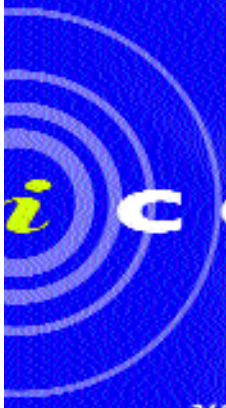
BUSINESS PLAN

MARCH 2000



iCORE

ALBERTA INFORMATICS
CIRCLE OF RESEARCH EXCELLENCE

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Financial information has been removed from this public version of the iCORE Business Plan

Executive Summary

The ability to create, distribute and exploit knowledge and information seems ever more important and is often regarded as the single most important factor underlying economic growth and improvements in the quality of life (OECD 99).

Information and communication technology (ICT) is transforming the way we live, learn, work, and play, the way we deliver health services, conduct business, design and build, understand our environment, pursue research, and govern.

ICT is the world's fastest growing economic sector. Global annual ICT revenues exceed $2 trillion, growing at 9 percent annually. Canada's annual growth rate from 1990-97 for telecommunications was 27 percent and software and computer services was 15 percent. The largest employment g rowth in 1996-97 was software and computer services at 27 percent. An ICT revenue growth rate in Alberta of 15 percent means annual ICT revenues will exceed $30 billion by the year 2010.

The Government of Alberta is committed to creating a globally competitive knowledge-based economic sector. The Ministry of Innovation and Science is implementing a four-pronged strategy to achieve this goal:

- investing in education
- developing Alberta's ICT infrastructure
- investing in research and development
- supporting the growth of ICT business

iCORE is the Ministry's initiative to foster university-based fundamental research that supports the ICT sector of the economy. The mandate of iCORE is to attract and grow a critical mass of leading researchers in the fields of computer science, electrical and computer engineering, and other ICT-related disciplines. iCORE is also exploring ways to support current ICT research faculty and graduate students at Alberta universities.

As the knowledge-based economy requires new skills and competencies, the quality of human resources is the major factor behind the invention and diffusion of technology (OECD 99).

iCORE invests in people – the highest caliber research scientists and leaders who work on fundamental problems in information technology.

By increasing fundamental ICT research at universities, iCORE accelerates the generation of new knowledge and innovation as important cornerstones for knowledge-based economic growth and societal gains in Alberta.

It must be recognized, however, that recruiting outstanding researchers in ICT-related disciplines is exceptionally difficult. The competition for good people is intense. Industry is offering huge salaries. At least three provinces within Canada are now committed to doubling the number of computer science and electrical and computer engineering graduates. This has created massive demands for scarce faculty who are more frequently opting for industry.

iCORE is developing a proactive strategy to recruit these scarce researchers and research leaders. A collaborative, focussed effort by the stakeholders, that is, by iCORE and current Alberta ICT university and ICT industry researchers is based on:

- advertising iCORE, the universities and Alberta to general ICT audiences, and in specific areas, to targeted audiences
- making effective use of colleague networks of current Alberta researchers to identify qualified candidates in targeted areas

- executing an extensive recruiting program that brings outstanding researchers to Alberta for discussions of research and funding options
- using these recruiting processes to explore Alberta "grand projects" in areas that are dependent on ICT innovation, and which draw broad local support
- developing collaborative processes with iCORE, the universities and relevant industry participants for screening and selecting candidates
- developing high-quality, impartial, and responsive refereeing, review, and selection processes that satisfy stakeholder criteria

The recruiting, selection and award process typically begins with an ICT Strategy Planning and Recruiting (ISPR) Grant. It supports workshops and interviews with candidates, and subsequent proposal development jointly undertaken by the candidates and host faculty members and department. The proposal is screened by the iCORE Review Committee and peer reviewed by an impartial External Review Committee. Finally, an appointment and award decision by the university and iCORE is made. The objective is to develop close collaboration among all stakeholders throughout the process.

The benefits of this program to Alberta are substantial. The quality of Alberta's university undergraduate and graduate programs will be improved. We will be better able to attract high-quality junior faculty members and graduate students. Innovative ideas and students educated in areas of high demand by local industry will be produced. ICT industry will be attracted to Alberta. New spinout companies will be created. Local industry will be able to exploit new ideas and technology that are produced. Alberta's ICT infrastructure will continue to be improved, offering better, more cost-effective learning, health and government services.

Information and communication technologies (ICTs) are a pillar of the knowledge-based economy. How countries adopt and master ICT is thus key to their future economic performance (OECD 99).

The Ministry of Science and Innovation has committed $10 million per year to the iCORE program, launched in October 1999. In March 2000, the Alberta government announced the Alberta Heritage Foundation for Science and Engineering Research (AHFSER), an endowment to ensure long-term funding of science and engineering research in Alberta. iCORE is pursuing its mandate to attract and grow ICT research in the province, and may become a part of AHFSER. This commitment to research in ICT will place Alberta well within the international information technology community, and will have a major positive impact on its knowledge-based economic sector.

1 Background: Information and Communications Technology

The ability to create, distribute and exploit knowledge and information seems ever more important and is often regarded as the single most important factor underlying economic growth and improvements in the quality of life (OECD 99).

Information and knowledge will dramatically drive progress in the twenty-first century. Communications technology is a crucial enabler of the distribution and exploitation of information and knowledge. Information and communications technology (ICT) therefore will transform the way we relate to our work, leisure and each other.

The central role of ICT and ICT research in Alberta's future is outlined below. This forms the background and context for iCORE's Business Plan.

1.1 Transforming Society

The Internet, an example of information and communication technology, has had a significant impact on the way people communicate. In the coming decades this change will accelerate. Communication over the Internet with friends, relatives and colleagues, real-time interactive meetings, secure electronic financial and commercial transactions, and reading the news and gathering information, are examples that are easy to imagine. Many more unimagined forms of communication are to come.

The transformations under way in the way we learn, deliver health services, conduct commerce, work, understand our environment, govern, and pursue research, are described in the Information Technology Advisory Committee Report to the President (PITAC 99), summarized below.

ICT will transform the way we learn. Interactive education programs that are independent of distance, age, and schedules are possible. The accumulated knowledge of the world can be accessible and downloadable. Education can be focussed on individual needs and interests. A group of ten people living anywhere in the world can work collaboratively to study narrowly focussed subjects. Our entire personal education, the world's literature and history can be recorded and accessed at any time from anywhere.

ICT will transform the way health services are offered and delivered. Specialists can interview and examine patients at a distance. Surgical operations can be done at a distance. We can radically extend the information collected about our health, illness and treatment history. People can have access to their own and the world's accumulated medical knowledge and thus be better able to participate in making decisions regarding their own care.

ICT will transform the way we conduct business. A company can interact with potential clients and customers anywhere in the world using the Internet. People can find the best products and services at the best prices regardless of location. Companies can receive immediate customer feedback and can quickly revise their marketing, pricing, inventory, and delivery strategies. Electronic financial transactions may completely eliminate the need for money as we know it.

ICT will transform the way we work. Extreme flexibility in both where and when people work is possible. Age, disabilities, and lifestyle may become less important. Simulation and visualization systems can enable massive improvements in our ability to create, design and build products, buildings, vehicles, music and art.

ICT will transform our understanding of the environment. Detailed data on weather, water, ecosystems, and pollution can be collected, stored, and accessed from anywhere. Farmers can access accurate short-term weather and long-term climate forecasts. Integrated environmental simulation models can enhance our understanding of the earth and the impact of specific human activity on ecosystems and climate change.

