible costs, with the CANARIE contribution being in the range of $0.5 million to $2 million. The application procedure under the Virtual Clusters program was initiated with an Expression of Interest (EOI), submitted electronically. EOI's were evaluated against project selection criteria by the e-business Senior Steering Committee and projects selected from the EOI stage were invited to submit a more extensive project plan.

E-learning: In the e-learning program, CANARIE again acted as a catalyst to enable Canada to become a world leader in the use of broadband networks for the development and delivery of

[3] The New National Dream: Networking the Nation for Broadband Access, Report of the National Broadband Task Force, 2001

[4] CANARIE, Annual Progress and Performance Report 2001-2002, p. 8.

education and training. The specific program goals are to enable appropriate innovation and to reduce structural impediments to effective use of broadband network technology for education and training.

Applicants were expected to adopt and apply advanced information technology in the mainstream of economic and educational activity, to encourage applications and network system inter-operability, and to support emerging international standards. In addition, projects have been encouraged that focus on the exploitation of the convergence of new media, interactive multi-media, and broadband networks. The application procedure involved EOIs followed by submission of full project plans that were reviewed by the e-learning Senior Steering Committee, whose recommendations were then passed to the Board of Directors for decision.

A total of $28.35 million has been allocated to the e-learning program to 2004.

E-health: In the area of e-health, CANARIE has aimed to encourage the development, demonstration, promotion and possible deployment on advanced networks of leading edge medical and health-related applications. The goal of the program is to facilitate the development and use of innovative applications of e-health within the health care system. The program has both a development and a diffusion-based focus. The Health Advisory Committee established that the evaluation of proposals should occur on a quarterly basis rather than continuously.

Intelligent Systems: Having recognized the emerging intelligent systems sector as an important driving force towards a more connected and knowledge-based Canadian economy, the intelligent systems program, delivered by Precarn Inc., has also been included in Phase 3 of CANARIE. A separate Memorandum of Understanding, dated August 23, 1999, between Industry Canada and Precarn covers Precarn's role as Primary Delivery Agent for this component and a budget allocation of $10 million. Precarn's mission is to create competitive advantage for Canadian industry and social and economic benefits for the people of Canada through innovation in intelligent systems. The Precarn contribution to a project did not exceed 40 percent of eligible costs up to a maximum of $1 million.

Under the Project Management Agent Agreement between CANARIE and Precarn, Precarn is implementing the intelligent systems program in order to generate, capture, collect and report information so that CANARIE and, in accordance with the Contribution Agreement (between Industry Canada and CANARIE), the Minister will be able to assess Precarn's performance against the following criteria:

- Knowledge production (number of projects, applications, products, services, patent or licensable items);
- Diffusion of knowledge (number of companies and others reached by reports, attending events, participating in projects, etc.);
- Innovation related networking (number of collaborations, consortia, alliances, etc.);
- Degree to which contributed funds are levered by resources from other sources; and
- Impact on participants (number of new jobs, growth in trained personnel, new products, services and processes, uptake of applications by companies and other institutions, etc.).

In addition, Precarn's performance will be evaluated on the administration and management of the intelligent systems program according to the following specific criteria:

- The extent to which intelligent systems component proposals are solicited, evaluated, approved and monitored in an impartial and confidential manner and this process is reported and otherwise documented.
- The extent to which proposals selected for approval comply with the agreed assessment criteria.
- The extent to which Precarn prudently and responsibly manages the disbursement of funds to Lead Participants so as to ensure value-for-money.

2.3 Phase 3 Funding

The AADP provides financial assistance to R&D projects of up to 50% of eligible costs. Of the program's $78 million budget, $56.8 million has been allocated evenly to the e-business and e-learning programs, $9 million to intelligent systems (Precarn) and $4.5 million to e-health projects. The remaining $7.8 million or 10% of the program's budget is earmarked for project management and administration costs of CANARIE and Precarn. The profile of program expenditures as of September 2003 is as follows:

Table 2-1: Program Expenditures, as of September 2003

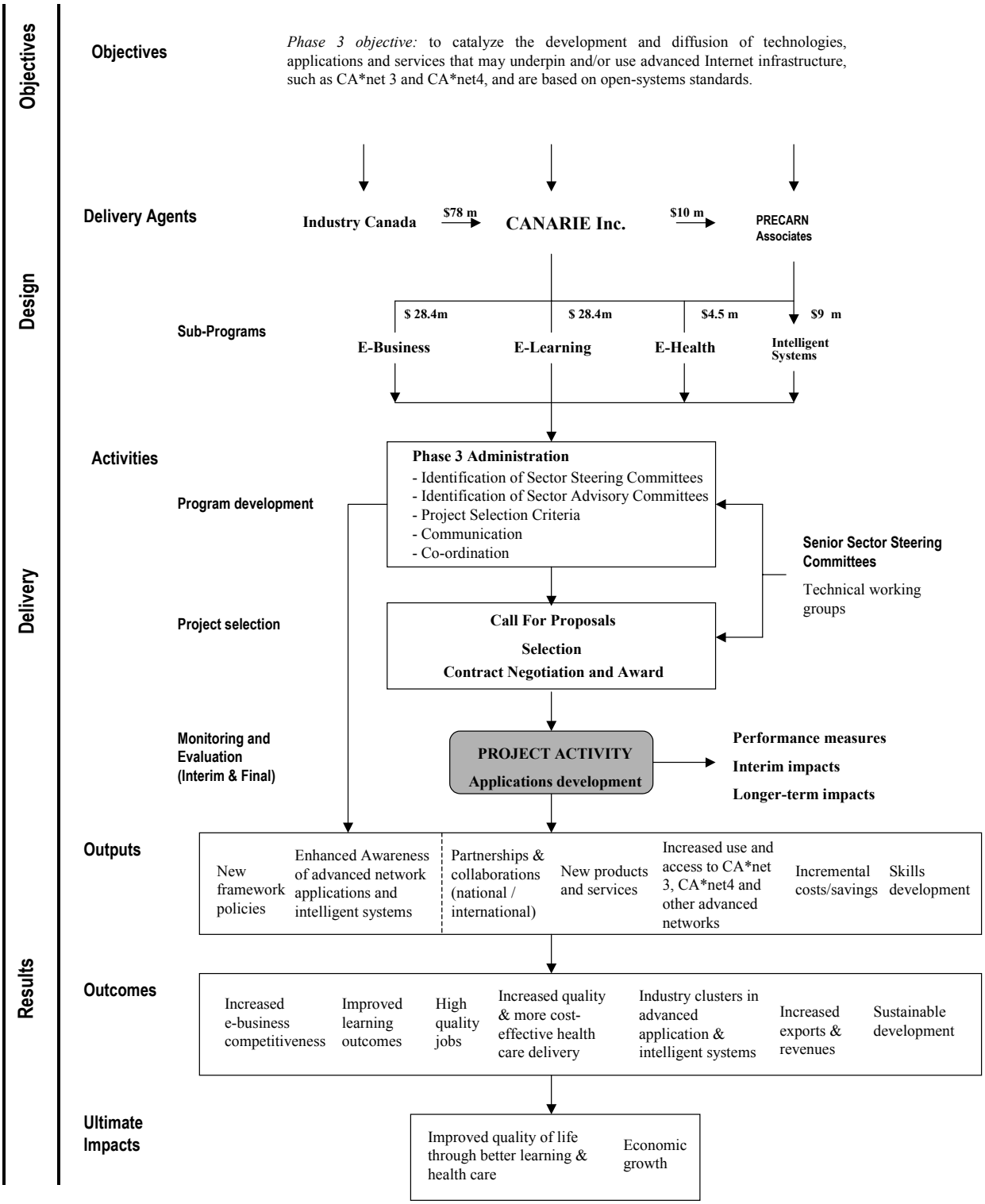
		Total Actual Expenses '99-'00	Total Actual Expenses '00-'01	Total Actual Expenses '01-'02	Total Actual Expenses '02-'03	Total Forecast Expenses '03-'04**	Total Forecast Expenditures to Completion
1.)	**Advanced Applcations Development Project:**						
	a.) E-Business Sector	5,000	387,013	3,005,990	6,674,090	18,277,907	28,350,000
	b.) E-Learning Sector	81,966	2,060,215	6,201,606	8,014,272	11,991,941	28,350,000
	c.) E-Health Sector	87,500	-28,814	628,597	1,273,955	2,538,762	4,500,000
	d.) Intelligent Systems	0	1,501,153	2,965,499	3,651,977	881,371	9,000,000
	Sub-Total	**174,466**	**3,919,567**	**12,801,692**	**19,614,294**	**33,689,981**	**70,200,000**
2.)	**Project Management and Administration Costs:**						
	a.) CANARIE Inc.*	1,008,359	1,522,872	1,335,180	1,591,795	1,591,795	7,050,000
	b.) Precarn Inc.	50,024	217,561	267,024	151,977	63,414	750,000
	Sub-Total	**1,058,383**	**1,740,433**	**1,602,204**	**1,743,772**	**1,655,209**	**7,800,000**
Total CANARIE Program		**1,232,849**	**5,660,000**	**14,403,896**	**21,358,066**	**35,345,190**	**78,000,000**

Source: CANARIE Inc., Annual Progress and Performance Report 2001-2002, September 2002, and interviews with program staff.
Note *: CANARIE Project Management Administration Costs forecasts for 2002/3 and 2003/4 were estimated as the total five-year budget ($7,050,000) minus total cumulative actuals to 31 March 2002 ($3,866,411), divided by two.
Note **: Does not consider reprofiling

2.4 Phase 3 Logic Model

A logic model for the AADP program is provided below depicting the logical linkages among the delivery agents, objectives, program activities, outputs and outcomes. The model highlights CANARIE's direct role in promoting the use and awareness of advanced networks and contributing to the development of new policy frameworks.

Figure 2-1: Logic model for Phase 3



2.5 CANARIE Management

2.5.1 Phase 3

Program Management

Apart from intelligent systems which is delivered by Precarn, all programs are managed by CANARIE staff and overseen by senior steering committees made up of experts in each of the priority sector application areas.

These committees, whose members are selected from across Canada, are responsible for:

- defining a set of projects that will implement strategic directions and issuing calls for proposals;
- encouraging the development of project partnerships between industry, universities and governments;
- reviewing project proposals for applications and content development, and making decisions on funding with the advice of CANARIE staff; and
- developing ways and means to transfer knowledge and diffuse applications to self-sustaining use on a commercial basis.

