iCORE STRATEGIC PLAN 2003

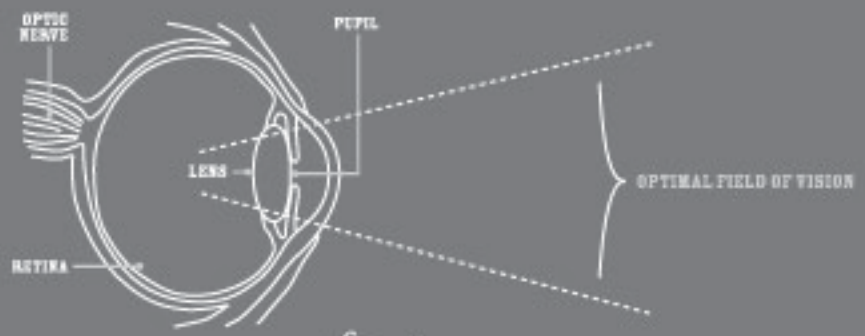


fig. 3
VISION AND FOCUS

BUILDING ON SUCCESS

ALBERTA INFORMATICS CIRCLE OF RESEARCH EXCELLENCE

Executive Summary

In the midst of intense competition for research dollars, informatics is an area of research, development and commercialization that warrants special attention. Informatics is an enabler of success in all of Alberta's economic sectors, in particular, in energy, agriculture, forestry, health, education, and the environment.

iCORE is part of Alberta's 1998 information and communications technology (ICT) strategy and action plan. Key Alberta ICT goals defined in this plan are 140,000 jobs, $1.5 billion in R&D, and $30 billion in revenues by 2010.

iCORE has met or exceeded all of the goals defined in its business plan to date:

- 13 internationally recognized research teams are active, including 33 faculty members and 203 graduate students and postdoctoral fellows.
- An additional 138 of Canada's best graduate students are currently funded by iCORE and 196 have been supported as of March 2003.
- Alberta's percentage of Canada's best graduate students in ICT has increased from 11.3 percent before iCORE existed to 24 percent in 2002-03, a doubling in three years.
- iCORE has granted $27.8 million in awards through March 2003, which has secured total commitments of $222.5 million for ICT research and development within Alberta.

Given the momentum that has been achieved, it is becoming clear that Alberta can achieve critical mass in ICT, and reach its ICT goals for 2010, *provided this momentum is sustained*. This iCORE 2003-2010 Strategic Plan outlines a way to sustain that momentum. This plan proposes building on programs that have been demonstrably successful. Specifically:

- Sustained focus with the potential for one-time renewals in our Chair and Professor Establishment (**CPE**) program, particularly in areas that support cluster formation.
- Increased outreach to industry through the Industrial Chair Establishment (**ICE**) program to accelerate technology commercialization and further increase the leverage of iCORE funding from federal and industry sources. This outreach will focus on informatics areas central to applications of high importance to Alberta, *particularly in energy and the life sciences*.
- Moderate growth in support for iCORE's spectacularly successful Graduate Student Scholarship (**GSS**) program.

Two budget scenarios are presented in this plan.

***Base budget* involves significant risk**

The *base budget* of $10 million per year through 2010 continues a reduced CPE program with support for renewals limited to 50 percent, continues the ICE program at half the current level, and terminates the GSS program after 2005-06. The reason a flat $10 million budget requires drastic program cuts starting in 2005-06 is because that is when the first major awards will begin to come up for renewal. This base budget plan therefore risks losing the benefits of past investment, for example, losing several of the exceptional researchers that have been attracted to Alberta, and failing to achieve critical mass.

***Realize goals budget* achieves Alberta's ICT targets**

A second *realize goals budget* increases the annual budget to $14.5 million in 2005-06. This proposed budget sustains the CPE, ICE and GSS programs at current levels. It addresses the need to renew our most successful grant recipients for a second period. It is certain to achieve critical mass in several ICT areas of high importance to Alberta, and it maintains the momentum needed to achieve the province's ICT goals.

Clear evidence of the continued central importance of ICT is reflected in the 2003 US National Science Foundation's Blue Ribbon Advisory Panel's Report on Cyberinfrastructure "Revolutionizing Science and Engineering through Cyberinfrastructure":

The Panel's overarching finding is that a new age has dawned in scientific and engineering research, pushed by continuing progress in computing, information, and communication technology [**ICT**], and pulled by the expanding complexity, scope, and scale of today's challenges. The capacity of this technology has crossed thresholds that now make possible a comprehensive "cyberinfrastructure" on which to build new types of scientific and engineering knowledge environments and organizations and to pursue research in new ways and with increased efficacy.

Such environments and organizations, enabled by cyberinfrastructure, are increasingly required to address national and global priorities, such as understanding global climate change, protecting our natural environment, applying genomics-proteomics to human health, maintaining national security, mastering the world of nanotechnology, and predicting and protecting against natural and human disasters, as well as to address some of our most fundamental intellectual questions such as the formation of the universe and the fundamental character of matter.

The amounts of calculation and the quantities of information that can be stored, transmitted, and used are exploding at a stunning, almost disruptive rate. Vast improvements in raw computing power, storage capacity, algorithms, and networking capabilities have led to fundamental scientific discoveries inspired by a new generation of computational models that approach scientific and engineering problems from a broader and deeper systems perspective. Scientists in many disciplines have begun revolutionizing their fields by using computers, digital data, and networks to extend and even replace traditional techniques. Online digital instruments and wide-area arrays of sensors are providing more comprehensive, immediate, and higher-resolution measurement of physical phenomena. Powerful "data mining" techniques operating across huge sets of multidimensional data open new approaches to discovery. Global networks can link all these together and support more interactivity and broader collaboration....