ICT will transform government. Government information and services can be made accessible to citizens regardless of location. Services can be automated and delivered 24 hours a day and seven days a week. Protection and emergency response processes can be developed and delivered more effectively. Feedback from citizens on government policy, regulation, taxation, and services can be continuous.

ICT will change the way we pursue research. Similar to the impact of ICT on work, learning, health, and government, ICT is transforming the way we pursue research. All research journals and publications can be available online. Researchers can collaborate in virtual laboratories, share scientific instruments and computing resources, and communicate and collaborate on results, regardless of location.

The information revolution will have as large an impact as the industrial revolution. To what extent will Albertans be carried along by this revolution? To what extent will we lead, design, develop and benefit from this revolution?

1.2 Opportunities in the ICT Sector

Information and Communications Technology (ICT) is the world's strongest, fastest growing economic sector … Globally, annual revenues exceed US$2 trillion,growing at rates over 9 percent annually, and employing more than 10 million workers worldwide … Over the past five years, output from Alberta's ICT sector has grown 10 to 12 percent annually (ASRA 98).

Industry Canada estimates that in 1997, Canadian revenue in the ICT sector was more than $100 billion (IC-ICT 99). It is estimated that Alberta's share of this market is currently over $8 billion.

> *Today's rapid advances in science and technology mean that OECD economies are increasingly based on knowledge. At the same time, countries are increasingly integrated into the world economy, through international flows of goods and services, investment, people and ideas. This has given rise to new forms of competition and co-operation among firms and countries and encourages the diffusion of new ideas and technologies. These mutually reinforcing changes have profound implications for today's economies.*
>
> *Scientific and technological advances seem more rapid and more pervasive than ever before, and information and communications technologies (ICTs) are now essential to the operation of any business.*
>
> *The internationalization of science and technology is a major aspect of economic globalization. ICT has made possible the globalization of financial markets and largely underpins the expansion of international trade of goods and services and investment flows. Scientific and technological activities are also increasingly performed at international scale.*

Information and communication technologies (ICTs) are a pillar of the knowledge-based economy. How countries adopt and master ICT is thus key to their future economic performance (OECD 99).

> *Knowledge-based industries have been outpacing growth of GDP for many years in virtually all OECD countries. In OECD-wide GDP, the share of this broadly defined group (i.e. high- and medium-high-technology manufacturing industries and services such as finance, insurance and communications) is now more than 50 percent, up from 45 percent in 1985 (OECD 99).*

ICT accounted for 19 percent, and telecommunications accounted for 36 percent, of Canada's Gross Domestic Product (GDP) growth in 1996-97. Canada's compound annual growth rate (CAGR) from 1990-97 for telecommunications was 27 percent and for software and computer services was 15 percent. The largest employment growth sector in Canada in 1996-97 was software and computer services at 27 percent (IC-ICT 99).

Can Alberta achieve higher growth rates in the ICT sector? A compound annual growth rate of 15 percent would quadruple Alberta's ICT revenue from $8 billion to $32 billion annually by the end of the first decade of the twenty-first century. This rate of growth would result in a knowledge-based work force of over 140,000 (ASRA 98). How can higher growth rates be achieved?

1.3 Importance of Research

> *Scientific discoveries and new technological devices are a direct outcome of research (OECD 99).*

OECD economies spend more and more resources on the production of knowledge. Investment in knowledge as defined here (R&D, software, public spending on education) now represents 8 percent of OECD-wide GDP, a figure similar to investment in physical equipment (OECD 99).

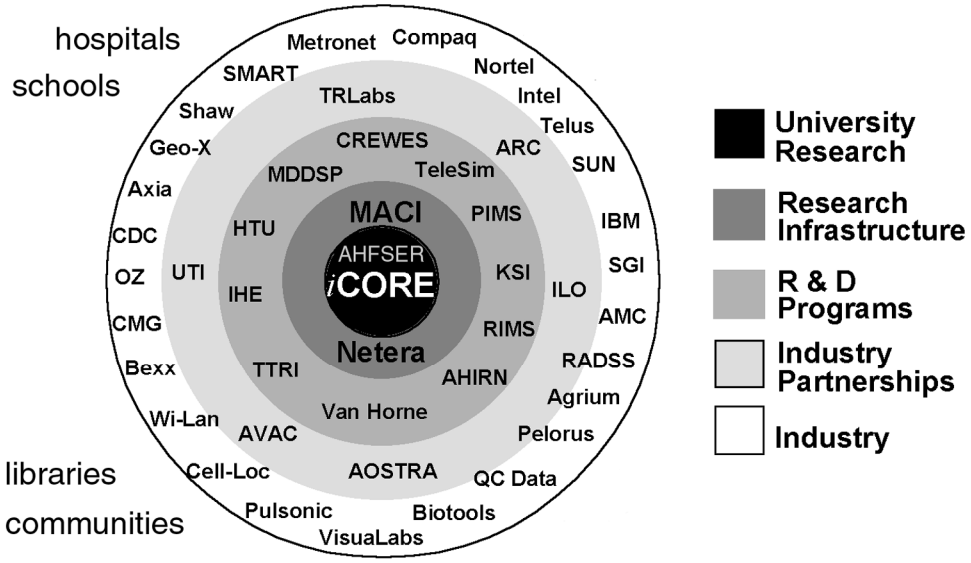
Canada's investment in R&D is 1.6 percent compared to the worldwide average of 2.2 percent. Canada's percentage investment in the production of knowledge as defined by the OECD above is 9 percent. If Alberta is to achieve dramatically accelerated growth in the ICT sector, its investment in ICT-related R&D must also be substantially accelerated.

The central influential role of fundamental research in ICT sector growth is illustrated in Figure 1. Information and communication science and technology is fundamental to almost all aspects of research, business, and society. Strong investment at the core, in high-quality researchers, and in a high-quality ICT research infrastructure, can affect many research programs, applied research organizations, industry, and society.

ICT research at the "core" supports, and is supported by, Alberta's advanced ICT infrastructure, which includes MACI (Multimedia Advanced Computational Infrastructure), and by Netera Alliance (the Advanced Internet in Alberta). See www.maci.ca and www.netera.ca for further information. MACI and Netera provide nearly $30 million in high performance computing facilities and an advanced wave-division-multiplexed Internet that connects the universities and research organizations.

University-based multidisciplinary research programs use the ICT R&D infrastructure and expertise that is provided by iCORE, MACI, and Netera. Government/ university/ industry applied research organizations, such as TRLabs and Alberta Research Council, bridge the gap between university research and innovation, and the application of this innovation by industry. The universities and bridging research organizations provide trained people to industry, as well as innovation and new technology. These in turn can improve hospitals, schools, libraries, and the quality of community life. A high quality of life, in turn, is attractive to researchers.

Figure 1:Economic Impact of Research



Innovation is particularly important for information and communication technologies. In the late 1990s, almost one patent in five granted by the United States Patent and Trademark Office (UPSTO) is ICT-related, against one in ten in the early 1990s (OECD 99).

The role of fundamental high-caliber university-based research is central to the overall Alberta ICT strategy. It is a key part of developing a knowledge-based economic cluster. It is easy to find examples of where this clustering in ICT has been dramatically successful. Examples are Stanford University and the Silicon Valley, Massachusetts Institute of Technology and Boston's Route 128, the University of North Carolina and the Research Triangle Park and the computer industry centered around the University of Texas at Austin.