Evaluation of AADP proposals

The senior steering committees usually appoint independent evaluation committees to review proposals and recommend projects for CANARIE support. The evaluation committees follow evaluation criteria, processes and timeframes set out by the senior steering committees.

Projects are to conform to the following set of mandatory criteria:

- Must involve an innovative application;
- Would not proceed on its own without funding support under the program;
- Are supported by other sources of funding (cash and in-kind) that at least match the funding from CANARIE;
- Must result in services or applications or framework policy innovations (e.g. in e-business delivery) that advance the state of the art;
- Must be expected to have on completion a significant impact on the sector it targets and proposals must have a diffusion plan for promoting the application on the sector affected;
- Must involve a lead contractor that is a Canadian corporation or other eligible participant; and
- Must involve work that is performed in Canada.

2.5.2 Other CANARIE Programs

Along with AADP, which constitutes the core of Phase 3, CANARIE managed or co-managed other R&D funds and programs. These other programs are outside the scope of this evaluation, but are described below for information purposes.

The other programs include support to CA*net 3 and CA*net 4 through the Next Generation Network (NGN) Project, the CA*net Institute, the Advanced Network Applications, Services and Technologies (ANAST) program, the E-Content program, and the E-learning in a Team-based Healthcare Environment. The first three programs ended on March 31, 2002 (CA*net 4 funding goes to March 31, 2007) while the E-Content program covers the 2001-2004 period, and the E-Learning in a Team-based Healthcare Environment program covers the 2002-2004 period.

NGN Program

CA*net 3, an optical communications backbone for Canada, has been supported through the Next Generation Network (NGN) Project since 1998 and co-ordinated by Bell Canada through their network operations centre, ARDNOC (Advanced Research and Network Operations Centre). Funding for CA*net 3 amounted to $55 million by the end of March 31, 2002. The Advanced Networking Advisory Committee of the CANARIE Board provided oversight to CA*net 3 as well as the interface between the AADP of Phase 3 and the network.

In the 2001 Budget, the Government of Canada committed $110 million to CANARIE Inc. for the design, deployment, and operation of CA*net 4. A Funding Agreement was signed between Industry Canada and CANARIE on March 28, 2002 detailing the terms and conditions under which CANARIE would administer the grant.[5] CA*net 4, as did its predecessor CA*net 3, interconnects the provincial research networks, and through them universities, research centres, government research laboratories, schools, and other eligible sites, both with each other and with international peer networks. Through a series of point-to-point optical wavelengths, most of which are provisioned at OC-192 (10 Gbps) speeds, CA*net 4 yields a total initial network capacity of between four and eight times that of CA*net 3.

CA*net Institute

The CA*net Institute, sponsored in part by Bell Canada, was established as a non-profit organization to carry on the traditions and purpose of the original CA*net organization with an emphasis on developing the Canadian Internet. The CA*net Institute Program is administered by CANARIE Inc. as directed by a Program Advisory Committee (PAC) which was responsible for providing an executive overview function for the CA*net Institute Program as well as the selection of all future projects and approving all project outcomes. Funding for CA*net Institute amounted to $900,000 by the end of March 31, 2002. The objectives of the program were:

- To stimulate the development and availability of new and innovative network centric technologies, services, solutions and applications.

[5] CANARIE Inc., Annual Progress and Performance Report 2001-2002, September 30, 2002, p. xiv.

- To foster Canadian dialogue on Internet development and to encourage development of Canadian content.
- To support and encourage the use of the Internet for the Canadian public good[6].

ANAST Program

The Advanced Network Applications, Services and Technologies (ANAST) shared-cost R&D funding program was designed to support research and application development in the areas of high-speed caching, advanced network applications development and advanced network services and technologies. The purpose of ANAST was to assist businesses, universities, research institutions and schools in developing innovative applications for high performance networks or use advanced networks like CA*net 3 to evaluate and test new modalities of instruction, E-business and health delivery over a high performance network. Funding for ANAST amounted to $8 million by the end of March 2002[7].

E-Content

In order to encourage the delivery of Canadian Content and Culture in a Broadband environment, CANARIE and the Department of Canadian Heritage have jointly launched the Applied Research in Interactive Media (ARIM) program. Funding from this program is supporting projects consisting of research and development of broadband technologies and tools that facilitate the creation and use of broadband content, or projects that perform research to address existing barriers to accessing broadband content. The $6 million fund for E-Content is composed of equal contributions from both Canadian Heritage and CANARIE[8].

E-Learning in a Team-based Healthcare Environment

To better understand the key e-learning issues in the health sector, the Office of Learning Technologies (OLT), Human Resources Development Canada and CANARIE launched the E-Learning in a Team-based Healthcare Environment program in 2002. The overarching goal of the program is to demonstrate to key stakeholders in government and policy makers that e-learning will effectively create enhanced learning environments in the workplace and as a result, increase the quality of health outcomes and the standard of living of Canadians. The $2 million fund for the program is composed of equal contributions from both OLT and CANARIE[9].

[6] CANARIE web site: www.canarie.ca
[7] CANARIE web site: www.canarie.ca
[8] CANARIE web site: www.canarie.ca
[9] CANARIE web site: www.canarie.ca

3. Study Approach

3.1 Approach

Our approach to the evaluation study involved four lines of enquiry: document reviews, consultations, a survey, and case studies, and was guided by the evaluation framework prepared in March 2000[10] and the interim evaluation of November, 2001[11]. The evaluation issues and questions were determined in consultation with the client and are given below together with the details of the methodologies.

3.2 Evaluation Issues and Questions

Issue 1: Are the objectives of Phase 3 still relevant?

- To what extent and in what manner have the needs that gave rise to CANARIE evolved?
- Could Phase 3 objectives be achieved without federal funding?

Issue 2: Is Phase 3 achieving its objectives?

- What outputs have there been from Phase 3 investments?
  - What are the number, amounts and distribution of CANARIE contributions by program?
  - What leverage are CANARIE contributions having on funding of related network applications development by industry and other organizations?
- What currently are or expected to be the impacts and effects, both intended and unintended, of the Phase 3 program in terms of the following program objectives? Are the initiatives on course to achieve the intended impacts and effects?
  - Facilitating the development and demonstration of advanced network applications and related technologies;
  - Improving the access and use of advanced networks;
  - Facilitating the diffusion and deployment of these advanced technologies;

[10] Program Evaluation Framework for CANARIE Phase 3, Hickling Arthurs Low, March 28, 2000.
[11] Interim Evaluation of CANARIE Phase 3, Hickling Arthurs Low, November 14, 2001.

- Developing new products and services related to advanced network applications;
- Creating awareness of advanced network applications and related technologies;
- Creating partnerships and collaborations; and
- Developing linkages with other federal, provincial and regional initiatives?

- Has Phase 3 improved Canadian industrial competitiveness in the area of advanced network applications?
- Has Phase 3 led to or contributed to improved services through the use of advanced networks and related applications in business, learning, healthcare and government?

Issue 3: What are the potential future directions for CANARIE?

- Is there a continuing need for federal support of advanced network applications?
- What is an appropriate focus for CANARIE in a potential phase 4?

3.3 Methodologies

3.3.1 Document/File Revew

CANARIE annual reports, project files and reports, submissions to Industry Canada, workshop results on future directions, and other relevant material were reviewed. Project data furnished under CANARIE's Performance Measurement and Review System was also examined. A list of documents reviewed is attached as Appendix B.

3.3.2 Consultations

Consultations were conducted with 48 representatives of the CANARIE Board, CANARIE staff, Industry Canada, Precarn, and project participants (including the lead participant, other participants, users and potential users) of applications initiated through the AADP, as well as representatives of organizations whose project proposals were not funded, and provincial and international observers, as follows:

Table 3-1: Breakdown of Consultations

Interview Groups	Interviews Planned	Interviews Completed
CANARIE Board	2	2
CANARIE Inc.	2	3
Sector Advisory Committees	4	4
Industry Canada	3	3
Precarn Inc.	3	3
E-business projects (participants, users)	10	9
E-learning projects (participants, users)	10	7
E-health projects (participants, users)	4	5
Intelligent systems projects (participants, users)	6	7
Other (not funded, provincial, international)	5	5
Total	49	48

A list of the individuals consulted (completed interviews) is attached as Appendix C. Reasons for the difference between the planned (49) and completed (48) interviews: 1) one e-business project declined to be interviewed since all staff associated with the project were no longer with the organization; 2) many e-learning projects indicated that it was too early, or not appropriate, to identify users; 3) additional interviews were conducted in e-health, intelligent systems and with CANARIE staff because of the additional information they could provide.

The interviews were conducted both in-person and by telephone making use of interview guides based on the agreed evaluation issues and questions.

3.3.3 Survey

An electronic survey was administered to all lead participants who worked on CANARIE and Precarn (CANARIE supported) projects, with the exception of those who had been interviewed. The survey was sent to the 74 projects (65 CANARIE projects, 9 Precarn projects) that were not selected for interviews or the case studies. Of these, two email addresses (two CANARIE projects) were undeliverable. In addition to the undeliverable surveys, seven projects (seven CANARIE projects) were removed from the survey list[12]. The survey results are attached as Appendix D.

Of the 65 valid surveys (56 CANARIE, 9 Precarn) distributed, 33 responses were received for an overall response rate of 50.8 percent. More specifically, CANARIE projects had a response rate of 51.8 percent, while Precarn projects had a response rate of 44.4 percent. A more detailed breakdown by project type is presented in the table below.

Table 3-2: Breakdown of Survey Response Rate by Project Type (n=33)

[12] Reasons for removal were as follows: Email addresses for two (2) projects were not provided, and five (5) projects had the same contact person as another project (not to overly burden survey respondents, individuals identified as the contact person for multiple projects were only asked to complete the survey once).

	Responses Received	Valid Addresses	Response Rate
CANARIE Projects			
E-Business	9	19	47.4%
E-Learning	14	22	63.6%
E-Health	6	15	40.0%
CANARIE Total	**29**	**56**	**51.8%**
Precarn Projects			
Intelligent Systems	4	9	44.4%
Precarn Total	**4**	**9**	**44.4%**
Grand Total	**33**	**65**	**50.8%**

3.3.4 Case Studies

Three case studies were conducted, one project drawn from each of the e-business, e-learning and intelligent systems (Precarn) programs. The selection was made in consultation with Industry Canada, CANARIE and Precarn. The case studies included:

- E-Business: ECCnet (Canada's Online Product Repository), lead participant is the Electronic Commerce Council of Canada. The ECCnet case study is attached as Appendix E.
- E-learning: BELLE (Broadband Enabled Lifelong Learning Environment), lead participant is Netera Alliance. The BELLE case study is attached as Appendix F.
- Intelligent Systems: ROSA (Remote Operations with Supervised Autonomy), lead participant is MD Robotics. The ROSA case study is attached as Appendix G.