Achieving this vision will challenge our fundamental understanding of computer and information science and engineering as well as parts of social science, and it will motivate and drive basic research in these areas. We envision radical improvements in cyberinfrastructure and its impact on all science and engineering over time, as work ripens at the intersection of fundamental social and technical research about cyberinfrastructure and its application to advance discovery and learning....

A vast opportunity exists for creating new research environments based upon cyberinfrastructure, but there are also significant risks and costs if we do not act quickly and at a sufficient level of investment....

Contents

Figures and Tables

About the ICT Research Advisory Committee (IRAC)

iCORE is guided by an international information and communications technology (ICT) Research Advisory Committee, called the IRAC.

The recommendations of the IRAC have shaped the direction and tenor of this plan. Excerpts from recent IRAC reports are included throughout this document.

IRAC members are:

Dr James Gosling
Chief Scientist, Java, Vice President and Fellow
Sun Microsystems

Dr David Jefferson
Computer Scientist,
Lawrence Livermore National Laboratory

Dr Eric George Manning
Professor, Computer Science,
University of Victoria

Dr William R. Pulleyblank
Director of IBM Exploratory Systems
IBM Research

Dr Richard E. Taylor
Professor
Stanford University and Nobel Laureate

1. Alberta's ICT Sector in 2003

In 1998, a task force of the Alberta Science and Research Authority defined a strategy and action plan for the Information and Communications Technology (ICT) sector. iCORE's role in this provincial plan is to recruit and fund "exceptional researchers" in ICT (or informatics) at Alberta universities. This visionary strategy is based on the simple truth that exceptional people produce exceptional results.

This plan reflects a commitment to diversifying and strengthening a sustainable Alberta economy. Support for this visionary plan comes from many sources, for example, the April 2003 Report on the Calgary-Edmonton Corridor produced by TD Economics:

> Given all of its assets, the Corridor enjoys enormous potential – not only to widen its economic lead within Canada, but to become the region that stands out as the most prosperous and best place to live in all of North America. However, vulnerabilities also exist in the regions' still-high reliance on its important oil and gas industry.

The report suggests that increasing success in the information and communications technology sector is part of the Corridor's "winning formula" contributing to the buzz about Alberta.

The ICT sector leads economic growth worldwide, and it enables growth in nearly all other major sectors of the economy including: energy, agriculture, forestry and the environment, as well as social development, particularly in health and education. Over half of Alberta's fastest growing companies are in this sector[1] despite the perception that the ICT sector is in decline. The strong growth of ICT in the toughest economic times suggests that ICT will become even more central in Alberta's future.

[1] Alberta Venture *survey of the top 30 fastest growing companies in Alberta (January/February 2003).*

This strategic plan sets a course for iCORE from the present through 2010. It suggests that four to six chairs and associated teams must be created in a given target area in order to achieve world-class stature and the benefits of critical mass. This means an increase in funding will be required in 2006 to maintain the momentum of iCORE's success. Failing to do so will expose Alberta to risks that can undo the success of the plan to date.

1.1. ICT is a Special Case Enabler

As many indicators suggest, it is essential to treat ICT as distinct from other sectors from an economic development standpoint.

* Annual growth in the ICT sector has been 14% since 1997 compared to 3.5% for the economy as a whole (despite 0.6% growth for ICT in 2001).

* Fast growth of the ICT sector means that it has accounted for 20% of the GDP growth since 1997.

* Employment has also experienced strong growth. The number of jobs in ICT industries increased 43% in 1995 to 2000.

* Most job gains have occurred in software and computer services, where there were two times more jobs in 2000 than in 1995.

* In 2001, R&D expenditures in ICT reached $5.3 billion, 46% of total Canadian private sector expenditures on R&D.

Compared to the national context, Alberta's profile contains some mixed messages, and clearly points to areas where additional focus is required.

* Alberta had the highest income per capita in Canada in 2000, and was the only province to outperform the U.S.

* Alberta's corporate income tax rate by 2005 will be the third lowest in Canada after Ontario and Quebec.

* Combined federal-provincial corporate income tax rate compares favorably with the U.S.

* However, venture capital investment in Alberta has decreased each year since 1998, with just 2.4 percent of the Canadian total in 2001.

* Notably, 60% of the Alberta venture capital invested was in ICT.

* Alberta's gross expenditures on R&D divided by GDP is half that of Canada as a whole, and one third that of the US.

* Despite a major international downturn, the number of people employed in the Alberta ICT sector has been roughly constant in the past 2 years.

* 70% of R&D investment by Alberta's 30 fastest growing companies is in ICT.

Overall spending on research and development (R&D) as a share of GDP in Alberta stands at roughly half the level recorded in Canada. TD Economics report on the Calgary Edmonton Corridor (April 2003).

The business climate indicates that spinout industry resulting from R&D can be achieved. However, the gap that needs to be filled in Alberta's ICT sector includes encouragement and support of technology commercialization, investment in R&D by the private sector, and further investment in research and education.

Commercialization of new research is largely licensed elsewhere. One idea put forward to explain this is that a critical flow of deals outside the energy sector is required to warrant the establishment of venture capital, which is strongly linked to innovation and commercialization. That is, there is a need to increase the generation of ideas, from research through to pre-commercialization, in order to attract the capital to turn these ideas into viable new businesses.

iCORE can help to address this gap by building partnerships and confidence in the people and research that is undertaken in ICT in Alberta and forming early links between researchers, graduate students and industry in Alberta.