2 Objective: Recruiting ICT Researchers

The mandate of iCORE's program is to attract and grow a critical mass of outstanding researchers in the fields of computer science, electrical and computer engineering, physics, mathematics and other ICT-related disciplines.

Twenty years ago, the Alberta Heritage Foundation for Medical Research (AHFMR) was created to foster superior research in this province. As a result, Alberta is now recognized throughout the world as a center of excellence in medical research. The AHFMR program is similar to Alberta's current goals for ICT.

The Government of Alberta is committed to creating a globally competitive ICT sector. The Ministry of Innovation and Science has launched a strategy for accelerating growth in the ICT sector that focuses on four key areas:

- investment in education
- development of ICT infrastructure
- growth in investment in research and development (R&D)
- growth in ICT business

The Informatics Circle of Research Excellence, iCORE, is an initiative of the Ministry of Innovation and Science directly aimed at growth in investment in research and development (R&D) by fostering university-based fundamental research. iCORE's mandate is to attract and grow a critical mass of outstanding researchers in the fields of computer science, electrical and computer engineering, physics, mathematics and other ICT-related disciplines. Emphasis is on fundamental research with both short-term and long-term potential benefits to Alberta industry.

iCORE supports the formation of strong scientific teams in ICT by building on existing excellence and strengths in Alberta's universities, and recruiting outstanding researchers with established international reputations in selected areas. To support the research teams, resources are committed to develop a competitive research infrastructure, including excellent junior scientists and engineers, and outstanding graduate students.

The central iCORE mandate is also aligned with the other three strategies in Alberta's ICT strategy. It is strongly supported by Alberta's ICT infrastructure, and is crucially important to achieving accelerated growth in the ICT business sector. It is also tightly connected with the commitments of the Ministry of Innovation and Science and the Ministry of Learning to double the number of students who graduate in computer science and computer engineering, by supporting university attempts to increase the number of faculty members and students through access expansion in these areas.

Launched in October 1999, Alberta's Ministry of Innovation and Science has committed $10 million per year to the iCORE program. iCORE may become a strong and significant part of the Alberta Heritage Foundation for Science and Engineering Research (AHFSER), which was announced in February 2000. By increasing the quality and quantity of fundamental ICT research at universities, iCORE accelerates the generation of new knowledge, innovation and high-quality personnel, as important cornerstones for knowledge-based economic growth and societal gains in Alberta.

iCORE invests in people – the highest caliber research scientists and leaders who work on fundamental problems in information technology.

The indirect impact of iCORE is to be many times direct iCORE expenditures as has been true for AHFMR. Quantitative and qualitative methods for measuring the impact of ICT research on the economy are being explored.

2.1 Scope of the Challenge

Starting salaries in higher education run about $65,000 to $70,000 US for nine months work. That's well above the average for new assistant professors in the humanities, but not nearly as attractive as the starting salaries in industry, which are closer to $100,000 US … According to Edward Lazowska, chairman of the University of Washington's computer-science-and-engineering department, people in his state's software industry earn an average of $295,000 US per year. That figure includes their paychecks and the value of exercised stock options (CS-Flee 99).

It must be recognized that recruiting outstanding researchers in ICT related disciplines is exceptionally difficult. The competition for good people is very intense. Industry is offering huge salaries. At least three provinces within Canada are now committed to doubling the number of computer science (CS) and electrical and computer engineering (ECE) graduates. This has created massive demands for scarce faculty who are frequently opting for industry.

According to an article in the *The Chronicle of Higher Education* (CS-Flee 99), in academia "CS and ECE departments are suffering a serious shortage of professors at a time when undergraduate enrollments are booming." The same article called the shortage "severe" and referred to the "seed-corn problem: that the high industrial demand for IT workers is siphoning too many graduate students and faculty from the universities, leaving an insufficient number to educate the next generation of IT workers … The number of new Ph.D's [in CS and ECE in the US] peaked in 1992 at 1,113, and dropped to 933 by 1998."

Recruiting outstanding ICT researchers is a significant challenge. The plan for addressing this challenge is presented in Section 5.

2.2 iCORE Program Overview

iCORE's objective is to build ICT research teams in areas that have the potential for making substantial research contributions and having long-term impact on Alberta's socioeconomic development. It accomplishes this through a program aligned with the Alberta government's four-pronged strategy to support the ICT sector in Alberta.

iCORE's grant programs focus on the growth of R&D. The flagship of iCORE's grant program is the Chair and Professorship Establishment (CPE) Grant. CPE Grants, valued at $200,000 to $1,000,000 per year, are used to establish research teams led by a strong academic leader, who holds an iCORE chair or professorship. A sample research team consists of an iCORE chair, several iCORE professors, research fellows, postdoctoral fellows and a number of graduate students. However, a research team may also be a small focused group, or simply a strong solo researcher. The positions associated with a research team are funded as part of the establishment grant, with a commitment of up to five years of funding. After such an award, renewal may be possible; otherwise the university is expected to continue funding the academic positions.

iCORE also has a grant program to support current ICT faculty within the universities who have already established outstanding research programs, or who have outstanding research potential. iCORE Research Grants are aimed at supporting and retaining exceptional Alberta researchers now working within Alberta, in the same way that CPE Grants are used to recruit non-Albertans. Funds awarded to current Alberta researchers under this program are applied, like CPE Grants, to the building of a research team. The funds cover salaries of research fellows, postdoctoral fellows, graduate students, minor equipment purchases and other costs of pursuing research. Awards are valued at $50,000 to $500,000 per year for up to five years.

iCORE also operates two additional grant programs in support of its central goal. First, iCORE offers Graduate Student Fellowships to increase the number of high-

iCORE's program is aligned with the Alberta strategy for developing the ICT sector, which includes:
1) investing in education
2) developing Alberta's ICT infrastructure
3) supporting the growth of ICT business
4) investing in research and development.

quality graduate students working in ICT at Alberta universities. Through this program, all new computer science and electrical and computer engineering students who hold NSERC Post Graduate Scholarships (PGS) in 2000-01 are offered additional iCORE awards if they attend an Alberta university. An additional 22 awards are available for scholarship holders in other areas of science and engineering related to ICT at an Alberta university. Second, iCORE operates an ICT Strategy, Planning and Recruiting (ISPR) Grant program. The purpose of these grants is to engage researchers at Alberta universities in the process of identifying and attracting global leaders in ICT research and in the subsequent process of building strong research teams.

iCORE's program is also aligned with the Alberta ICT strategy to develop ICT infrastructure. iCORE offers support for core ICT research teams by providing access to world-class advanced computing and networking resources. Access to nearly $30 million in advanced computing and networking research infrastructure is facilitated by working in close collaboration with MACI (Multimedia Advanced Computational Infrastructure) and Netera Alliance. For example, lectures, seminars, workshops, courses, and research collaboration at a distance, is supported using Netera's advanced broadband network infrastructure. iCORE also supports collaboration and cooperation among existing and new university research teams and industry through workshops and web-based tools.

Another important component of iCORE is its support of the Alberta ICT goal of building ICT industry. iCORE assists in developing research relationships with relevant industry that may include participation in recruiting processes, membership on the iCORE board or committees, supporting jointly funded chairs and/or research teams, or supporting grant programs, such Graduate Student Fellowships.