3.4 How the Methodologies Related to the Issues

The number of marks (■) identifies the extent to which the issues/questions were fed by the corresponding methodologies. Three marks indicates that it played an important role in the review of the corresponding issues, while no marks for a given methodology meant that it played a limited role, if any.

Methodology / Issue	Relevance	Success	Future Directions
Document/File Review			
Project Files, Annual Reports	■	■■■	■
Submissions to Industry Canada	■■	■■	■■■
Workshop results on future directions	■	■	■■■
Performance Measurement & Review	■■	■■■	■■
Consultations			
CANARIE Board	■■■	■	■■■
CANARIE Inc.	■■	■■■	■■■

Methodology / Issue	Relevance	Success	Future Directions
Sector Advisory Committees	■■	■	■■■
Industry Canada	■■■	■	■■■
Precarn Inc.	■■	■■■	■■■
Project Participants	■	■■■	■
Users/Potential Users	■	■■■	■
Survey			
Electronic Survey	■	■■■	■
Case Studies			
ECCNet	■	■■■	■■
BELLE	■	■■■	■■
ROSA	■	■■■	■■

4. Program Relevance

In this Chapter, we examine the relevance of the CANARIE Phase 3 program by considering the following issue and questions.

Issue 1: Are the objectives of Phase 3 still relevant?

- To what extent and in what manner have the needs that gave rise to CANARIE evolved?
- Could Phase 3 objectives be achieved without federal funding?

4.1 Overall

Interviewees and survey respondents believe that the objectives of Phase 3 continue to be relevant, especially given the goals and targets outlined in "Canada's Innovation Strategy". The target of moving from 15th to 5th in international rankings of R&D performance will require the infrastructure and applications development that CANARIE has been initiating and supporting in Phase 3 and previous phases.

CANARIE is seen by many as an organization attuned to the needs of the time, able to evolve to meet changing needs. In Phase 1, its focus was on technology and product development; in Phase 2, attention moved to incorporate applications; and in Phase 3, the program has concentrated on sectoral applications. The importance to Canada of CANARIE's work on infrastructure development was also emphasized and, while outside the scope of this evaluation, we noted comments such as "without CANARIE, Canada would not have a high-speed research infrastructure which has been essential in keeping Canada in the forefront of research in areas like genomics, and high energy physics involving the transfer of large volumes of data".

Further, many believe that CANARIE is more necessary today than at the start of Phase 3 in 1999. With the recent dot-com crash, venture capitalists have become extremely conservative, and the ability of companies to raise financing has become tougher. Some 85 percent of all projects responding to the survey gave financial need as the main reason for submitting a proposal to CANARIE. We were informed that venture capitalists are only interested if there are customers, a revenue stream and a project that is "close to market". Project approval from CANARIE or Precarn, however, has reduced risk and allowed companies to leverage additional sources of financing. Venture capitalists and the e-business, e-learning, e-health or intelligent systems communities know that if a project has been approved by CANARIE or Precarn, it has been subjected to rigorous review by peers, and has attained a certain standard, or "seal of approval".

Respondents were of the view that the objectives of Phase 3 could not be achieved without federal funding. Some suggested that the royalty funding ($5 million to date from Phase 2) could be combined with provincial funding in place of continuing federal support. The result for CANARIE, however, would probably be an encumbering of its activities with jurisdictional issues. If CANARIE were totally self-funding, CANARIE would be likely to only fund projects close to market in order to maintain a flow of funds. The feeling was that larger companies would then dominate the program and the innovative content would diminish.

Both CANARIE and Precarn indicated that the number and quality of proposals have increased over the 1999-2003 period. In 1999/00, CANARIE received approximately 100 Expressions of Interest (EOIs), and by 2002/03 this had increased to 160 EOIs in e-business, e-health and e-learning. In total, over this period, 517 EOIs were submitted to CANARIE, leading to 124 proposals of which 87 were recommended for funding. The approval rate based on the EOIs submitted was therefore 17 percent, and on the basis of proposals submitted was 70 percent. From 1998 to 2003, Precarn received 92 proposals and funded 34, giving an approval rate of 37 percent. Precarn could not indicate the approval rate specifically for those projects funded through the CANARIE component but it is reasonable to assume that it was similar. Precarn also point out that they are currently supporting three projects under the Precarn program that would have been supported by the CANARIE program had more funding been available.

If the number of proposals is an indicator of need, then both CANARIE and Precarn continue to be very relevant, noting though that the unfilled demand is considerable and could dissuade prospective participants from staying in the field. We note in Chapter 5 that unsuccessful applicants to CANARIE have difficulty seeking alternate sources of funding, particularly projects in the public sector ie e-learning and e-health, and consequently tend not to proceed. We also note in Chapter 5 that for successful applicants, CANARIE and Precarn funding has been important to maintaining their competitive edge relative to competitors in the US, Europe and elsewhere.

More detailed findings on the relevance issue related to each of the program areas are provided below.

4.2 E-Business

Industry, government, and university interviewees expressed concern that small and medium enterprises (SMEs) are by and large underserved by the IT industry, and are not accustomed to using IT in business processes, let alone e-business applications. The slowness of Canadian SMEs to adopt technologies in general is viewed by some as a significant contributing factor in the productivity gap between Canada and the United States[13]. CANARIE's infrastructure and applications investments, particularly in projects like ECCnet (Canada's Online Product Repository), are seen as important initiatives in upgrading the technology know-how of SMEs and improving productivity.

[13] Why are Americans More Productive than Canadians?, Andrew Sharpe, International Productivity Monitor, Number Six, Spring 2003

ECCnet had to create a whole new set of business rules and procedures to work with SMEs. Serving the SME market is particularly tough, which is why the IT industry has traditionally focused on large corporations. SMEs do not have the staff or the time to learn how to use complex applications, and/or the technical know-how to integrate new applications into old systems. For an SME to use an application, the process has to be close to "plug and play". At the start of the ECCnet project, some SMEs did not have a computer and had to go to the local library (or CAP site) to access the project. Through the e-business program, CANARIE has begun to increase the participation by SMEs in advanced networks and applications. The process of stepping-up technology adoption by SMEs is unfinished and it appears that promotion and support beyond Phase 3 will be needed.

The very nature of e-business applications is collaborative, leading to the building of community of interests. E-business applications mean integrating business processes across company lines, and connecting buyers with sellers. The existence of a community of interest is a prerequisite for a successful and widely adopted e-business application. Very few organizations have the range of technologies required to build the offering and the skills needed for the "go to market" phase. In addition, it is unlikely that venture capitalists are going to finance the development of an e-business application. Thus, CANARIE fills a gap. Associations, such as the Electronic Commerce Council of Canada (ECCnet), are not allowed to go into debt or borrow, which means that government sources of financing, such as CANARIE, represent the major source of financing available to them.

4.3 E-Learning

CANARIE has filled a void in e-learning with the demise of the Telelearning Centre of Excellence. While the provinces, with their constitutional responsibility for education, are concerned with supporting the development of online content for K-12 and post secondary institutions, CANARIE is the only national e-learning organization. In its e-learning work, CANARIE has stayed away from curriculum development and thereby has not been viewed as infringing on provincial jurisdiction. Many consider the arms-length nature of CANARIE as a necessary attribute in the development of e-learning because of the effective interface it provides between researchers and government. It was noted that CANARIE's sponsorship of e-learning had facilitated collaboration with federal laboratories, namely the National Research Council, and the Communications Research Centre and access to funding from school boards involved in the projects.

One of the ways of making learning resources accessible to educators and learners is through learning object repositories (LORs). CANARIE has supported two significant projects (BELLE and POOL) that are developing the hardware and software that will underpin operation of the LORs. CANARIE is also concerned in the LearnCanada project with the professional development of K-12 educators. In this project, online learning is taking place through peer-learning communities, and telementoring, using multimedia tools and middleware. We were told that because of the need for a pan-Canadian focus, a number of organizations that historically had not worked together, for example, educational organizations in different provinces, ended up

becoming partners in the project. Interviewees attributed this level of cooperation to CANARIE's presence.

The importance of CANARIE to projects in e-learning was affirmed in the results of the survey of e-learning project participants, not only as a source of funding (primary reason 71.4 percent) but also for the access it provides to partners (primary reason 28.6 percent, secondary reason 42.9 percent), and the recognition it gives projects (primary reason 28.6 percent, secondary reason 50.0 percent).

4.4 E-Health

Unlike e-business, e-health needs large broadband and it must be a secure and stable system. E-health is an emerging field. If it weren't for the advancements in the infrastructure in Phases 1 and 2, supporting e-health applications under Phase 3 would not have been possible.

It is far more difficult to obtain funding in e-health than the other programs (e.g., e-business, intelligent systems). The health sector is always under financial constraints, so it is almost impossible to convince health care organizations to invest in new technology, when they are faced with immediate concerns such as emergency care, nurses, etc. Compounding this tight financial situation is the general perception that the private sector does not belong in the health care field. It means that raising private financing for e-health technologies can be particularly difficult and problematic. CANARIE fills this financial need. In addition, several of the lead participants noted that where the CANARIE funding was really needed was to support small health care providers who do not have, or have access to, financing.

An illustration of the tight financial environment that the telehealth sector operates under was a proposal to provide remote surgery to patients in remote communities. Apparently it was one of the better proposals, but because they couldn't get the matching funds, the project could not be supported. The survey results also point to the importance of funding in influencing participation in the CANARIE program (financial was the primary reason for seeking CANARIE support, with access to an appropriate partner, and recognition for the organization seen as secondary reasons). As with the other program areas, e-health participants commented on the leverage a CANARIE award provided them in obtaining funding from other sources.

Unlike Health Canada's CHIP program (Canada Health Infostructure Partnership), CANARIE insists on inter-operable systems using national standards, which is a key aspect of telehealth. Paraphrasing one participant, "CANARIE has always been upfront on requiring inter-operable systems, especially when you are talking networking to other organizations". This requirement makes CANARIE relevant to the development and use of national health care standards.