1.2. iCORE'S Role

iCORE is paying specific attention to the role of ICT in the innovation system through its focus on several key objectives:

* Attract and fund top researchers in focused target research areas, with a concerted aim to achieve a critical mass.

* Attract and fund a substantial number of the best graduate students in ICT to support high quality research and to feed local industry needs.

* Increase linkages between the university research teams and industry in order to commercially exploit research results locally.

* Foster investor confidence in the ICT sector in Alberta through awareness of the expertise and support available for ICT research in the province.

1.3. Success to Date

As of March 2003, iCORE has achieved major successes toward supporting the realization of Alberta's ICT goals. All iCORE target goals have been met or exceeded:

* iCORE has made $27.8 million in awards to date. This funding has attracted an additional $73.4 million where an iCORE Chair has been the prime recipient ($31.4 million federal, $13.6 million provincial, $22.4 million industry), and another $121.3 million where the iCORE Chair has been a significant contributing influence ($61.3 million federal, $60 million provincia).

* 13 research teams are in place, which include 33 faculty and 203 graduate students and postdoctoral fellows. The team members are funded by various sources, including the iCORE, NSERC, the universities, and others.

* 138 of Canada's best graduate students (recipients of federal Natural Sciences and Engineering Research Council [NSERC] awards) are currently supported by iCORE and 196 have been funded to date.

* Alberta's percentage of Canada's NSERC graduate student awards in computer science and electrical and computer engineering has increased from 11.3 percent in 2000, to 14 percent in 2001, to 21 percent in 2002, to 24 percent in 2003.

* The University of Alberta department of Computer Science is now #1 in Canada in the attraction of Canada's best graduate students (NSERC award holders) and the University of Alberta and the University of Calgary are now #2 and #3 in Canada in the attraction of NSERC Masters students in Electrical and Computer Engineering.

* iCORE Chairs and their teams have created substantial intellectual property in the form of research papers, patents, and partnerships.

* iCORE Chairs hold six Canada Research Chairs, three Steacie Fellowships, and two were inducted into the Royal Society of Canada this past year.

Major impact is now evident in:

* The expansion of the ICT sector in Alberta, which is now making up over half of the fastest growing companies in the province, despite an economic downturn.

* Widening application of ICT as an enabler for all of Alberta's sectors, including energy, agriculture, forestry, health, education, and the environment.

2003 IRAC Report

ICT opportunities in the energy sector (oil & gas exploration and production)

- **Distributed/immersive 3D/4D visualisation**
- **Field data acquisition and control**
- **Integration of diverse data**
- **Archiving/retrieval of project knowledge**
- **Reservoir modelling**
- **Bitumen extraction optimization**
- **Seismic processing and interpretation**
- **Storage management**
- **Analytic analysis of complex decisions**

ICT challenges in the energy sector, addressed in iCORE's target research areas

- **Management of massive amounts of data, data assimilation and mining, data conversion, integration and audit**
- **Real time collection of data**
- **Security and privacy of information**
- **Communications – wireless and broadband**
- **Sensing, monitoring**
- **Visualization/Presentation of results**
- **High performance computation**
- **Control systems**
- **Management of explicit and tacit knowledge, metadata and machine intelligence**

* Greater collaboration ensuring response to market direction and government strategic objectives as demonstrated by the industry uptake of iCORE's Industry Chair program.

* Greater opportunities perceived for highly skilled workers and students, such that 24 percent of the top students in Canada in computing science and electrical and computer engineering are choosing to do their graduate studies in Alberta.

* The formation of clusters of critical mass of expertise and real and potential industry in emerging high-tech areas.

Significant clusters have been formed in networks and wireless communications, nanoscale and quantum informatics, and a third cluster in intelligent software systems is beginning to emerge.

Figure 1: Emerging Clusters

1) Networks and Wireless Communications	start date
Wireless Communications (Dr Norman C. Beaulieu)	2000-01
Advanced Technology Information Processing Systems (Dr Graham Jullien)	2000-01
Wireless Location Research (Dr Gérard Lachapelle)	2000-01
Broadband Wireless Protocols, Application and Perfomance (Dr Carey Williamson)	2000-01
Wireless Internet Traffic Modeling (Dr Carey Williamson)	2001-02
High Capacity Digital Communications (Dr Christian Schlegel)	2001-02
Algorithmic Number Theory and Cryptography (Dr Hugh Williams)	2001-02
Wireless Science and Technology (Dr Jim Haslett)	2002-03
2) Nanoscale and Quantum Informatics	
Nanoscale Engineering Physics (Dr Michael Brett)	2000-01
Nanoscale Engineering Physics (Dr Mark Freeman)	2000-01
Nanoscale ICT (Dr Robert Wolkow)	2002-03
Quantum Information Science (Dr Barry Sanders)	2003-04*
3) Intelligent Software Systems	
High Performance Artificial Intelligence (Dr Jonathan Schaeffer)	2000-01
Software Engineering Decision Support (Dr Guenther Ruhe)	2001-02
Reinforcement Learning (Rich Sutton)	2003-04*
Intelligent Oils Sands Mining Systems (Hong Zhang)	2003-04*

* new in 2003-04

iCORE's efforts in these areas are aligned with clusters identified by Calgary Economic Development, and to some extent Economic Development Edmonton, as rapidly-growing economic sectors that warrant special attention.

1.4. Key Strategic Elements of iCORE's Success

The most important elements of iCORE's structure and operation that have contributed to its success include:

* **CLEAR FOCUS**: iCORE recruits and funds exceptional people in targeted research areas of high relevance to Alberta industry.