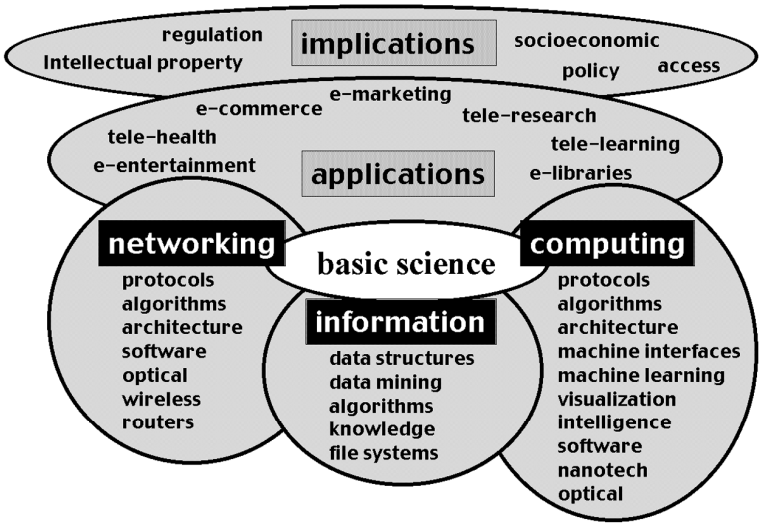
Finally, and importantly, through all of its programs, iCORE is contributing to the larger effort to expand access and increase the number of ICT faculty members, graduate students and undergraduates in general at Alberta universities. By focussing on excellence, iCORE complements efforts to build up the ICT populations at the universities through access expansion. In this way, iCORE supports the Alberta ICT goal of investing in education.

2.3 Research Priorities

The goals of iCORE are to strengthen and build research excellence in areas related to ICT. One view of the subject areas relevant to ICT is illustrated in Figure 2. This view identifies core ICT areas such as computing, networking and information systems. The basic science that is at the foundations of these disciplines includes physics and mathematics.

Applications and implications of ICT are also identified. One characteristic of this view is that it does not define the scope of ICT in terms of traditional academic faculties and departments but rather attempts to present its fundamental interdisciplinary nature.

Figure 2: Research in ICT



2.3.1 Information, Computing and Networking

The core technologies of ICT involve the capture, organization, storage, processing, retrieval, presentation and transmission of information. A key aspect of this characterization is the transformation of basic data into information, and structured information into knowledge. The organization and structured storage of information, and the algorithms and processes for capturing, manipulating, and retrieving data, information and knowledge are central to ICT. Other areas such as artificial intelligence, robotics, machine learning, human-computer interaction and the graphical and animated presentation and visualization of data and information are also important.

The accelerating convergence of computing and communications is being driven by the ability to represent data, information and knowledge in digital formats. Thus we see in Figure 2 a strong relationship between networking and computing. Both involve a focus on communication protocols, distributed algorithms for the processing and communication of information, and on the architecture of software and systems that implement these data structures and algorithms.

The devices and materials that are used to build computers, network equipment, and communication networks are changing while, at the same time, becoming more integrated. Computing and communications may now involve electronic, wireless, and optical components. Future systems may be composed of organic or new advanced materials.

2.3.2 Initial Target Research Areas

Given limited resources and funding it is crucial that iCORE focus on a few areas of ICT research that can have the greatest impact. This implies selecting areas in which Alberta universities have a chance to compete and develop internationally recognized research teams, in which we are likely to be able to produce valuable innovation and intellectual property, and in which Alberta companies are in a position to take advantage of both this innovation and the high-quality knowledge workers that are produced.

Initial Target Research Areas

- broadband networks
- software engineering
- high performance computing
- terabyte database systems
- nanotechnology and quantum computing

Five initial areas of focus have been identified by the iRC and approved by the iCORE Board. All of these fall within the ICT core:

- broadband networks including wireless, Internet protocols, protocol design and analysis
- software engineering, including embedded and distributed systems
- scalable high performance computing and computational science, including the modeling and simulation of complex systems
- terabyte database systems, including data mining, data fusion and very large real-time multimedia databases and libraries
- nanotechnology and quantum computing

Pervasive wireless access to the Internet, that is, "wireless Internet" or "pervasive computing" builds on existing university research and industry presence. There is a strong wireless research sector within Alberta, with initiatives such as Nortel's wireless base station research and development, Calgary TRLabs and its focus on wireless, and Internet protocol design and analysis at the universities. There have already been several significant spinouts from the universities in wireless Internet protocols and architectures.

The second target research area is software engineering. Alberta has strong software engineering initiatives within the computer science and computer engineering departments at both major universities. These initiatives already have significant industry support. It is also desirable to focus on specific areas within software engineering such as embedded software and distributed systems that are important to our traditional economic base and can have world-wide impact. The broadly emerging software industry within Alberta can certainly benefit from a focus in this area.

Scalable high performance computing (HPC) builds on MACI's $20 million in funding for HPC and visualization research infrastructure. Acquiring more expertise in scalable high performance computation, distributed and parallel algorithms and architectures, and in scientific computation is crucial to support Alberta's traditionally strong HPC user community. Many examples can be given of the latter, including Alberta's world-class research in computational chemistry and seismic data processing.

The storage and retrieval of very large databases is also an area of strength within Alberta, primarily due to the oil and gas industries. Alberta has significant research activity in the universities in multimedia data bases, distributed file systems, and geographical information systems. This areas of research also has significant application in bioinformatics, health informatics and geomatics.

Quantum computing and nanotechnology offer exciting long-term potential. Although the risk is high, the return, if successful in this area, is huge. Alberta has several new university researchers now working in these areas.

Initially iCORE will give preference the above core ICT areas. Application areas of informatics such as bioinformatics and geoinformatics are also considered important.

2.3.3 Applications and Implications

The initial priorities for iCORE funding are in information, computing and networking technologies. Nevertheless, approaches to the support of innovative research

proposals in application and implication areas are also possible. The applications of information processing and communication are exploding, particularly as they relate to the Internet. Health services, library and educational services, business sales and services, government services, and entertainment are all beginning to be delivered remotely over the Internet and web. Collaborative work environments, including the support of remote research collaboration, are important to enable.

The application and usage of the Internet and web in education, health and business are also having a profound impact on socioeconomic environment and quality of life. The formulation of government policies regarding universal access, regulation, privacy, intellectual property, copyrights and licensing is crucial in the face of these broad applications. These policies will have a substantial impact, for example, on e-commerce, web data mining, and software engineering.

3 Benefits to Alberta

Because of its pervasive influence, ICT research has many benefits, both direct and indirect.

Information and communications technology (ICT) affects almost all aspects of business and society. It is as fundamental to the way that we live in the knowledge-based society as transportation is to a products-based society. It is shifting the way that we do business and interact with the world. Because of its pervasive influence, ICT research has many benefits, both direct and indirect.

Most, if not all, of the technology driving the information revolution is developed in research labs. Transistors, computers, operating systems, programming languages, programming algorithms, network protocols, network devices, the Internet, and the World Wide Web all emerged from research performed at universities and in industry. Research influences our economy through business and societal gains. Research is fundamental to growth in the ICT sector.

3.1 Research and Industry

Research is fundamental to ICT industry. ICT R&D accounts for 42 percent of total Canadian private sector R&D (IC-ICT 99). Many ICT businesses start as spinouts from university research. Large and growing businesses often fund their own research, a necessary part of thriving in a knowledge-based economy. University research in ICT has been dramatically successful in creating ICT business.

Alberta industry has in the past, and will even more so in the future, have access to researchers and their students. Industry often indicates that access to high-caliber graduates is an important factor when deciding where to locate. Knowledge businesses will locate close to where they can access high-caliber expertise.