4.5 Intelligent Systems

Precarn is the only program in Canada that funds intelligent systems (convergence of computing, robotics, sensors, remote sensing). The program has provided opportunities for collaboration

between industry and universities, and industry and government, especially for SMEs, that have accelerated technical and commercial developments. These ties would have been difficult to establish otherwise.

Over the last ten years, Precarn has evolved from supporting pre-competitive university-based research to being a funder of the initial prototyping and commercialization phases. Ten years ago, Precarn's focus was based on a technical model to develop intelligent systems, whereas today, the focus is that of a service model to develop a system that is useful to the end user. While some questioned the negative implication of this shift for risky projects, not close to implementation but with the potential to make breakthroughs, all interviewees believed that, without Precarn, Canadian firms would fall behind their competitors in the USA, Europe and Japan.

An example of the evolution in the field of intelligent systems is the ROSA project (Remote Operations with Supervised Autonomy). ROSA built on the lessons learned from the earlier Interactive Intelligent Remote Operations (IIRO) project, by adding artificial intelligence and machine vision technologies that enabled higher levels of decision-making and autonomous operation. ROSA has led to downstream work with NASA, and a DARPA contract. All participants and users involved in the ROSA project believe that intelligent systems will be the next breakthrough in space applications. At the moment, space applications are human intensive and costly. The use of intelligent systems is not only safer but is expected to provide a faster turnaround and greater return on investment.

5. *Success/Objectives Achievement*

In this Chapter, we review the success of Phase 3 by considering the following issue and questions.

Issue 2: Is Phase 3 achieving its objectives?

- What outputs have there been from Phase 3 investments?
  - What are the number, amounts and distribution of CANARIE contributions by program?
  - What leverage are CANARIE contributions having on funding of related network applications development by industry and other organizations?
- What currently are or expected to be the impacts and effects, both intended and unintended, of the Phase 3 program in terms of the following program objectives? Are the initiatives on course to achieve the intended impacts and effects?
  - Facilitating the development and demonstration of advanced network applications and related technologies;
  - Improving the access and use of advanced networks;
  - Facilitating the diffusion and deployment of these advanced technologies;
  - Developing new products and services related to advanced network applications;
  - Creating awareness of advanced network applications and related technologies;
  - Creating partnerships and collaborations; and
  - Developing linkages with other federal, provincial and regional initiatives?
- Has Phase 3 improved Canadian industrial competitiveness in the area of advanced network applications?
- Has Phase 3 led to or contributed to improved services through the use of advanced networks and related applications in business, learning, healthcare and government?

5.1 Overall

Outputs from Phase 3

Table 5-1 summarizes the number of projects by program area, total project costs, the contribution by CANARIE or Precarn. Details on each project in the four program areas are provided in Appendix H.

Table 5-1: Summary of Phase 3 Contributions[14]

Program	No. of Projects	Project Size (000,000)	Phase 3 Contribution (000,000)	Leveraged Contributions (000,000)	Leveraged Contributions Percent
E-Business	29	$65.6	$28.3	$37.3	57%
E-Learning	33	$64.0	$30.0	$33.9	53%
E-Health	23	$11.8	$4.6	$7.2	61%
Sub-Total: CANARIE	85	$141.3	$62.9	$78.4	55%
Intelligent Systems	13	$31.8	$9.0	$22.8	72%
Total: Phase 3	98	$173.2	$71.9	$101.3	58%

Impacts of Phase 3

Phase 3 is not at a point where it can demonstrate final results although the evidence from the interviews, survey, and case studies suggests that the program, despite initial delays, is on course to achieving the intended impacts and effects. It should be noted, however, that an audit/evaluation is conducted at the end of each project, which will provide Industry Canada with additional information on impacts. In e-business, e-health, e-learning, and intelligent systems, a major achievement of the program has been the promotion and facilitation of collaboration among organizations and individuals in creating network applications. A key impact has been the development of communities of interest, and full involvement by SMEs, particularly in e-business projects. CANARIE exercised considerable care in choosing the communities of interest to be supported and involving the appropriate industry associations. A critical challenge in the four areas has been the social and cultural issues around communities of interest.

As noted in Section 4.1, access to financial assistance was the main reason projects applied to the Program (85 percent) with access to potential partners stated as having a lower priority (15 percent). However, the development of communities of interest involving the formation of

[14] Only ninety projects were included in the evaluation study because eight were approved after the evaluation study began. The eight included: 3 e-business projects; 4 e-learning projects; and 1 intelligent systems project.

partnerships through implementation of the projects has clearly been an additional benefit of the Program.

In e-health, the major impact has been on demonstrating the unique contribution telehealth can make to improving the quality of health care services. However, until the provinces agree to implement and integrate telehealth applications into the delivery of health care, the full impact of the e-health program will not be realized. In e-learning, Canada is leading the world in learning object repositories but not in implementation of e-learning initiatives. In intelligent systems, the major impact has been to move Canada further up the innovation chain, as well as the development of communities of interest and the greater participation of SMEs. All participants in this program believe that intelligent systems will play an increasingly important role in the Canadian economy, particularly in the space, mining, biotechnology, health care, and geomatics fields.

Most project participants that were interviewed indicated they had met the objectives of their projects. Delays in the "go to market" phase were the main reason for not fully achieving objectives. The survey confirmed the high level of satisfaction of participants with the CANARIE program: meeting project needs (72.7 percent); enhancing the quality of products/services (75.8 percent); developing new products/services (67.7 percent); developing new partnerships (75.0 percent); increasing revenues (33.3 percent); increasing the number of high quality jobs (57.6 percent); increasing the uptake of network applications (45.5 percent); and, changing service delivery costs (30.3 percent).

Network Usage by Projects

CA*net 4, as did its predecessor CA*net 3, interconnects the provincial research networks, and through them universities, research centres, government research laboratories, schools, and other eligible sites, both with each other and with international peer networks. The use of CA*net by the application programs (e-business, e-learning, e-health) corresponds closely to access. Under Phase 3, 55 percent (18 of 33) of e-learning projects, and 22 percent (5 of 23 projects) of e-health projects used CA*net to carry out their research, while none of the e-business projects used CA*net. E-learning and e-health projects, where the lead participant was a private firm, also did not use CA*net, the main reason being lack of, or difficulty in getting, access to CA*net by the private sector partners. The fact that broadband was not rolled out across the country as originally contemplated in the National Broadband Task Force report could also have had an impact on private sector usage of high bandwidth.

In e-business, another reason for not using CA*net has been that the applications under development have not required large bandwidth; they have required innovative network management but have been readily accommodated within the capacity of the publicly available Internet. It is interesting to note that in the e-business projects, while none are using CA*net, 24 percent (7 of 29) of the projects are using wireless networks.

In the case of the Precarn projects, there was an ambiguity in terms of network usage. The funds to Precarn were linked to the use of advanced networks, however, the Precarn Board objected to this requirement and Industry Canada agreed to soften the condition. As a result, some projects do use networks such as the ROSA project that demonstrated ground-based control of space

robotic operations but others do not. A further consequence has been that the CANARIE Board in approving Precarn projects has applied a fiduciary responsibility only.

Management of Phase 3

A review of program design and management is not within the terms of reference of this study. However, certain aspects of program management were brought to our attention that we felt useful to report. The burden of reporting was noted in the interim evaluation of Phase 3 and was again noted in this study in the survey responses, particularly by university participants in the e-learning program. A related aspect was the timing of reporting. CANARIE requires reporting quarterly whether or not this coincides with a project milestone, whereas, in contrast, Precarn's reporting is based on milestones and on the project's schedule. The flexibility of the Precarn approach was appreciated by project participants.

More detailed findings on impacts and effects achieved in each of the application areas follow.

5.2 E-Business

Preamble

The e-business program took a year to get going while CANARIE waited for the results of the E-Business Roundtable. The wait was considered worthwhile in light of the favourable response of Canadian industry and internationally that CANARIE had come up with the right approach to running this program. Government and industry interviewees emphasized that the key factor in the success of the program has been the choosing of the communities of interest and the appropriate industry associations to which CANARIE had adopted a sector by sector approach. Another broad achievement of the program has been the creation of consortia within individual projects, a development that represents a distinct change from Phase 2 to Phase 3. Another general point made concerned the use of networks. The use of advanced networks was promoted by CANARIE but projects wanted to be sure that commercial networks rather than research networks were used to enable ready access to their products.

Technology development and knowledge production

Two examples illustrate technology development under the e-business program. In the Sources Management and Requisition Tool (SMaRT) project, a software solution to capturing the knowledge base of marine engineers was developed which involved the transfer of a complete ontology of marine language into information systems language; and, in the Rapid Development Environment (RDE/CPT) project, the design of handcrafted software tools for SMEs was replaced by smart software agents working together in a virtual environment. In these and other e-business projects, the technologies are moving into the testing and commercialization phases. For the marine knowledge transfer project, the technology was validated by NRC and is now being deployed in a desk-top approach – the big challenge is the expansion of the knowledge base. In the second example, systems providers and software developers who work with SMEs are the target audience for the project, allowing SMEs to be more productive and in the longer run contributing to Canada's competitivity.

Development of the capability of Canadian industry

Survey results showed increased revenues and increased high quality employment for 55.6 percent and 88.9 percent of respondents respectively as a consequence of participation in e-business projects. Many of the participant interviewees also indicated that the number of employees in their firms had increased as a result of the CANARIE project. Often this increase in employment was attributed to an expansion in their R&D program and the acquisition of new skill sets required for the "go to market" phase. For example, ECCnet reported that CANARIE enabled them to go from 34 employees before the funding to its current level of 86 employees. Working on the project highlighted for the participants the advantages of conducting R&D, as well as the benefits of tightening up procurement. The potential impact on Canadian industry of improved procurement procedures could be considerable given the statistics noted in the ECCnet case study that supply chain information inefficiencies represent an industry loss of $25 to 50 billion around the world each year.

Diffusion of knowledge and the promotion of technologies and applications

All of the participants interviewed are working on the "go to market phase" using their own funds or non-CANARIE funds or have already reached the phase and, as in the case of ECCnet, have operational systems being used by industry. Several of the participants' "go to market" phases involve exporting the product or service. The case study of ECCnet (Appendix E) notes that ECCnet is having an influence globally through collaborative arrangements with similar services such as UCCnet and Transora in the US. ECCnet uses GTINs (Global Trading Identification Numbers) as does the US and Europe which assists interoperability, ultimately providing Canadian manufacturers with access to a global marketplace through a single 'built in Canada' solution.