* **CRITICAL MASS**: iCORE supports teams, collaborations and outreach with industry and other partners to build a significant presence in each research area.

* **RESPONSIVE PROCESS**: iCORE has developed effective recruiting processes that directly involve the universities, and flexible, timely decision procedures that include world class arms-length refereeing for all award decisions.

* **EXTENSIVE PARTNERSHIPS**: iCORE has built mutually beneficial partnerships with organizations, programs, projects and industry, including: Alberta Ingenuity, Alberta Heritage Foundation for Medical Research, Inno-Centre, Natural Sciences and Engineering Research Council (NSERC), Canada Foundation for Innovation, Canada Research Chair program, National Institute for Nanotechnology, Netera Alliance, TRLabs, WestGrid, Telus, Syncrude, and others.

1.5. Year One Case Study: Twelve-Fold Economic Impact

The impact analysis shows that there has been a *fourteen-fold* return on the iCORE investment, plus vastly expanded influence on the ICT sector in Alberta through the energy and vision of the iCORE-funded research leaders.

This plan is shaped by the evident impact of iCORE's first year and what it foretells for the value of continuing this momentum.

Figure 2
Case Study
Impact of
iCORE's First Year

Researcher	Additional Funding Attracted	Activity
Norman Beaulieu $3.5 M iCORE	$ 3.34 M	58 team members 10 research collaborations 4 industry collaborations Editor of leading journal
Graham Jullien $3.6 M iCORE	$ 1.1 M	30 team members 16 research collaborations 10 industry collaborations 3 multidisciplinary collaborations Spinoff company: in development
G rard Lachapelle $2.5 M iCORE	$2.77 M	42 team members 8 research collaborations 9 industry collaborations $2 million in licensing agreements
Jonathan Schaeffer $2.5 M iCORE	$48 M	40 team members 3 research collaborations 3 industry collaborations Co-leader of $48 million WestGrid project Part of Alberta Ingenuity Centre for Machine Learning Spinoff companies: Biotools, Chenomx
Michael Brett/Mark Freeman $2.5 M iCORE	$134 M	57 team members 6 research collaborations 4 industry collaborations Part of $120 million National Institute for Nanotechnology Spinout company: ChiralTF Devices Inc.

iCORE aims are closely aligned with the goals of the universities to achieve excellence in informatics research

The University of Alberta aims to be indisputably recognized, in teaching, research, and community service, nationally and internationally, as one of Canada's finest universities, and amongst a handful of the world's best.

The U of A's goals and objectives for ICT are to build on strength in areas of established and emerging research excellence, specifically:

- Communications and Software Engineering
- Intelligent Systems and Control
- Nanoscience and Technology

from the University of Alberta presentation on information and communications technology (ICT) and R&D at the U of A to the Ministry of Innovation and Science ICT Advisory Committee, September 2003

The University of Calgary academic plan identifies four areas of strength in which it plans to build and for which it expects to be pre-eminent.

One of these is looking at new methods of processing information effectively and developing new technologies. Within this theme, three pillars have been identified as having outstanding or emerging strength:

1) Quantum Information and Cryptography
2) Wireless Communication, Location and Microelectronics
3) The Social Contexts for Technology

from Raising Our Sights*, Academic Plan 2002-06, University of Calgary and* Pillars of Prominance *Report to the President from the Academic Plan*

At the University of Lethbridge,unique and specialized research opportunities exist – from small lab and seminar classes which involve senior students in original research to independent studies where a student can work one-on-one with some of the nation's leading experts .... Getting approval for a PhD program recently is something that does not happen often at universities of this size, and it is reflective of the strong international reputation in the research community.

from the University of Lethbridge web site 2003

2. Strategic Plan

The essence of this strategic plan is to build on success, so that the province's goals of critical mass in ICT research, employment and industry can be achieved. Studies and planning to date have shown that in order to develop strong economic results and vibrant associated industry, a limited number of research areas must be targeted in which Alberta can reasonably expect to achieve internationally competitive university-based informatics research. These must be high-growth ICT segments – such as wireless applications, nanotechnology and intelligent software systems. As the first section of this strategic planning document demonstrated, iCORE is committed to this and is achieving the anticipated results.

In this section of the plan, we describe how to build on this success and protect the investments already made. This plan reiterates the critical mass target identified as central to the success of Alberta's ICT strategy, and describes the steps necessary to achieve it.

2.1. Critical Mass Target

* A certain threshold of activity must be achieved to create and sustain a culture of research excellence that will attract and retain a dynamic critical mass of exceptional informatics researchers.

* The consensus reached through a series of workshops and meetings held with the iCORE board, universities, industry and ICT committees is that achieving international recognition for Alberta research in ICT will require an ongoing commitment to at least 10 percent of total informatics-related faculty.

* Additional funding for new awards annually and for renewed awards to excelling teams is required to sustain this threshold.

* We are nearing a critical mass in some targeted segments of ICT.

This critical mass target will be achieved through the following strategies.

2003 IRAC Report

Definition of critical mass

There are currently 30 to 45 faculty members in Computer Science and Electrical and Computer Engineering departments at Alberta universities. Each department has plans to grow so that there will be approximately 60 faculty members in each department by 2010.

The committee felt that minimum critical mass that would increase the potential for excellence in each department is:

- **10 percent of total faculty**
- **this is equivalent to 25 Chairs**

More would be better.