3.2 Research and Education

ICT research influences education in a number of ways. World-class faculty members attract higher quality junior faculty members and better graduate and undergraduate students. These resources benefit the entire education system.

The province of Alberta is committed to increasing substantially the number of ICT graduates in its post-secondary programs. These programs need professors and instructors who have post-graduate education. University-based research programs are necessary in order to educate post-graduates for institutions and industry.

ICT is used in education. ICT tools and techniques are becoming a basic part of all subjects. It is also used to distribute education in electronic form via videoconferencing or web-based materials, which is especially useful to Alberta rural schools and population. An area of ICT research using artificial intelligence, interactive media, and instructional design creates intelligent tutoring systems to deliver interactive, media-rich course content anywhere, anytime.

Having ICT research groups active in the province allows other people in the education system to interact with them and be aware of upcoming technologies. Having scientists in the community exposes the entire community to the excitement of, and opportunities in, a science career.

3.3 Research and Health

ICT research is now fundamental to health and medical research. Health information systems are needed to improve information flow, enable better knowledge-based decision making, and assist in understanding and optimizing health business operations. Issues in the design of secure, distributed, portable, complex medical information systems are important areas of applied ICT R&D.

ICT research is being applied to assist in planning and carrying out surgery, in designing medical devices, in simulating pharmaceutical designs, in processing medical data and images, and in managing and analyzing vast quantities of data. The are many potential research opportunities in the use of ICT in health and medicine.

3.4 Research and Government

Government's role in funding fundamental research in information and communication technology is critical. In spite of the current industry success and rapid development and deployment of information technology, there is still a necessity for fundamental ICT research. The information and communications technologies that are fueling the knowledge-based economy today are the results of fundamental ICT research carried out over the past fifty years. As we are still at the beginning of the knowledge-based revolution, there is still significant fundamental research to be done. ICT industry recognizes the importance of funding short-term applied research, but cannot be expected to fund long-term fundamental research.

Also, like any business today, the government must look to using ICT to improve operations and services. Government is a major user of ICT, is a promoter of societal good, and a sponsor of university research. Government can act as a champion for research and the growth of a knowledge-based economy by setting an example of funding ICT research and using ICT for efficient and effective government services.

3.5 Socioeconomic Benefits

ICT is a cornerstone of a knowledge-based economy in Alberta. A knowledge-based economy implies a healthy, educated, wealthy society. Alberta already has a thriving and growing ICT sector. Alberta's other major sectors – energy, agriculture, forestry, manufacturing and distribution – rely on ICT to enhance business. A thriving ICT research program feeds the growth of new-economy knowledge-based industry and supports traditional industries to compete internationally. This is a clean industry that employs and attracts highly educated people and creates wealth for all.

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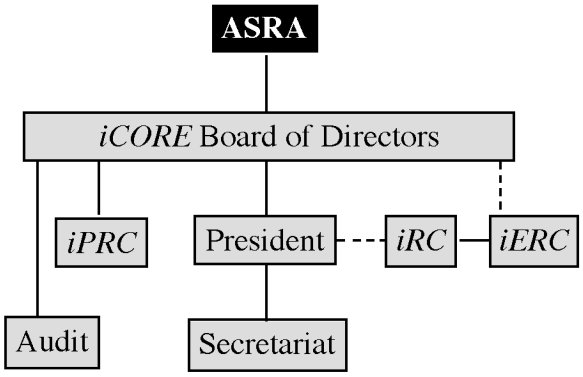
The Alberta government's ICT Strategy is targeted at growing the ICT business sector from the current $8 billion to $30 billion in revenues by the year 2010. Much of this growth will come from local business creation and expansion. This growth will be fed with the high-quality people that have exposure to and experience in high-quality active research programs at out universities.

4 Corporate Structure and Organization

iCORE is a not-for-profit Alberta corporation with a mandate to attract and recruit outstanding researchers in the ICT sector to Alberta. The structure of iCORE Inc. is illustrated in Figure 3. The Board of Directors have responsibility for all strategies, awards, grants, processes, and policies.

Figure 3: Organizational structure



The President and CEO reports directly to the Board. The President, along with iCORE secretariat staff, are responsible for implementing Board policy and for all iCORE operations. The iCORE Review Committee (iRC) and iCORE External Review Committee (iERC) are working committees responsible for recommending awards and appointments to the Board and universities.

The corporate structure, ownership, board, review committees and secretariat are outlined in the following sub-sections.

4.1 Board of Directors

The corporate structure is that the corporation owners elect a Board of Directors that consists of no less than 12 persons and no more than 24 persons. The composition of the Board is:

- President and CEO of iCORE
- Deputy Minister of Alberta Innovation and Science
- Member of the Legislature of Alberta
- VP (Research) of the University of Alberta
- VP (Research) of the University of Calgary
- Four university professors with outstanding research records in ICT
- Four or more industry representatives with broad experience in the ICT and business sectors

The Board appoints the iCORE Review Committee (iRC), the iCORE External Review Committee (iERC) and the International Program Review Committee (IPRC). Other committees, including executive and audit committees, are appointed by the Board as appropriate. In addition to the Board chair, a vice-chair position is filled by an industry representative on the Board.

The Board of Directors as of March 2000 is listed below. Additional industry members are to be appointed.

Board of Directors

Chair: Dr. Roger Smith, VP (Research and External Affairs), University of Alberta
Vice Chair: Mr. John Webb, Chairman, Electrobusiness.com

Dr. Len Bruton, VP (Research), University of Calgary
Dr. Elizabeth Cannon, Professor, Geomatics, University of Calgary
Dr. Peter C. Flynn, Poole Chair, University of Alberta
Mr. H.S. (Scobey) Hartley, Prism Petroleum
Dr. James Gosling, VP and Fellow, Sun Microsystems
Mr. Denis Herard, MLA, Calgary Egmont
Mr. Phillip C. Lachambre, Executive VP and Chief Financial Officer, Syncrude
Dr. David Jefferson, Systems Research Center, Compaq
Dr. Roger Palmer, Deputy Minister, Innovation and Science
Dr. Bill Pulleyblank, Director, Deep Computing Institute, IBM Research
Dr. John Samson, Professor, Physics, University of Alberta
Dr. Jonathan Schaeffer, Professor, Computer Science, University of Alberta
Ms. Monica Sloan, Management Consultant
Mr. George Squires, VP Research and Technology, TRLabs
Dr. Richard Taylor, Professor Emeritus, Physics, Stanford University
Dr. Brian Unger, President and CEO, iCORE

4.2 Review Committees

The Board appoints an iCORE Review Committee (iRC) that consists of 4 to 6 university research faculty, 2 to 3 industry researchers and 2 to 3 iCORE Board members. It is expected that iRC members will either be actively involved in ICT research or have extensive relevant experience in ICT areas.

The terms of reference of this committee are to:

- recommend research priorities
- define guidelines and criteria for letters of intent and candidate proposals
- evaluate candidates and proposals for funding
- use impartial external referees and external review committees as appropriate
- recommend awards to the iCORE Board and universities

A key objective of the iRC is to develop review and refereeing processes that support recruiting top people, involve an impartial peer refereeing procedure, and that work well with university structures and appointment procedures.

Proposals are accepted by the iRC from candidates, from individuals within the universities, industry, government, and the iCORE Board. Key objectives in the review process are autonomous, independent decisions by the iRC and by appropriate university selection committees, as well as close coordination between iCORE and the universities in the interest of making high-quality timely decisions.