An unintended impact of ECCnet was a better understanding of the SME audience. An SME offering has to be more sophisticated. While large corporations have a sufficient number of staff to deal with the technical and system integration matters, SMEs do not. This is the major reason that SMEs are underserved by the IT industry. Almost all large corporations indicated that had it not been for CANARIE, they would not have involved SMEs in their CANARIE projects. Although this initial collaboration with SMEs was a requirement of the e-business program, all indicated that the relationship was beneficial and will continue into the future. The adoption of IT by SME participants appears to have been accelerated through the Program. This result, albeit for a small number of SMEs, is in contrast to the general findings of the Canadian e-Business Initiative which reported growth in SME adoption of Internet business solutions peaking between 2000 and 2001 and slowing in 2002[15].

ECCnet is an excellent example of the benefits of this SME requirement. The project had to be structured and priced so that SMEs could easily participate and be on the same system as large corporations. One of the other lessons of the ECCnet project, whose lead participant (the Electronic Commerce Council of Canada) is an association, is that industry associations are an effective way of reaching SMEs.

[15] Net Impact Study Canada, the SME Experience, Canadian e-Business Initiative, November, 2002

It was brought to our attention that under the Industrial Research Assistance Program (IRAP) of the National Research Council, e-business applications are also being promoted to the extent of about $3 million from 2001 to 2005. IRAP's focus is at the level of the individual firm whereas CANARIE has been directing its efforts in Phase 3 to overcoming structural barriers through the coordination and facilitation of joint projects involving SMEs and larger companies. The focus, therefore, of CANARIE on process and organizational innovation, and its ability to work within networks of companies can be considered to be complemented by the success of IRAP in raising the IT competence of individual SMEs.

Innovation related networking

Phase 3 has created over 25 e-business offerings, and most have created new communities of interest, which are a prerequisite for this type of offering. Collaboration is the backbone of a community of interest and the key ingredient to a successful e-business offering. Half of the participants interviewed indicated that the probability of working on a new venture with the same community of interest is very high. The community of interest approach has been key to the success of ECCnet. ECCnet is the largest collaborative supply chain initiative in Canada, and one of the most successful in the world. The US tried to develop an integrated collaborative supply chain system like ECCnet in the late 1990s but failed because they did not build communities of interest. In light of ECCnet's experience, the US is trying again to integrate their four supply chain systems into one, but this time, they are borrowing ECCnet's approach, which is to build the community of interest first and then develop the technology.

Levering of funding from other sources

The levered contribution for e-business projects amounts to 56 percent of total project costs. Accessing traditional sources of financing was often difficult at the beginning of the projects and participants moved to partnerships with other companies and to venture capital. For example, one project that initially partnered with a software company that made a $500,000 investment, now has four venture capital firms putting up capital.

The impact on the productivity and competitiveness of Canadian firms

The higher revenues and employment point to companies being more competitive through their participation. One company stated, "We wouldn't exist without CANARIE and are definitely more competitive. CANARIE has leveraged what could be a billion dollar business. We employ 23 people and we're going to hire more. So, yes, the CANARIE funds have made a tremendous difference." Another benefit was the discipline involved in participating in CANARIE, such as developing a business plan, identifying the type of skills required to successfully complete the project as well as where to get the identified skills for the "go to market" phase.

5.3 E-Learning

Preamble

A major focus of the e-learning program is on advancing the development of Learning Object Repositories (LOR). The primary motivation for supporting R&D on LOR is that the creation and development of online content is expensive, and costs can rise astonishingly as production increases. In principle, by creating content in small objects, a variety of educational needs can be met and shared amongst a variety of educational organizations in a cost-effective manner. It is this latter property that has attracted the interest of many educational administrators. If content can indeed be shared amongst several jurisdictions, with each jurisdiction still able to maintain control over its own curriculum, then all can benefit by being able to offer rich content to their students structured as the jurisdictions see fit.

Technology Development and Knowledge Production

Over 85 percent of e-learning projects (both LOR and others) indicated in the survey that they have developed new products and services, as a result of CANARIE support. As one respondent noted, "the tools developed in the project can potentially revolutionize online learning and use of broadband." Some concrete examples of major advancements in LOR technology include:

- Alexandria repository, which is Canada's first national prototype LOR built under the BELLE project by Canadian educational institutions for Canadian educational institutions.
- The BELLE project also developed the Advanced Learning Object Hub Applications (ALOHA) metadata tool; content repurposing facilities; and client learning environment.
- CAREO (Campus Alberta Repository of Educational Objects), supported by BELLE and Alberta Learning, is a prototype of searchable, web-based collection of multidisciplinary teaching materials for educators across the province and beyond.
- Authoring Tool for learners was developed by the Creating Barrier-Free Broadband Learning Environments Project. These learners have traditionally been excluded from using network based educational environments due to access barriers, such as individuals who are blind, deaf and hard of hearing, visually impaired, physically disabled, have learning disabilities.

As one respondent noted, "CANARIE has been a valued partner in our project. With CANARIE support we have created an educational model that we believe is sustainable, and scalable. Our project is gaining recognition across Canada for its innovation in teaching and learning. The strong collaboration among the project's teachers, school administrators, researchers and private sector is a model for Canada's innovation agenda. Our project is branded as Canada's #1 source for broadband enabled learning."

Development of the Capability of Canadian Education Organizations

Relative to the other AADP programs, e-learning, and in particular LOR projects, are the furthest away from market applications, with "successes" indicated by advancements in development of LOR technology. Over 90 percent of e-learning projects (both LOR and others) indicated that they have enhanced their products/services. As one respondent noted, "the project has resulted in exciting tools and technological advances that are presently in Alpha testing. Early indicators are of substantial rewards." Many e-learning projects have moved up the LOR technology ladder to other e-learning projects. For example, the eduSource project builds on earlier LOR projects (by

combining the teams from the earlier BELLE and POOL projects), to provide a forum for the ongoing development of the associated tools, systems, practices and protocols that will support learning object repositories. This approach to learning gives both educators and learners enormous flexibility in how they obtain and use online learning resources.

Diffusion of Knowledge and the Promotion of Technologies and Applications

The very nature of LOR, the collaborative creation of content in small objects by education institutions across Canada, has changed the way curriculum is developed. According to many respondents, Canada has become a world leader in the LOR field, with the main drivers being CANARIE's e-learning program and Industry Canada's EduSpecs initiative. The EduSpecs initiative, as described on its web site (www.eduspecs.ca), facilitates the creation and adoption of international e-learning specifications and standards for Canada.

The e-learning program has fostered collaborative content development, which has increased the quality and the sophistication of curriculum. As several university/college respondents noted, the CANARIE projects have introduced controlled peer-to-peer sharing and develop very sophisticated online modules to their curriculum. Support from the e-learning program has facilitated collaborative teaching with other colleges and universities through video conferencing, for students to have face-to-face interaction with practitioners during their case studies. Teachers have the power to create their own working group, and can include students from their class, school, province, or create working groups that include students from all over Canada.

At the K-12 level, many respondents noted that the CANARIE projects allowed teachers to work with teachers from other provinces, which had, up to the time of their project, been rare. CANARIE also gave schools recognition within their own school boards and provinces. As one respondent noted, "traditionally, the education sector has tended to operate in "silos", each working independently of the other. Our project involves the participation of a broad cross-section of educational organizations: school trustees, teachers, principals, superintendent and directors of education, thereby fostering new partnerships."

Innovation Related Networking

A key element of e-learning projects has been the development of communities of interest (also referred to as communities of practice by the e-learning community). Communities of practice are a key factor in e-learning and with LOR in particular. Over 85 percent of respondents in e-learning indicated that they had developed new partnerships as a result of undertaking the CANARIE project. They noted that the e-learning program has been instrumental in increasing their ability to forge alliances with other research and development partners both in Canada and abroad. These alliances were established as a result of participating in the competitive collaborations needed to respond to CANARIE's RFPs.

Initially this "forced" collaboration introduced additional stress and cost on the project as the various partners learned to work together, but as many respondents noted, it was an investment that paid off in terms of building relationships and developing strategies to deal with communications across four time zones and different institutional cultures. The first advantage

was the development of stronger local alliances. Secondly, project participants developed a national perspective and began to seek other partners in geographically distant parts of the country. A third advantage was that the relatively larger size of the projects made it possible to have a higher profile than an individual researcher might enjoy. As one respondent noted: "I was pleasantly surprised on a recent trip to Europe to find that our projects are well known and our progress monitored by other countries. This international presence has opened potential opportunities for collaboration with new European partners which may lead to future student and researcher exchanges, exchange of learning objects, and joint projects in learning technology."

Levering of Funding from Other Sources

E-learning program participants, as with other programs, indicated that once their project had been approved by CANARIE, they were able to raise additional funds. A CANARIE project indicates to provinces and investors that the project has been subjected to rigorous review by peers, and is of high quality. There are three categories of e-learning projects, in terms of the ability to leverage funding from other sources. First, projects where the lead participant was an educational institution or a not-for-profit organization, were generally able to raise additional funds from other educational institutions, and other public sector programs (e.g., provinces). Second, projects where the lead participant was a firm, were generally able to raise additional funds from both private and public sector sources. Third, projects whose focus was on the K-12 level, were generally unable to raise additional funds, at best, only in-kind support was obtained from other sources. Overall, 52 percent of project costs were levered from a variety of public and private sources for the e-learning projects.

Approximately 40 percent of the e-learning respondents indicated that the administrative and reporting burden imposed by CANARIE is too onerous; the highest level of complaints relative to the other programs of e-business and e-health. One respondent summed up the general sentiment of e-learning participants: "CANARIE needs to examine the various management practices they have put in place. They are onerous and fluid (change towards the end of the project). There should be an examination of how heavy the management of the project weighed on the projects. Careful estimation of the total cost of managing the project - simplify practice to reduce associated cost. The approval process is complicated and it is not transparent."

The Impact on the Productivity and Competitiveness of Canadian Education Organizations

Given the basic research orientation of most e-learning projects, it is too early to assess the impact on the productivity and competitiveness of Canadian education organizations. There are, however, some indications that current research efforts will lead to gains in productivity and competitiveness. Approximately two-thirds of the e-learning lead participants indicated an increased uptake of advanced network applications by other participants and organizations. Roughly half of the respondents have seen an increase in the number of high quality jobs in their organization. As one respondent noted, "innovation comes from many sources. Not only have we been able to work with leading edge software concepts, and discuss our work nationally and internationally, but the project work had directly lead to the significant development of a large number of professionals, academics and students who are gaining experience in large project development issues, methods for software development, and in the research and evaluation of educational systems. Our project has developed a number of components that will likely lead to

productivity gains for a number of levels of e-learning developers and consumers. These may become quantifiably demonstrable as a critical mass of users embarks".