2.2. Focus on Target Research Areas

Targeted segments that are strengths in the ICT sector of Alberta have been identified by iCORE through ongoing consultation with its many stakeholders and advisory groups. iCORE's target research areas have been revised to update the areas supported by its flagship Chair and Professorship Establishment (CPE) grants program.

The target research areas of interest for the CPE program

networks and communications (for example, wireless communications, Internet protocols, protocol design and performance analysis)

high performance computing (for example, grid computing, very large database systems, distributed systems and computational science)

human and computer interfaces (for example, computer graphics, multimedia, collaboration, the Web, privacy, cryptography and secure systems integration)

intelligent information systems (for example, artificial intelligence, machine learning, data mining, and data integration)

software systems (for example, system design, development, tools, and evaluation; embedded and distributed systems)

new architectures and devices (for example, quantum computing, molecular computing, and nanocomputing)

iCORE's other major program, Industrial Chair Establishment (ICE) grants, can also be made in "application" areas that can be outside the above core areas of informatics, for example, bioinformatics and geoinformatics. These ICE grants are awarded in collaboration with other funding partners such as industry and NSERC. Industry Chair application areas will support and enable advances in other important Alberta sectors, particularly in the energy and environment areas.

The CPE program is restricted to funding iCORE Chairs and Professors who are recruited to Alberta research universities as part of the grant. In contrast, current Alberta university faculty members are eligible for the ICE program. NSERC is normally involved with ICE awards and their grant rules stipulate that a new junior position be created in the same research area as the chair. Thus, an award to a current faculty member also results in the creation of a new position in the research area. In addition, the participation of industry partners and their funding ensures market relevance and commitment.

2.3. Strengthen Current Programs

iCORE accomplishes its goals through three primary grant programs, which are supported by outreach activities.

Current core programs

Chair and Professor Establishment (CPE) Grants

* Designed to recruit world-class and mid-career leaders with exceptional potential.
* Typically based on a five-year research program that may be renewed once.
* An average of two new awards annually, one at the Chair level and one at the Professor level, plus renewals.
* Strategy: further refine target high-growth segments of ICT in which Alberta industry and Alberta universities can be global leaders.

Industry Chair Establishment (ICE) Grants

* Designed to jointly fund with industry and NSERC outstanding faculty with a strong industrial interest and track record. Funding and active participation by an industry partner is required.
* Typically based on an initial five-year research program.
* Two new awards annually.
* Strategy: iCORE will focus on areas that offer the highest potential for industrial revenue growth, in particular, on informatics research programs that support R&D progress in energy, the environment and the life sciences. This program is aimed at the early commercialization of research results.

Graduate Student Scholarships (GSS)

* Designed to recruit exceptional graduate students to Alberta.
* Operates in conjunction with NSERC and Alberta Ingenuity.
* Up to two hundred awards annually.
* Strategy: increase budget allocation for this program. There are several ways this program could be expanded, depending on the budget available. For example, many excellent international students are currently ineligible and other high quality awards in addition to NSERC and Alberta Ingenuity could be recognized.

The major programs are supported by activities that support team building, collaboration, excellence and industry interaction.

Visiting Professor (VP) Grants

* Designed to bring internationally recognized researchers to Alberta for six months to two years to develop partnerships and possibly recruit Chairs or Professors.

* Strategy: increase activity in this award program to further Alberta's participation in targeted global research programs, and to support recruiting efforts.

ICT Strategy Planning and Recruiting (ISPR) Grants

* Designed to support the interaction with potential candidates for the major award programs.

* Supports ICT conferences and workshops in the province in areas where a Chair or Professor award may be made.

* Strategy: support focus and visibility in target research areas.

Lecture Series

* A monthly lecture by an iCORE Chair held at a host university and broadcast live to the other universities, technical schools and some colleges in Alberta via the Alberta Video Classroom Network. Also available as a webcast.

* Strategy: increase publicity efforts aimed at industry to increase opportunities for interaction between researchers in university and industry.

iCORE Banff Informatics Summit (iBIS)

* A new annual event that will begin in 2004. This annual week-long think tank of Alberta and international ICT researchers will include a meeting of iCORE's current ICT Research Advisory Committee (currently consisting of Dr. James Gosling, Dr. Richard Taylor, Dr. William Pulleyblank, Dr. David Jefferson, and Dr. Eric Manning), a meeting of iCORE's board of directors, and will also include a focused workshop bringing iCORE researchers and industry together to work on current issues in ICT research.

* Strategy: create framework for iCORE Chairs to organize annual thematic workshops, to foster regular interaction among iCORE research teams and industry, and to increase the visibility of Alberta ICT R&D.

2.4. Strengthen Internal Processes

* iCORE will focus its recruiting efforts on the revised target areas that represent potential high-growth ICT segments for Alberta industry.

* A panel of internationally recognized experts in ICT – the ICT Research Advisory Committee (IRAC) – will advise iCORE's board and secretariat on target areas, strategies and programs. This committee is also available to provide advice to other provincial bodies on ICT objectives, strategies and programs.

* iCORE will continue to ensure timely high-quality arms-length review of candidates and proposals. Within the ICT sector quick decisions are often crucial, thus proposals will be accepted at any time with monthly reviews.

* iCORE will continue to work with the Alberta government and its ministries to address the retention of top Alberta university faculty, and the funding of indirect costs of research associated with iCORE's programs.

2.5. Develop Long-term Industry Collaboration

* iCORE will focus on areas of industrial research activity where Alberta can become an international player – areas that are clearly sensitive to market needs and opportunities, sufficiently narrow in scope and around which there is existing or emerging local industry strength and potential.

* iCORE will identify and support the faster growth areas that exceed or are likely to exceed general levels of growth in ICT.