In carrying out these functions it is expected that the iRC uses, as appropriate, an impartial external review committee, the iERC. The iERC uses external referees and subcommittees for the evaluation of candidates in different subject areas. The iERC referees and committee members would normally not be associated with any Alberta university or Alberta research organization. The purpose of the iERC is to ensure that conflicts of interest are dealt with properly, and that high-quality peer reviews are performed for all senior appointments.

4.3 Secretariat and Staff

The President and CEO reports directly and is responsible to the Board of Directors. Corporate administration and operations are carried out by a secretariat led by the President. The secretariat's Director of Programs implements, manages, and supports the design and leadership of award programs. The Office Manager handles administrative matters.

These full-time roles are augmented by the services of the Director of Corporate Relations, who develops industry support and connections. Communications services are also contracted for strategic planning, public relations and media relations.

The secretariat is housed within the new Calgary facility of the Alberta Research Council.

iCORE researchers are primarily located on the university campuses. It is also possible for iCORE research teams to be located at other research organizations, such as the Alberta Research Council and TRLabs.

4.4 Incorporation and Ownership

iCORE Inc. is incorporated under Alberta's Business Corporation Act, similar to the Alberta Research Council Inc., with internal restrictions that limit activities to not-for-profit undertakings. The business to be carried out by the corporation is "limited to activities, programs, and undertakings that seek to attract and encourage the growth of world class research in disciplines that support the growth of the information, computing, and communications sector of the Alberta economy."

Upon incorporation, there were three founding owners and directors: Roger Palmer, Deputy Minister of Innovation and Science; Roger Smith, Chair of the Board; and Brian Unger, President and CEO. In March 2000, by an Order in Council, iCORE Inc. became a wholly owned subsidiary of Alberta Science and Research Authority (ASRA), a relationship similar to that between ASRA and the Alberta Research Council Inc.

5 Action Plan

The plan for achieving iCORE's goals is outlined in this section. First the recruiting strategy, grant programs and selection process that make up the central iCORE program are summarized. The supporting industrial strategy, communications plan and operations plan are then outlined.

5.1 Recruiting Strategy

The recruiting strategy that has been developed, depends on,and synthesizes, the networks and ideas of Alberta's existing ICT researchers.

The current importance of ICT in both industry and academe means that recruiting ICT researchers is exceptionally difficult. In addition to this difficulty, there are also issues related to academic appointments that are of concern to the universities. These include long-term financial exposure and tenure commitments that may exist after iCORE support ends, and the hiring process and policies with respect to immigration and collective agreements.

Given the difficulty of the task, significant resources and a strong proactive recruiting strategy are required. Close effective cooperation and collaboration among the stakeholders – the universities, industry and iCORE – is crucial.

iCORE's recruiting strategy incorporates several goals:

- making effective use of networks of colleagues that current Alberta researchers have to identify qualified candidates in targeted areas
- bringing outstanding researchers to Alberta for discussions of research areas, research strategy and planning, and research funding
- using these workshops to explore "grand projects" in areas dependent on ICT innovation that might be broadly supported in Alberta
- developing collaborative processes with iCORE, the universities and relevant industry for attracting, screening and selecting candidates

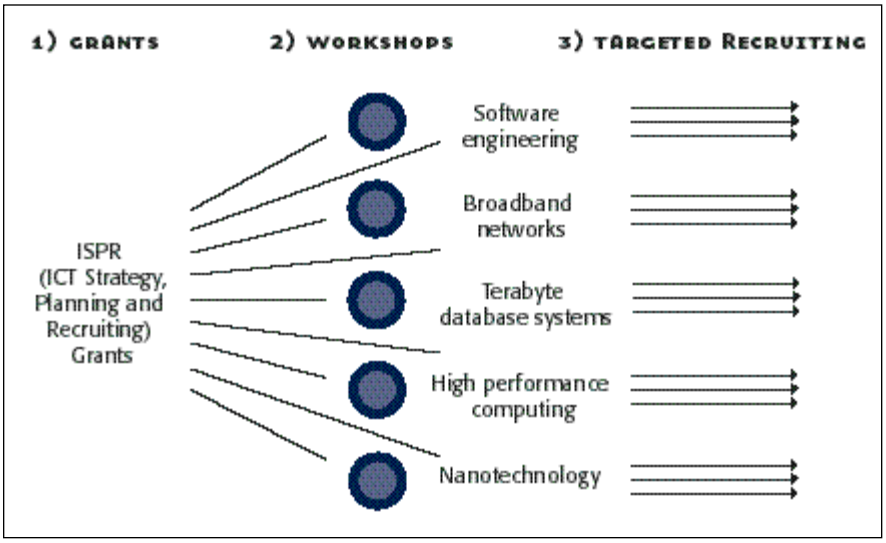
These goals have been incorporated into a recruiting strategy with three components: general recruiting grants, more specialized recruiting workshops, and highly targeted recruiting activities.

Recruiting Grants: The purpose of iCORE recruiting grants is to engage researchers at Alberta universities in the process of identifying and attracting global leaders in ICT research and in the subsequent process of building strong research teams. The recruiting grants, called ISPR (ICT Strategy, Planning and Recruitment) Grants, cover the costs of travel, accommodation or other expenses in support of the development of a proposal for an iCORE chair and associated research team. Grants proposals can be submitted at any time.

Recruiting Workshops: Five specialized recruiting workshops starting in the spring of 2000 explore possible options, configurations and candidates that will lead to the proposals for a chair and associated research team in each of the five target research areas: software engineering, broadband networks including wireless, terabyte database systems, high performance computing, and nanotechnology.

These individually tailored workshops bring together the key figures in Alberta universities, Alberta industry, and selected international thinkers to develop strong,

Figure 5:
Recruiting Strategy



original tactics for building teams of outstanding researchers in each of the research areas identified above.

Targeted Recruiting Activities: Very targeted recruiting activities that emerge from the workshops involve personal contacts and communications that are sensitive to the research needs and competitive factors in specific areas of research. At this level, recruiting is tailored to the needs of the individual invited to join an Alberta university.

5.2 Grant Programs

iCORE operates grant programs to support recruiting for and establishing research teams in the initial targeted research areas. It also operates grant programs to support existing faculty members and attract superior graduate students in ICT research to an Alberta university. These are designed to work in concert to stimulate and upgrade the quality of ICT research in the province. Additional grant programs are being considered to further nurture research excellence that feeds into the development of strong teams.

5.2.1 Chair and Professorship Establishment Grants

The chairs that iCORE will support will have a world-class research record and outstanding research potential in ICT.

The primary goal of the iCORE program is to attract world-class leaders in ICT research to Alberta. Chair and Professorship Establishment (CPE) Grants represent the central iCORE program to fund these outstanding researchers or research teams at Alberta universities.

The Chair and Professorship Establishment (CPE) Grants are intended to fund the salary of an iCORE chair or professor, the salaries of associated research team members including professors, research fellows, postdoctoral fellows and graduate students, and may also cover research operating and equipment costs.

The chairs that iCORE will support will have a world-class research record and outstanding research potential in ICT. Professorships are intended to support senior researchers with outstanding potential.

CPE Grants are intended to be flexible and address a wide variety of needs. The research teams funded will vary in size from a single chair or professor working alone to teams with ten or more members. The research will range from fundamental to applied. Positions funded can include:

- Chairs
- Professors
- Research Fellows
- Postdoctoral Fellows
- Graduate Student Fellows

The requested funding may range from $200,000 to over $1,000,000 per year for periods from two to five years. Shorter term grants can be used for visiting or adjunct professors who will contribute to the building of a world-class team. Proposals are accepted at any time and reviewed as they are submitted.