5.4 E-Health

Preamble

Canada is recognized as a leader in telehealth. In the opinion of one participant, however, "We are hanging by our fingernails to keep this lead. If we want to capitalize on this, we have to maintain the momentum." The benefits of e-health, in terms of cost efficiencies and increased reach to rural and remote areas, are still down the road until the availability of e-health is more ubiquitous. Of all the programs – e-business; e-learning, intelligent systems – support by project participants and users for the e-health program was the strongest. This is perhaps a reflection of the difficulties e-health care organizations have in accessing funds.

Technology development and knowledge production

In the e-health field, initial developments were in video conferencing, and stand-alone workstations for telehealth. Communications infrastructure was basically ISDN; the Internet was not necessarily robust enough for e-health applications to develop. "Now, the capacity is there to move a lot of the e-health applications off the phone and onto the Internet. We're currently in the midst of this migration." Among the new developments arising from Phase 3 are the storage and transmission of diagnostic images and medical records. Imaging information can now be included in a patient's electronic records and disseminated to other healthcare organizations. This innovation was based on the use of distributed computing grids.

Diffusion of knowledge and the promotion of technologies and applications

It appears from the interviews that the e-health sector offers the most promise, among the CANARIE programs, of improving the quality and cost-effectiveness of service. According to users of an e-health project, Home Telehealth Service, the project could do at a distance almost all of what would have been done in a personal visit. All 82 of the clients in the pilot indicated that they actually preferred the home telehealth service because the "visit" could be done at home, at the scheduled time (as opposed to waiting in the doctor's office), and avoided travelling time. From a cost-effectiveness perspective, a nurse could conduct a home telehealth visit in 15-20 minutes, as opposed to 60 minutes for a personal visit (travel time plus the actual visit).

A key impediment to the widespread use of telehealth is related to security and privacy concerns. The Policy and Peer Permission System (PPP) supported by CANARIE addresses these concerns by allowing health care providers to access medical records at a distance in a secure environment. Access to funds for implementation, however, remains a problem. Even with successful projects like the Home Telehealth Service and the Policy and Peer Permission System, the utilization of e-health applications in the delivery of health care services is dependent upon provincial governments at a time when health care dollars are very stretched. Having sufficient broadband is also key to the wider use of telehealth. An example of where broadband makes a

difference is the transmission of sign language for deaf people. Any blurring from low bandwidth is not acceptable - the visual image has to be close to the actual.

Awareness raising (e.g., conferences and networking) activities by CANARIE to a broad based audience led to the creation of the Canadian Society of Telehealth. A lot of dissemination activity has been taken over by the Society, a development that has somewhat diminished CANARIE's leadership role. Some interviewees expressed concern about this especially at a time when CANARIE is gaining more prominence in the e-health field.

Development of the capability of Canadian industry

Canadian companies were viewed as pioneering in e-health. It was noted, however, that many of the companies in the field have been bought out or have folded. In addition, the Canadian companies have come up against big conglomerates from the US and Europe that are more aggressive, and have as a consequence experienced diminished buyer interest in Canadian telehealth products. The survey results confirm a modest impact on companies from participation in the e-health program; only 16.7 percent claimed increased revenues, and 50 percent, increased number of high quality jobs. These were the lowest impact figures among the four application areas.

Innovation related networking

Five of the 23 e-health projects are using CA*net. Lead participants usually have the intent to utilize the power of the Internet but a barrier to greater usage has been the lack of roll-out of the networks to rural and remote regions which often were the target for many of the e-health applications. A number of the projects "stretched the limit" to see what could be done for rural communities. "One thing that the CANARIE e-health program does is to make sure the project is meeting a need, not just there for the sake of developing the technology." Within the projects, with participants in urban areas, there has been networking, for example, the Policy and Peer Permission System has a lead in Calgary connected to the Heart Institute of Ottawa.

Levering of funding from other sources

Some 58 percent of project costs were levered from a variety of public and private sources for the e-health projects. Many of the sources were participants, others included private foundations, telecommunication companies, drug companies, government (Health Canada, Industry Canada), and international organizations (European Commission). Because of the small size of the 23 e-health projects, most of the shared funding or in-kind contributions was provided by participants.

The impact of the productivity and competitiveness of Canadian firms

As noted above, e-health offers considerable promise in improving the quality and cost-effectiveness of the health care service. This expectation, however, is muted because of the dependence on, and uncertainty of, provincial government support for the utilization of e-health applications. The productivity and competitiveness of Canadian firms will be enhanced if e-health takes hold in a major way and opportunities exist for new applications, products and services. Canadian firms will face considerable competition from larger US and European companies in capturing new business; winning out will have to be through superior technology solutions and knowledge of health care requirements.

5.5 Intelligent Systems

Preamble

All respondents expect intelligent systems to play an increasingly important role in the Canadian economy, particularly in the next five years. The pervasiveness of cheap and reliable micro-computing, micro-sensors, bandwidth, is enabling the development of distributive systems in a variety of sectors. Federal funding through Precarn of intelligent systems has acted as a catalyst. Precarn funds have helped participants to implement their projects faster, get ahead of foreign competitors and in some cases to export. All respondents interviewed believe that Precarn has helped Canadian companies participating in the program to be leading edge.

Precarn's definition of intelligent systems has changed over the years such that proposals are received from not only traditional resource sectors such as mining and forestry, but also from other newer sectors such as health and space. Another change has been for intelligent systems to be applied vertically to the entire production cycle, for example, in forestry to cover tree cutting,

pulping and milling. The number of proposals has risen to the point where Precarn can only fund one in ten (last year, 27 proposals were submitted and three were funded).

The CANARIE sponsored projects were funded before other Precarn projects: all CANARIE funds are committed to March 2004, with the projects to be completed by December, 2003. Of the six on-going projects, five will be finished by December, and the other in March, 2004.

Technology development and knowledge production

The 13 projects supported by Precarn under CANARIE funding (12 completed or ongoing, one terminated) have developed many new technologies, largely associated with intelligent vision systems, e.g. mining (rock face location), forestry (wood identification, dryness), and robotics (vision helping robots to be more intelligent). Information analysis has also been a product. The results of this support are seen in advances in vision systems, telerobotics, data mining, and knowledge base development more generally.

All Precarn projects funded with CANARIE support demonstrate the application of intelligent systems using advanced networks although the focus of Precarn's interest is in how the information is captured, not in network development, as previously noted. Many new technologies associated with information capture and analysis have been developed in the 12 projects supported through this program. For example, the ROSA project will allow robotic systems to be remotely controlled by combining artificial intelligence technology with computer vision and robotic behavioural control techniques to develop a system that can demonstrate independent vision functions in space flight robotic operations. The lead participant in this project, MD Robotics, is demonstrating these capabilities in the MDR Space Vision Test facility in emulated satellite docking operations. Due to the project's success, MDR and its American partner, Boeing, were selected by the US Defense Advanced Research Projects Agency (DARPA) to perform Phase II of the Orbital Express Advanced Technology Demonstration.

Another example is the ELAP (Emulsion Loader Automation Project) that is demonstrating the advantages of intelligent systems in the mining sector. The most important benefit of ELAP is increased safety for miners who will no longer need to go to the face to load explosives. The FIFEDOM project is enabling Canadian remote sensing and mapping businesses to maintain a leading position through the development of algorithms for the best use of aerial remote sensing data. MDA and another partner are marketing two new products from the project nationally and internationally. The IVE project which is developing a system for corrosion detection in aircraft and aerospace structures will also be bringing a new technology (an intelligent visual inspection technology) to market next year.

Development of the capability of Canadian industry

The Precarn projects are building a capability in Canadian industry, in particular in SMEs which constitute about 30-40 percent of participants. An industry participant commented that the program has allowed companies to do R&D outside their normal sphere and, in the process, take bigger risks. The consequence of this breadth of technology development is often to create multiple applications and an extended range of users and developers, thereby extending capabilities within Canadian industry. A further factor in building capabilities is the sharing of IP

under the terms of Precarn's Lead Participant Agreement. New foreground IP created as a result of a Precarn funded project is made available to any Precarn member, royalty free, for the purposes of further research.

According to a recent sector profile[16], the total number of companies in the intelligent systems industry is estimated at 400, with total revenues of $2.5 billion and employment of 7,300. On average, companies spend 34 percent of their revenues on R&D. The industry is export oriented with 70 percent of revenues earned in the US, European, and Asian markets. The component of the intelligent systems industry involved in the CANARIE program also gives evidence through their project performance of the same level of technology intensity and growth potential.

A vital characteristic of the Precarn projects is the partnerships, or the community of interests (COI) created. Intelligent systems require a multi-disciplinary team, and a successful project is dependent upon effective COI or partnerships. COI allows each partner to focus on the aspect that they do well. Another benefit of Precarn management of the program is the discipline that comes in not only planning the R&D project, identifying and obtaining the appropriate skills, but in planning the last, "go to market" phase. Precarn has gone the "extra and final step" by asking all project participants to develop "business case" documents. One respondent noted that he had taken some of Precarn's principles and applied them to his own organization.

Diffusion of knowledge and the promotion of technologies and applications

Diffusion is a key central responsibility of Precarn. Project reports in summary are available publicly on the Precarn website, more detailed reports are available to members. At Precarn's annual meetings, lead participants give presentations on their projects; participants meet people and organizations outside their normal circle to exchange knowledge. Precarn conferences are open to non-members; an unintended result has been that others see applications not previously considered. Precarn has stepped up its diffusion activities in Phase 3; it has attended more trade shows, at which it has taken out booths and made presentations of developments in technology and applications.

Innovation related networking

The convergence of technologies that characterize intelligent systems is brought about through networking and leads to innovation in products and services. The range of participants in Precarn projects (researchers, developers, and users) both stimulates and benefits the networking process. In essence, Precarn brings communities of interest together to solve problems. For example, an outcome of the ROSA project is a relationship between MDR and vision researchers at NRC that continues to grow. The linkages formed between industry and universities have led to ongoing research and technology collaboration and to job opportunities for graduates. On occasion, networking occurs before projects are initiated. We learned that the operating engineers training association (OETIA) wanted a simulator, approached Precarn who brought in CAE, NRC, and academics to work on it; in the end, a project was initiated without Precarn.