* The priority areas are acted upon through the Industry Chair Establishment (ICE) program whereby individual corporate goals for focused research activity can be met through participation in the selection and development of the research team and its work with substantial leveraged financial support. The benefit of the program to industry, researchers and Alberta is a fast tracked market responsiveness that provides the "first links" of the technology commercialization chain.

* Other key strategies to establishing industry relationships include: establishing annual high level Summits involving iCORE Chairs, research teams, graduate students and international researchers together with industry partners and potential partners; fostering direct research relationships between specific industry players and iCORE Chairs and research teams; an enhanced iCORE lecture series with select industry presence and participation; and, specific outreach support for industry partners from iCORE research teams.

* Through these programs and outreach efforts, a "critical mass" of research capability will evolve around industry partners responding to high growth market opportunities and corporate needs. "First links" will be established towards commercialization of technology with the establishment of intellectual property, formation of spin-off companies and further links to incubation, mentoring and financing opportunities through partners such as Inno-centre Alberta and other Alberta technology commercialization agencies.

2.6. Strengthen Partnerships with Complementary Programs

* iCORE will build on cumulative activity with other funding agencies, industries and organizations, recognizing that no single government investment program or technology commercialization organization can provide the climate in which thousands of little decisions must be made in Alberta's favour.

* Increased coordination and effectiveness among provincial ICT initiatives, such as iCORE, Inno-Centre, TRLabs and the Netera Alliance, may be possible. iCORE is exploring mechanisms for achieving this with these organizations. One approach may be the creation of an institute whose mandate covers the spectrum of recruiting excellence, funding research, supporting collaborative university-industry research, and technology commercialization.

* Collaborative programs and cooperative projects with Alberta Ingenuity, Alberta Heritage Foundation for Medical Research, TRLabs and others will continue to be developed, and new relationships will be built with Alberta Energy Research Institute (AERI), Alberta Agriculture Research Institute (AARI), and Alberta Forestry Research Institute (AFRI) to respond to Alberta's economic strategy in energy and the environment.

* iCORE will join with industry and NSERC to support research in ICT at Alberta universities through its Industrial Chair Establishment (ICE) grant program. Chairs, Professors and their associated research teams are appointed in collaboration with Alberta universities, NSERC and industry partners.

* iCORE will work with Alberta Inno-Centre and other technology transfer organizations in the province to ensure that its researchers have knowledge and access to commercialization processes.

* Much of the success in the development of Alberta's energy and agricultural resources is due to ICT applications that provide value-added and global competitiveness. iCORE will pursue opportunities to work with research organizations such as AERI, AARI and AFRI to further those successes.

iCORE collaborates with a number of organizations collectively establishing the reputation of Alberta as an advanced place for ICT research and business, including:

ALBERTA INGENUITY: iCORE works with Alberta Ingenuity to attract the best graduate students in Canada working in ICT to Alberta universities and supports other initiatives within Alberta Ingenuity to build ICT Centres of Excellence in Alberta.

NETERA ALLIANCE: This research network organization supports a research infrastructure that is key to attracting top talent. It connects the WestGrid resources, and enables collaboration in international research projects.

TRLABS: This research organization works with iCORE in support of joint Chair research programs and advances research into the nature of ICT infrastructure itself.

WESTGRID: iCORE's CEO is one of five principal investigators in this project, along with an iCORE Chair whose research is highly reliant on advanced research networking and computing infrastructure. This $48 million Alberta-BC information technology infrastructure project is an important attractor for top talent to Alberta.

ELISA: The Alberta-Saskatchewan network research project provides a simulation test bed for wireless network research by iCORE Chairs.

MICROFAB AND NANOFAB: This open facility at the University of Alberta led by iCORE researchers supports the fabrication at the microscale and nanoscale level by researchers throughout Canada.

NATIONAL INSTITUTE FOR NANOTECHNOLOGY: Several iCORE researchers in both Edmonton and Calgary are part of NINT research teams and iCORE is providing a key component by attracting world-class researchers and students to work in the exciting new field.

BANFF INTERNATIONAL RESEARCH STATION: iCORE Chairs lead workshops at the Banff International Research Station (BIRS) for Discovery and Innovation in Mathematics, located in Alberta and attracting scientists from around the world.

FUTURE COLLABORATIONS: Several new partnerships are being explored, specifically with the Alberta Energy Research Institute, the Alberta Agriculture Research Institute, the Alberta Forestry Research Institute and Western Economic Diversification.

2.7. Strengthen Support for Infrastructure Projects

* A significant factor in our ability to attract and retain the best people is the availability of leading-edge research infrastructure. This applies not only in informatics research, but also to all areas of research and development – from energy to agriculture and to priorities in health and education.

* Research infrastructure is of crucial importance to high quality researchers and includes advanced computation and laboratory facilities, as well as very high-speed research networks that connect to other leading-edge researchers and research organizations throughout the world.

* iCORE will continue to support building an internationally competitive research infrastructure within Alberta. This includes active (non-financial) support for enablers such as Alberta's research network, NeteraNet; collaborative computing infrastructure projects such as WestGrid; open access advanced technology laboratories such as the MicroFab; next-generation research facilities such as the National Research Council's new National Institute for Nanotechnology (NINT); thinktanks such as the Banff Centre and the Banff International Research Station (BIRS), and public infrastructure initiatives such as SuperNet.