CPE Grants may be used to complement other programs, such as existing chairs or institutes, or the federal government's new 21st Century Chairs.

It is expected that CPE Grants will be renewable on a competitive basis. Nevertheless, CPE proposals must also contain a transition plan for funding after the initial grant period, in the event that the grant is not renewed.

5.2.2 Research Grants

Whereas iCORE's CPE Grant program is aimed at recruiting outstanding ICT researchers to Alberta, the iCORE Research Grant program is aimed at supporting and retaining exceptional Alberta researchers now working within Alberta. This program recognizes that supporting the very best researchers already in Alberta builds on existing strength and draws new faculty, research fellows, postdoctoral fellows and graduate students into the province. In addition, because ICT faculty members currently have extremely high workloads which limits research activity, this longer-term funding also enables more time for research.

iCORE Research Grants are offered to outstanding ICT researchers who are currently working within Alberta universities and Alberta research organizations. Funds awarded under this program are intended for salaries of research fellows, postdoctoral fellows, graduate students, minor equipment purchases and for other costs of pursuing the proposed research

Through this program, ten to twenty grants of $50,000 to $500,000 per year for up to five years, are awarded. The guidelines, evaluation criteria, review and reporting procedures are modeled on the CPE Grant program. It is similar to the CPE program in every respect except that it does not cover the salary of the applying faculty member.

5.2.3 Graduate Student Fellowships

Graduate students are important to the iCORE program for their role on research teams. A strong graduate student population supports the development of a strong ICT research sector. Graduate students also support the recruiting of chairs and professors, elevate the research reputation and productivity of faculty members, and can develop important roles in Alberta industry.

To support its primary goals of creating strong research teams in Alberta, iCORE must also attract superior students in ICT research to the universities. Therefore, iCORE is offering Graduate Student Fellowships (GSF) to increase the number of high-quality graduate students working in ICT at Alberta universities.

This program supports graduate students in computer science, electrical and computer engineering, and other ICT-related areas, who hold an NSERC Post Graduate Scholarship. Awards are being made to new students in the 2000-2001 academic year.

Through this program, all new computer science and electrical and computer engineering students who hold NSERC Post Graduate Scholarships (PGS) in 2000-01 will be offered additional iCORE awards if they attend an Alberta university. An additional 22 awards will be available for scholarship holders in other areas of science and engineering related to ICT.

Specifically, for recipients of NSERC PGS-A scholarships, an additional $12,000 per year will be granted by iCORE. Those who hold a PGS-B scholarship will receive an additional iCORE award of $15,000 per year. Tenure of these iCORE Graduate Student Fellowships is intended to match the tenure of the NSERC scholarships.

The awards are offered to new students in 2000-01 and will support them for two to four years. The program may be extended to offer the award to new students in 2001-02 or beyond. However, as new iCORE-funded chairs and professors are recruited, this program may be phased out, since graduate students may then be funded through Chair and Professorship Establishment (CPE) Grants.

5.2.1 Recruiting Grants

The ISPR Grant program to support recruiting may be tailored and extended for as long as intense recruiting is required to establish the targeted number of ICT research teams.

The recruiting grants, called ISPR (ICT Strategy, Planning and Recruitment) Grants, fund travel, accommodation or other costs in support of the development of a proposal for an iCORE chair and associated research team. The activities supported by an ISPR Grant includes such things as: bringing in renowned researchers in ICT for workshops aimed at calibrating our understanding of research goals and methodologies in a particular area; organizing thinktanks with invited participants aimed at developing a proposal for a chair; or hosting workshops that explore “grand challenge” projects that may form part of a proposal to create a chair. (ICT research aimed at fire fighting in remote northern areas, or broad support of e-government, are examples of possible grand challenge projects.)

The initial launch of this recruiting grant program consists of approximately ten grants per quarter, starting January 2000, averaging $10,000 each. This level of support is expected to continue each quarter as necessary. Proposals may be submitted at any time. Applications received by the first Wednesday of the month are considered that month. Recipients of ISPR Grants are expected to follow with a CPE (Chair and Professorship Establishment) Grant proposal to build a research team in a given research area. (Chair proposals need not be preceded by an ISPR Grant, however.)

Among the benefits of involving leading researchers in a wide range of recruiting-oriented activities is the opportunity to spread the word about Alberta’s quality

research infrastructure, and significant university, industry and government support for those working in ICT research.

5.3 Selection Process

iCORE uses a four-step selection process to assess proposals for Chair and Professorship Establishment (CPE) Grants, and Research Grants.

1. iCORE receives a proposal. While a proposal may come from any individual, iCORE recommends to the applicant that support from a department head/chair and dean of an Alberta university is crucial for all university appointments. iCORE provides the full proposal to the iCORE Review Committee (iRC) and, at the same time, submits a one-page summary to the vice-presidents, research and academic (VPs) at all three universities. The full proposal is available to the VPs upon request.

2. The iRC reviews and decides whether a proposal is moved forward in the selection process or declined, based on the criteria stated in the grant guidelines. Those selected to move on are forwarded to the iCORE Board, to all VPs, and to the deans and head/chair of the applicant department(s). The full proposal is forwarded to the iCORE External Review Committee (iERC).

3. The iERC evaluates and returns an evaluation report to the iRC. iCORE provides copies of this report to the appropriate VPs, deans, and heads/chairs, and to the iCORE Board, upon request.

4. The iRC makes a final decision to fund the proposal and communicates this decision to the VPs and iCORE Board.

The award recommendations forwarded by the iRC includes all referee reports, comments and evaluations that were produced by the iERC. This ensures an open process when dealing with conflicts of interest, and thus supports making impartial high-quality decisions. It is also intended to support a timely university internal review and appointment decision process. The iCORE secretariat supports close collaboration, where appropriate, among all stakeholders throughout the process.

The iCORE Review Committee screens ISPR applications and recommends funding. Workshops and candidate visits are coordinated with iCORE so that both the workshops and visitors can be supported by iCORE and Alberta Science and Research Authority, and be evaluated by the iRC. ISPR Grant requests are accepted or rejected by the iRC.

5.4 Industrial Strategy

Companies in Alberta comprising the ICT corporate community are of vital importance to the program success of iCORE. Therefore, it is a priority of iCORE to foster the relationship with industry and establish “partnerships” with companies whose corporate objectives are aligned with iCORE target research areas, both present and future. The broader the base of collaboration and cooperation in the recruitment process and subsequent support of selected chairs and research teams, the more successful will be the resulting research activity. ICT companies, whether large or small, will be actively encouraged to play meaningful roles in one or more of the following areas:

Recruitment

- actively participate in the recruitment process in those areas of target research that are strategically important to the corporate objectives of the company
- assist in identifying target research areas that have compelling demand within the marketplace
- assist in developing recruitment processes that are responsive to industry criteria
- identify potential candidates for chairs and related research teams

Support

- partner with iCORE as a funder for chairs and research teams that reflect corporate objectives
- provide support “in kind” to facilitate specific research activity
- collaborate with iCORE supported research teams to pursue common research goals

Advisory

- serve as industry representatives on iCORE committees and boards

The benefits that iCORE believes will accrue to participating ICT companies are:

- corporate profile as an industry leader in research activity and support
- a close working relationship with research teams at all levels
- an opportunity to influence the target areas of research to reflect corporate objectives
- potential opportunities for human resource recruitment from graduate and postgraduate students associated with the related research activities

Partnerships with key industry leaders will benefit iCORE and the universities by:

- ensuring that priority research areas reflect the needs and opportunities of the marketplace, present and future
- adding credibility to the iCORE programs, to Alberta universities and to the iCORE research teams
- providing collaborative support and synergy through active and direct participation of corporate researchers with iCORE supported research teams
- providing leverage for funding support from other government agencies and industry players

In order to aggressively pursue the industry partnership objectives described above, iCORE has appointed a Director of Corporate Relations. It is the responsibility of this person to foster relationships that further iCORE’s goal of collaboration and cooperation with its industry, university and government stakeholders in the interest of overall success of its programs.