In the minds of some, the innovation momentum beginning to take hold in the intelligent systems sector is comparable to that which occurred in the information and communications technologies

[16] A Profile of Canada's Intelligent Systems Industry, Precarn and Industry Canada, March, 2003

sector. Business momentum will follow. "It takes a while to lay the ground work but where there is a suite of technologies available, with end users willing to implement them, innovation will happen."

Levering of funding from other sources

The agreement with CANARIE limits the Precarn contribution to 50 percent of eligible costs. The Precarn Board decided to hold the Precarn contribution to 40 percent, but project funding shows that actual Precarn funding has been less, ranging around 30-35 percent. An average of 72 percent of project costs were levered from a variety of public and private sources for the intelligent systems projects. The cost sharing, therefore, has been successful and comes in the form of cash represented by the cost of personnel or software used in the project. In-kind contributions also happen but they are defined strictly to be donations because of the difficulty of calculating what they are worth.

The impact on the productivity and competitiveness of Canadian firms

It is too early to comment with any assurance on this issue for all the CANARIE participants. In the case of ROSA, the case study notes that all participants and users associated with the project believe the project has helped to increase the competitiveness of the lead participant, MD Robotics. ROSA helped to push the technology envelope so that MD Robotics has few, if any, competitors in the area of ground control of space robotics. The respondents point to the DARPA contract, which is a major entrée into American space contracts, and which in turn will benefit MD Robotics Canadian partners and suppliers. The survey results indicate that, as a result of participating in the CANARIE program, companies are recording increased revenues and job growth, bringing out new products, enhancing existing products, and taking out patents. These responses are indicative of the participants at least maintaining and possibly increasing competitiveness.

6. Future Directions

Over the past ten years, CANARIE through three phases of programming has developed and diffused innovative applications, technologies and services associated with advanced networks. In this Chapter, we examine the issue of continuing need for federal support and, if so, the role that CANARIE might play in the future by considering the following questions.

Issue 3: What are the potential future directions for CANARIE?

- Is there a continuing need for federal support of advanced network applications?
- What is an appropriate focus for CANARIE in a potential phase 4?

6.1 Overall

Perhaps not surprisingly, all respondents to the survey and interviews indicated that federal support of advanced network applications and content development (e-business, e-learning, e-health, and intelligent systems) should continue. Momentum has been created over the ten years of CANARIE - the results of investment in Phases 1 and 2 are beginning to be evident in the work of Phase 3 - but the task is not considered to be complete. A general consensus in our data gathering is that CANARIE and Precarn have been key factors in helping Canada to maintain its competitive edge in network applications with our major trading partners, e.g., USA, Europe, Japan, Australia. In the absence of these programs, most believe industry in those countries would move ahead of Canada, especially given the relative generosity of their R&D programs compared to Canada.

A common view held by industry is that a future focus has to be the mid-market, that is SMEs. The software approach to e-business has not, in general, worked for SMEs as indicated in Chapter 5 because many SMEs haven't the necessary skills to adopt the solutions or are slow to adopt. Furthermore, they often can't afford them. Many respondents to our survey (see below) and interviewees advocated the honest broker role that has been played by CANARIE, working with industry associations and suppliers to develop communities of interest, as a productive approach to IT adoption by SMEs. It was felt that CANARIE had made a good start in this direction in Phase 3 and had the knowledge, experience and credibility to continue on this path.

Also of interest in considering future directions is the issue of Canada's innovation challenge. Part of this challenge is seen as the acceleration of research collaboration, for example between research laboratories, between industry, university or government. "Data sharing is now pushing

the frontiers of science. Collaboration is needed but it poses a challenge – all sectors are saying we need facilitation, cross fertilization, informed advice and leadership." A similar comment by an industry interviewee summarized the future situation: "Collaboration, consultation and facilitation will continue to be needed in the future supported by public funding, whether or not CANARIE is there as a performer of these functions".

Thus, the need for a continuing emphasis on collaboration is clear, according to CANARIE's stakeholders, and, while other organizations may be able to fulfill the needed coordinating role, CANARIE has demonstrated an ability to act as the necessary 'glue' at the national level.

The approach to collaboration and to programming in network applications could, however, change in the future. The discussions supporting this study indicate that the key change to take place will be the integration of the Internet into the applications such that the applications can take advantage of other data and computational resources that they can directly access over the network. As network processes become more integrated, there would also be benefit, according to some interviewees, for the now separate areas of e-business, e-health, and e-learning to be brought together into one program. It is recognized that significant technological barriers need to be overcome as well as organizational and cultural barriers to allow this transformation to happen. A further expected change will be an internationalization of the scope of collaboration in order to gain access to global markets.

The results of the survey provide a breakdown of support (primary, secondary) for various possible future roles for CANARIE. Continued funding of advanced network applications and maintenance of CANARIE's coordinating/facilitation (honest broker) role received strong endorsement (primary and secondary). Across the application areas, the top preference among respondents for funding was basic R&D, with the development of prototypes a close second.

What could be the potential future directions for CANARIE programs?

Potential Initiatives	Primary	Secondary	Not Answered
Continue financial support for the development of advanced network applications	63.6%	30.3%	6.1%
Financial support for advanced infrastructure development	48.5%	33.3%	18.2%
Financial support for advanced content development*	45.5%	33.3%	21.2%
Coordination/facilitation (honest broker role) of the development of advanced networks and applications	45.5%	45.5%	9.1%
Other	15.2%	0.0%	84.8%

* Not asked of intelligent systems projects

If you indicated that continued financial support from CANARIE would be beneficial, what type of projects should be supported?

Projects	Primary	Secondary	Not Answered
Basic Research and Development (R&D)	80.6%	9.7%	9.7%
Development of prototypes	77.4%	16.1%	6.5%
Pre-commercial testing activities	58.1%	22.6%	19.4%

Commercialization activities	35.5%	35.5%	29.0%
Other	6.5%	6.5%	87.1%

Most respondents noted that if there is a Phase 4, part of the funds should be used to finance demonstrations for the purpose of showcasing the advantages and benefits of CANARIE and Precarn. Many thought that a big challenge facing both CANARIE and Precarn is raising awareness, not only to potential project participants but also to the Canadian public. The general consensus was that stronger promotional efforts might have made the future of CANARIE and Precarn more certain. Several applicants (particularly in e-learning and e-health) whose proposals were not funded, expressed a desire to see detailed results of completed projects. They noted that the information provided in the newsletters is of a general nature, and although very useful for informing people on the types of projects completed, does not provide the detailed information that they would need to utilize and apply the results of CANARIE-funded research to their R&D efforts.

Findings on future directions for each of the application areas follow.

6.2 E-Business

A significant number of project participants indicated that in the absence of CANARIE, corporations would look to American and/or European programs to help fund R&D. This could be accomplished in two ways: a) being bought/acquired by a foreign company, thereby, providing access to foreign government R&D programs; or b) partnering with foreign firms, which means that the Canadian firm would have a secondary or subsidiary role. There was overwhelming support for the continuation of CANARIE, and in particular, the e-business program.

In the absence of CANARIE, many believe that firms will do less R&D. Even if companies do fund an R&D program themselves, the scope would undoubtedly be smaller and the pace of implementation much slower. Firms, and in particular SMEs, will have to generate revenue from their customers first in order to pay for the R&D.

Phase 3 was successful in promoting "needs based R&D" (e.g., based on the requirements of the community of interest) as opposed to the traditional "trickle down R&D" (e.g., university based R&D feeding out to companies). Thus, the current CANARIE model for e-business is seen by industry and government as meeting the needs of the community. A key aspect in a potential Phase 4 will be the further development of communities of interest; one interviewee felt that CANARIE should take more of an advocacy position and orchestrate the creation of communities of interest, "not passively wait for proposals". For example, "ICT suppliers need to understand the importance of SME productivity and thereby be convinced to initiate actions". It was noted that, particularly with respect to SMEs, CANARIE's due diligence has improved significantly.

6.3 E-Learning

The focus of the e-learning program has been on advancing Learning Object Repository (LOR) technology. LORs dependence on advanced networks tends to restrict the field to universities who have access to CA*net. Participation by private firms is difficult since they do not have access to CA*net, but, on the other hand, unless a private firm is involved, the prospects of commercialization are low and royalty payments even lower. Many respondents cautioned that CANARIE's focus on LOR technology has created a "closed club": those that are "in" with access to CA*net and conducting LOR research and those that are not. E-learning participants suggested that in future, efforts be made to "push the envelope" and go beyond the current "LOR community" by reaching out to and convincing more (not only distance education) universities of the advantages of LOR. Only when this happens, will the uses and advantages of LOR be fully realized.

The challenge for the e-learning program is reaching a balance between delivering education as a public good versus the need to demonstrate "value to the taxpayer" such as royalties. The general consensus amongst public sector educators, is that profits should not be derived from education, which is a public good. As one respondent noted, "making money was never a goal, so the project did not, and will not, generate any revenue." Not surprisingly, the only e-learning projects with immediate term prospects for commercialization and hence royalties, are projects where the lead participant is a private firm.

Most provinces are doing some work on LOR, and a logical role for CANARIE is to act as a repository of e-learning tools across provinces. This national mandate suggests that CANARIE should also focus on development of LOR standards. It is also unlikely that further research, connecting LOR communities of practice, and the deployment of LOR, can be undertaken without the participation of the provinces. One respondent noted that, "CANARIE would have a greater impact if it made an effort to promote programs at the provincial level." The Report on Learning Object Repositories sums up the general sentiment of the respondents, where it notes that: "funding agencies and implementation groups are fragmented and no one organization has the necessary core competencies and funding programs to provide the total solution to develop the needed infrastructure and advance practice in the sector. The study team urges CANARIE and Industry Canada to continue its leadership role in LORs to develop the vision and partnerships to realize the potential of broadband networks to meet the education and training needs of Canadians."

Many respondents noted that connectivity, particularly for the kindergarten to grade 12 (K-12) levels, is still an issue. Most schools do not have access to CA*net, which makes it difficult to deploy an application requiring high broadband. As one respondent noted, "there still remains a lot to be done, in terms of the number of schools connected, and especially in regards to connecting small/remote schools that are more expensive to connect. Once the infrastructure is there, management of that infrastructure will continue to be needed to ensure that it is used and maintained." It was also emphasized, however, that connectivity to schools (K-12) is the responsibility of school boards and CMEC (Council of Ministers of Education, Canada).