2003 IRAC Report

Observations

January 2003

- Current Computer Science and Electrical and Computer Engineering departments have approximately 30 – 45 faculty and each have plans to grow to approximately 60 faculty by 2010. iCORE's current target of 25 iCORE Chairs would then represent 10% of the faculty in each department. The committee felt that 10% (i.e. 25 iCORE Chairs) is sufficient to achieve a minimal "critical mass" that would increase the potential for excellence in each department, but this target is somewhat arbitrary, and more would be better.

May 2003

- iCORE would benefit from a better understanding of the dynamics and operation of the Energy Industry in Alberta.
- We endorse the ability of iCORE to award an ICE chair independently of NSERC, or ahead of the pace of NSERC. We recognize the value of the extra leverage provided by a three party award, which should be preferred.
- The membership of IRAC should be increased to seven before the next meeting, expected to be in Palo Alto in January, 2004.
- The iCORE CPE priorities are consistent with the ICT activities required to support the Energy Industry.

Recommendations

January 2003

1. We recommend ICE as an appropriate mechanism to support provincial goals of strengthening energy, environment. Additional funding will be necessary to do this effectively.
2. The Committee feels that it is important to the overall success of the iCORE program that current Chairs and Professors have the possibility of renewal for a second five year term. In addition, it is important that there be funds for one or two new appointments every year.
3. The committee believes that the independent nature of iCORE is a crucial element in its success. With an independent Board of Directors and an independent budget, iCORE is an organization that can move quickly and stay in sync with the rapidly changing ICT sector. Any possible benefits of a merger with Alberta Ingenuity would have to be weighed carefully against the potential losses.
4. In order to enhance recruiting possibilities, iCORE should tap further into existing networks of researcher colleagues in other countries, for example Germany, Australia, the UK, Russia, and India. The unique benefits of conducting research in Alberta's universities and of possible iCORE support should be more widely disseminated.
5. iCORE should continue to expand and enhance the use of internal and externally reported performance metrics.

May 2003

1. We believe that ICT research can be of great benefit to the Energy and Environment activities in Alberta. We encourage iCORE to actively pursue this opportunity, as part of its overall agenda.
2. In most cases, the ICE program will be an effective way to support this activity. A significant fraction of the planned ten ICE chairs could be targeted on ICT/Energy.
3. We recommend that iCORE launch initiatives, such as Universities/Industry information exchanges, focusing on graduate students.
4. We recommend the board review the complex interactions that arise through multiple iCORE awards to a single researcher.
5. In view of the strong and growing government funding for nanotechnology in Alberta, as well as the somewhat indirect connection to ICT, we recommend that iCORE funds be targeted at other areas.

3. Financial Plan

The strategy proposed in this plan requires an increased annual budget beginning in 2005-06. However, if the current fiscal environment does not allow such an increase, a "base budget" as outlined in the next section is proposed.

3.1. Working Within the Current Annual Base Budget

If funding is limited to $10 million per year, reduced CPE and ICE programs can be continued while the GSS program must be phased out after 2005-06.

Table 1

Programs sustained with $10 million per year

16 Teams	7 Chairs 4 Professors 5 Industry Chairs
No Graduate Student Scholarships	
Minimal secretariat	

This budget enables the continuation of the CPE programs with ongoing support for 7 iCORE Chairs, 4 iCORE Professors and 5 Industry Chairs.

Table 2 illustrates how this budget could be implemented through 2009-10 given actual expenditures in the three years from 2000 to 2003 (note that 2003 refers to fiscal year 2002-03, and so on). This budget supports one new CPE chair per year and one new CPE professor every two years, at $700K per year and $350K per year, respectively. Since all awards are for five years, 7 active chairs and 4 active professors are sustained. CPE awards are assumed renewable for a second five years at 50 percent of the original award level.

This base budget also supports one new ICE (Industrial Chair) award per year. These are non-renewable five-year awards at $150K per year which will sustain five Industrial Chairs. Note that the $10.1 million in revenue is a result of the $100K per year currently being received from Telus Mobility, which is assumed to continue.

The ICE program supports the acquisition of federal and industrial funding, which provides good leverage of iCORE investments. Further, the targeting of ICT research that supports the energy and life science sectors may significantly increase the opportunities for major progress in these areas that are of crucial importance to Alberta.

The outreach programs are also continued including the Visiting Professor (VP) program, the ICT Strategy Planning and Recruiting (ISPR) program and other communications and outreach activities. These supporting activities have been crucial to iCORE's previous success. These outreach programs are sustained through 2008 in this base budget but are subsequently decreased by about 50 percent.

Table 2: 2000–2010 "Base Budget" Details (date shown represents end of fiscal year, for example, 2004 represents 2003–04)

$ in Million	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CPE Awards	7.6	3.5	6.5	6.0	5.8	5.6	7.1	7.6	8.1	8.0
ICE Awards	0.0	0.0	0.4	0.7	0.8	1.0	1.1	0.9	0.8	0.8
GSS Awards	1.3	1.3	2.0	2.1	2.2	2.3	0.6	0.3	0.0	0.0
Collaboration & VP Awards	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.2	0.2
ISPR & Communications	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Secretariat	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0
Secretariat Overhead	8%	14%	8%	8%	8%	8%	9%	9%	9%	9%
Total iCORE Budget	10.0	5.8	10.0	10.1	10.1	10.1	10.1	10.1	10.1	10.1
# Active CPE-RG Chairs	4	5	6	7	8	7	7.5	8	8.5	9
# Active CPE-RG Profs	2	5	5	6	5.5	5.5	4.5	5	5	5.3
# Active ICE Chairs	0	0	2	4	5	6	7	6	5	5
Total Chairs & Professors	6	10	13	17	19	19	19	19	19	19
Students Supervised	125	184	257	322	363	364	306	297	278	289
Approx # GSS Awards	50	49	77	82	86	87	21	12	0	0
Cumulative Graduates	0	0	125	309	566	888	1251	1615	1921	2217

Although the total number of Chairs and Professors in this base budget scenario grows from 13 in 2003 to 19 in 2005, it will decrease to 16.3 at steady state (7.5 Chairs, 3.75 Professors, and 5 Industry Chairs). This is due to the fact that the larger number of major awards made through 2004 will begin to phase out after 10 years.