The messages that iCORE conveys to its audiences reflect its core values, which are based on a belief in:

• Excellence
• Vision
• Leadership
• Balance

5.5 Communications Plan

iCORE is the Alberta Government's key initiative to establish this province as a national and international leader in ICT research. The communication plan is designed to ensure that iCORE communicates its key messages to its stakeholders. As a publicly funded program operating in a highly competitive environment, iCORE has three very distinct communication goals. First, it must enable and facilitate the successful recruitment and establishment of world class research teams. Second, it must document and communicate program goals, progress and successes to its primary stakeholders – government, universities and industry. Third, it must contribute to the positioning of Alberta as a world centre of excellence in ICT research.

The communication plan emphasizes communication strategies and tasks to directly support the realization of iCORE program goals and objectives, which are to:

- attract internationally respected researchers to Alberta
- increase awareness and support for the program among ICT researchers, particularly existing Alberta ICT researchers
- garner support and involvement among Alberta universities in programs and the recruiting process
- attract participation and support from Alberta industry
- demonstrate success of the program to stakeholders
- develop public awareness of and support for iCORE's role in creating benefits for all Albertans

iCORE has several different audiences to whom it communicates. For each of these audiences, specific but complementary key messages help to shape the campaigns for reaching the targeted audiences.

The primary spokesperson for the organization is the President. In his or her absence, the spokesperson is the Chair of the Board, Director of Corporate Relations or Director of Programs. iCORE's media materials are developed in consultation with the communications department of the Ministry of Innovation and Science to ensure consistent messaging with government objectives for the program.

The communication plan emphasizes strategies and tasks to directly support the realization of iCORE program goals.

Primary considerations and challenges must be taken into account in the communications plan, including the current global demand for quality ICT researchers and the competitive levers that other institutions and governments are utilizing to attract and maintain a level of excellence in their respective areas of ICT research.

5.6 Operations Plan

The operations of iCORE consist of five areas: business governance, secretariat operations, program development, researcher recruiting, and financing operations for sustainability. Plans for iCORE operations in these areas for years 2000 to 2002 are:

Business Governance

- establish board meeting schedules, procedures and communications processes
- review governance by-laws and legislation

- establish reporting relationship with ASRA
- determine relationship with AHFSER
- establish International Program Review Committee for year three

Secretariat Operations

- establish banking, accounting, auditing, contractual and legal management procedures
- complete ARC negotiations and renovations for secretariat offices
- develop operations manual
- manage extranet and an internal communications intranet
- monitor program performance
- ongoing and annual business planning and reporting

Program Development

- maintain composition, schedules, procedures and communications for review committees, iRC and iERC
- publish guidelines and criteria for chair program (CPE), recruitment program (ISPR), graduate student program (GSF), and research program (RG)
- manage contract and reporting relationships between iCORE and the researchers and the universities

Research Recruiting

- review ISPR applications, awarding grants in January, 2000
- review CPE candidate proposals starting in March 2000
- target NSERC PGS award holders with Graduate Student Fellowship and Alberta university information campaign starting in March 2000
- review RG candidate proposals starting in June 2000
- hold workshops in key focus areas to bring the stakeholders in the province together to determine a cooperative plan for recruiting researchers.

Financing Operations

- establish funding agreement with ASRA for secretariat and program funding
- pursue partnering arrangements with universities on co-funding positions
- pursue opportunities for significant federal contributions
- pursue opportunities for industry sponsorship of chairs, research projects, and in-kind contributions

6 Accountability

iCORE enters into a contract with each award recipient that specifies performance measures and deliverables. Quarterly financial reports and comprehensive annual progress reports are required of all recipients. Award recipient annual reports, and the iCORE aggregate annual report, define progress against the results of research activity funded by iCORE.

The iCORE program has three levels of performance evaluation – the overall program, the research team, and the individual research investigator. Performance measures are defined at each of these levels.

6.1 Process Performance Measures

During the first two to three years, performance is measured against a number of milestones defined within the recruiting and selection process.

Initially, iCORE's performance is measured against specific milestones in the recruiting, selection and funding of outstanding ICT researchers. These initial milestones are:

- Develop and implement a strategic communications plan from January 2000 through 2002 with the objective of raising the national and international awareness of Alberta's ICT.

- Launch grant programs to initiate Alberta-based recruiting efforts (ISPR Grants), establish chairs and professorships and associated research teams (CPE Grants), attract top graduate students (GSF program), and retaining existing faculty members (Research Grants).

- Chair and Professorship Establishment Grants
  a) announce the first two chair appointments by September 2000, another two by March 2001, and two more by September 2001.
  b) first chairs start working in Alberta by January 2001.
  c) appoint a complement of research team members within one year of each chair appointment.

- Research Grants
  a) announce the first Research Grant by September 2000, another by March 2001, and two more by September 2001.
  b) announce up to 20 awards each year, beginning in 2001-02.

- Graduate Student Fellowships program
  a) attract an additional 20-25 NSERC PGS award holders in ICT-related areas to support a total of 70 at Alberta universities in the academic year 2000-01.

- ICT Strategy, Planning and Recruiting Grants
  a) select and fund 6 to 10 high-quality applications that support the recruiting process by July 2000, and 12 to 15 per year during 2000-02.
  b) organize and/or participate in 3 to 6 ISPR workshops that explore

research program options, grand challenge projects, and candidates by July 2000, and eight to ten workshops per year during 2000 through 2002.

6.2 Outcome Performance Measures

An International Program Review Committee (IPRC) appointed by the Board will evaluate the program after the first three years, and thereafter every five years.

After the first two to three years, performance measures that assess progress against research activity are to developed. iCORE's progress and performance are to be measured and reported annually against these measures. The iPRC also uses these performance measures for the third year, and subsequent, five year, program evaluations.

These performance measure are to assess:

- quality of research being conducted
- associated innovation and potential socioeconomic impact of research
- training, education, and skills development resulting from iCORE investment
- collaboration and networking with national and international researchers working in related areas
- collaboration with industry
- other funding acquired over and above iCORE's investment
- the transfer of knowledge to the community, industry and government

A study to benchmark the current state of ICT research within the Alberta universities and selected North American universities is currently being undertaken. The report will contain detailed information on faculty, students, research funding, facilities, research focus areas, and incentive programs for faculty and graduate students in computer science and electrical and computer engineering at the following universities: University of Alberta, University of Calgary, University of Lethbridge, University of British Columbia, University of Waterloo, University of Toronto, Queen's University, Carleton University, Stanford University, University of Texas at Austin, University of Utah. This study will be used to measure and compare the performance of iCORE and its Alberta-based ICT programs. The first benchmark report will measure the state of ICT research in Alberta universities as of March 2000.

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