Another respondent noted that the K-12 levels are really a service sector. Research is not carried out by the K-12 levels, but rather it is an untapped research laboratory, that universities and research institutes should use.

6.4 E-Health

Although there are other agencies, including Health Canada, involved in funding telehealth, few, apart from CANARIE, channel the support to technology advancements aimed at improving healthcare rather than funding projects solely from the health perspective. "The technology side has to keep pace with the clinical side. People assume (wrongly) the technology is there, it just needs to be used." The issue according to an interviewee directly involved in telehealth is that technology in health care is still in the development stage, in many cases, and not ready to be deployed, but this message is difficult to convey because "the technology language is something health care people do not understand". The interviewee believes that a great deal of effort will be required "to get the two groups understanding and working together".

Some believe that, for the full impact of e-health to be felt in Canada, the whole health system will have to be rethought. The system can't be restricted only to hospital care. "The system has to reach out to the entire population not just the older and the sick. Telehealth allows health care to be extended to rural and remote communities. A challenge today and continuing into the future will be access to communication facilities in these outlying areas that enable the transmission of video and data. More extensive application of satellite and wireless linkages will be required. The view expressed was that CANARIE was well positioned as a research organization to break into new thinking and offer the leadership and coordination that will be needed.

Smart telehealth systems were proposed as a focus for a potential Phase 4. CANARIE should stretch the imagination with the combined use of nanotechnologies, wireless, remote sensing technologies, and GPS that would allow medical attention to be quickly directed to where it is needed – "a smart system with GPS will tell the ambulance where to go, communicate with a hospital during the critical initial minutes when the person can be saved". Another suggested focus for e-health in the future would be demonstration projects. These are needed to show decision makers, and in particular provincial governments, that "telehealth is not science fiction but a practical and cost-effective complement to in-person health care delivery".

A number commented that CANARIE needs to do a better job of publicizing the benefits of e-health. As one project participant noted, "I certainly believe the support (for e-health) is necessary. Not just dollars, but opportunities in creating awareness and information to learn. There is a huge opportunity to facilitate partnerships, particularly at the federal and provincial level, to show Canadians the benefits, and real demonstrable value".

6.5 Intelligent Systems

All respondents are strongly in favour of the federal government continuing support for intelligent systems through Precarn. Sectors where intelligent systems will likely play a role in the future include space (including exports to the USA and Europe), mining, biotechnology and health care, and geomatics. As with the e-business program, many respondents indicated that developing communities of interest would likely be a key factor in the utilization of intelligent systems. In order to better promote new business solutions, some advocated a more expansive approach to financial support, spreading investments to a larger number of projects versus focusing on a few.

The need to continue funding was expressed by one interviewee as follows: "It's critical that we support intelligent systems to the next wave. It's a convergence of technologies: computing, robotics, visual sensors, remote sensing into useful applications. We need to continue funding the solid results close to commercialization, but we should also do some real 'pie in the sky stuff' because this is where the significant breakthroughs will happen. Sure, not all will come about, but that's the nature of research. If Canada wants to move from 15th place in innovation to 5th, we need to capitalize on this convergence and continue funding intelligent systems so that we continue to see the returns on our investment from phases 1, 2 and 3." The implications of not funding intelligent systems in future should also be examined. Canada would likely fall behind in an important technical area that, as noted above and in Chapter 5, represents a convergence of technologies having a wide impact on industrial processes.

Several respondents pointed to the competition from the US where projects are not jointly funded, they are fully funded by the government. For example, NASA and DARPA contracts cover 100 percent of the costs. A major breakthrough for MD Robotics was landing the DARPA contract through Boeing. The DARPA contract has definitely opened the doors to other possibilities, and ROSA was a key part in putting MD Robotics at the leading edge. A key question for CANARIE and Precarn is how intelligent systems will develop in terms of networks, "will the intelligence reside in the network or in the end systems?" There is an opportunity in the future for collaborative research between CANARIE and Precarn to work on this question.

Almost all respondents thought that Precarn needs to do a better job of promoting itself. One respondent noted that NASA drove a rover across Antarctica to find meteorites. The venture had no commercial value, but it was well advertised. Promotion is very important even though project results may be more at the research rather than commercial stage. One suggestion was for Precarn to put more of its projects (as was done for ROSA) on the Discovery Channel.

7. Conclusions and Recommendations

7.1 Introduction

The following section summarizes the major conclusions that we have drawn from our research, and are grouped into two main categories: first, the possible extension of Phase 3 for one year, including the issues of relevance and success; and second, possible future directions for CANARIE after Phase 3. It should be noted that the scope of the evaluation was restricted to the Advanced Applications Development Program (AADP) and specifically the application programs of e-business, e-health, e-learning and intelligent systems (managed by Precarn). The study's mandate did not include CA*net or other application programs, such as e-content, that are supported by other departments and royalties from Phase 2.

7.2 Extension of Phase 3

CANARIE has requested an extension of Phase 3 to March 31, 2005. The study was asked to include this request in its review of Phase 3.

Conclusions

We conclude, based on our research, that there is merit in extending Phase 3 to permit all AADP projects to be completed. Supporting this position is our conclusion that the objectives of Phase 3 continue to be relevant, especially given the goals and targets outlined in "Canada's Innovation Strategy", and that CANARIE is meeting the high-speed infrastructure and advanced network application R&D needs of educators, health practitioners and private firms. Although Phase 3 is not at a point where it can demonstrate final results, due in part to the delay in getting the AADP started, evidence from completed and ongoing projects indicates that the AADP is on course to achieving the intended impacts and effects. Industry Canada's support for AADP has put many of the participants at the forefront in their respective sectors.

Only 38/85[17] projects are or will be completed by March 31, 2004, with the remaining 47 projects being completed six months later by September 30, 2004. All 13 of the intelligent systems projects under AADP managed by Precarn are or will be completed by March 31, 2004. The termination of the AADP on March 31, 2004 would mean, therefore, that 47 projects would remain unfinished or possibly continue at a reduced pace without CANARIE funding. Project objectives would not be reached and potential follow-on service implementation on an operational scale or product commercialization would likely not happen.

Recommendation

CANARIE's request to extend the AADP to March 31, 2005 should be approved so that the remaining 47 AADP projects can be completed, and the intended impacts fully realized.

7.3 Future Directions

CANARIE is now in its fifth and final year (1999-04) of its three-phase program. Industry Canada will need to decide if it wishes to keep to the original Phase 3 sunset, or to support a subsequent phase. The outcome of the reprofiling request will be a factor in the decision. Other factors will be the perceived need for continued federal funding and the future role that might be played by CANARIE. We outline below a number of conclusions from the study and options for the future.

Conclusions

The technologies that have been supported in the AADP projects continue to evolve and are providing opportunities for applications that will involve new uses of advanced networks. The key change taking place will be the integration of the Internet into applications such that the applications can take advantage of other data and computational resources that they can directly access over the network. CANARIE, Precarn and others recognize that significant technological barriers need to be overcome as well as organizational and cultural barriers to allow this transformation to happen.

Our evidence is that a facilitator at a national level will be needed if Canada is to be able to take full advantage of these new applications that could have a profound influence on business practices, the Canadian health care system, the learning environment, and the manufacturing and resource industries. CANARIE has performed this function in the past, particularly in Phase 3, and has been credited with overcoming institutional and cross-jurisdictional impediments in a way that government agencies would have found difficult to do. All participants and other interviewees (including one rejected applicant) were in favour of a subsequent phase. Consultation with a provincial and US representative familiar with CANARIE also recognized the key contribution being made by CANARIE in advanced network development and utilization.

[17] Two e-business projects were approved after CANARIE's request for Phase 3 extension was submitted, bringing the total number of projects to 85. It was assumed, therefore, that these two projects would not be completed until the next fiscal year, 2004/05.

The leverage of funding from other sources that the AADP has achieved in Phase 3 is notable, particularly for the Precarn managed component. This reveals a strong commitment by firms and other organizations in the private and public sectors to work with CANARIE and Precarn in a coordinated effort to capitalize on the potential of new network and system technologies and applications. The evolution of CANARIE's programs and the broadening of its stakeholder base through Phases 1-3 also has demonstrated a capacity on the part of CANARIE to change to ensure Canada stays on the leading edge of network technology advances and the opportunities afforded to raise the productivity and competitiveness of Canadian companies and public services.

The four application areas of the AADP can be divided into those with a public sector focus, e-learning and e-health, and those with a private sector focus, e-business and intelligent systems, both having distinct characteristics that call for a differentiation in their requirements for support. This we believe to be a significant finding in considering future support in these areas.

- The study results indicate that the key determinants in supporting public sector application areas are: 1) projects would not proceed without public support; 2) cost sharing of the project creates significant difficulties; 3) participants' main interest is financial support for basic R&D; 4) most participants have access to CA*net and are using the network to carry out their research; 5) most do not expect to commercialize and/or pay royalties; 6) projects are dependent on the provinces for deploying the results of their project; and 7) large broadband connectivity such as CA*net remains an issue for the K-12 levels in e-learning and for rural and remote communities in e-health.

- By contrast, participants in the private sector programs noted that: 1) a primary need is financial support for pre-commercial testing activities and development of prototypes; 2) sharing of project costs with CANARIE/Precarn is fair, and in some cases desirable in facilitating the commercialization of results; 3) acceptance that failure to come up with their contribution means the project should not be funded; 4) without CANARIE/Precarn funds, projects would proceed at a slower pace and with a smaller scope; 5) none have access to CA*net and are relying on publicly available internet to carry out their research; 6) most expect to commercialize the results of their project and/or pay royalties; 7) projects are dependent on venture capitalists and other private funding organizations for deploying the results of their project; 8) their applications do not require the large broadband of CA*net; and 9) for e-business projects, the development of communities of interest is significantly more critical to the success of the venture than in the case of intelligent systems projects. .

Recommendation

Consideration should be given to providing federal funding for a subsequent phase of CANARIE, subject to an acceptable proposal from CANARIE that reflected the key findings of this study, namely, that:

- The communities of interest and communities of practice approach initiated in Phase 3 projects be continued and enhanced, thereby expanding CANARIE's stakeholder base;

- The involvement of SMEs continue to be a focus of attention;
- The different funding, commercialization, royalty payment, and network requirements of public and private sector application programs be recognized in program design and management; and
- Resources be allocated to publicizing through demonstrations the applications under development in order to broaden awareness of the potential benefits of the applications and facilitate their implementation.