This base budget scenario sustains the GSS program through 2006 but is then phased out in 2007 and beyond. The terminated Graduate Student Scholarship program, the halved Industry Chair program, the halved CPE Professor program, and the renewal of only 50 percent of all major awards, are the most significant cutbacks in this scenario from current iCORE programs.

3.2. Risks Associated with the Base Budget Scenario

The risks of status quo funding include the following:

1) The GSS Program has been spectacularly successful at recruiting Canada's best graduate students to Alberta – now close to one quarter of all national NSERC scholarship recipients in ICT areas come to Alberta universities. Also 40% of Alberta Ingenuity graduate scholarships are now in ICT. Since the 2003 GSS costs already exceed $2 million per year, and NSERC and the Alberta Ingenuity programs are both growing, the cost of continuing our GSS program will continue to increase. Terminating this highly successful program will inevitably result in substantial decreases in the percentage of the country's best graduate students that come to Alberta. Note that the amounts of NSERC awards are increasing and other provinces are beginning to follow our lead in offering top-ups, thus our impressive gains will almost certainly be lost.

2) Continuing the Industry Chair (ICE) program at only half the number of awards currently supported may significantly delay technology commercialization and will reduce the leverage that can be achieved with iCORE funds. Despite the downturn in the ICT sector of the economy this new program has been quite successful. Since this sector is already beginning to turn around there may be many opportunities for early technology commercialization lost.

3) The assumption in the budget of Table 2 is that 1 Chair and 1/2 Professor awards can be made each year. At this level of reduction in current award rates the CPE Program may not be able to achieve critical mass in more than one ICT area. Further, every indication is that all iCORE CPE award recipients are making exceptional progress and a 50% renewal rate may result in losing some of our best recruits. The number of iCORE chairs and professors needed to reach critical mass has been estimated by the iCORE Board and the ICT Research Advisory Committee to be about 25. This level will not be reachable.

3.3. Realize Goals Budget

iCORE's Board, its ICT Research Advisory Committee, its Internal Review Committee, and the secretariat believe that the potential benefits of sustaining the momentum achieved in our first three years strongly argues for building on success through the proposed "realize goals" budget.

A program that sustains the momentum of iCORE's first three years is outlined in Table 3. It contributes to Alberta's ICT goals through achieving critical mass, along with international recognition, in three or four high growth areas within ICT that complement and support dynamic industry clusters. This budget stays at $10 million per year in 2004 and 2005, increases to $14.5 million per year in 2006 through 2009, and then gradually increases to $16 million per year at steady-state, that is, in the long-term.

This budget scenario enables renewing CPE awards once at a 75 percent rate (either the number or amount of awards) for the second five-year period. Two new CPE awards (one chair and one professor) and two new ICE awards can be made each year. Further, the GSS program is assumed to grow in concert with the increasing number of scholarships awarded by NSERC and Ingenuity.

Table 3

Programs sustained long-term with $16 million per year

28 Teams	9 Chairs
	9 Professors
	10 Industry Chairs
115	Graduate Student Scholarships
Active	Visiting professor and recruiting programs
Active	Technology commercialization program
Active	Secretariat

Table 4 illustrates how this "realize goals" budget could be implemented through 2010 given actual expenditures in the three years from 2000 to 2003. The total number of CPE and ICE chairs and professors grows from the current 13 in 2003 to 31 in 2010. Thereafter the numbers decrease after the unusual number of awards made in 2000 expire. In the longer term (post 2010) there will be 8.75 Chairs, 8.75 Professors and 10 Industry Chairs sustained. This number of awards will enable achieving critical mass and sustainability of the research programs.

Table 4: 2000–2010 "Realize Goals" Budget Details (date represents end of fiscal year, for example, 2004 represents 2003–04)

$ in Millions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CPE Awards	7.6	3.5	6.5	6.0	5.6	9.6	9.1	8.9	8.7	10.9
ICE Awards	0.0	0.0	0.4	0.7	1.0	1.3	1.6	1.5	1.5	1.5
GSS Awards	1.3	1.3	2.0	2.1	2.2	2.3	2.5	2.7	2.9	3.0
Collaboration & VP Awards	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3
ISPR & Communications	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Secretariat	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0
Secretariat Overhead	8%	14%	8%	8%	8%	6%	6%	6%	6%	6%
Total iCORE Budget	10.0	5.8	10.0	10.1	10.1	14.5	14.5	14.5	14.5	16.8
# Active CPE-RG Chairs	4	5	6	7	8	8	9	10	10	11
# Active CPE-RG Profs	2	5	5	6	6	7	7	8	9	10
# Active ICE Chairs	0	0	2	4	6	8	10	10	10	10
Total Chairs & Professors	6	10	13	17	20	23	26	28	29	31
Students Supervised	125	184	257	322	386	430	482	516	547	573
Aporox # GSS Awards	50	49	77	82	86	88	96	104	112	115
Cumulative Graduates	0	0	125	309	566	888	1273	1703	2185	2702
Cum Estimated Leverage	25	38	63	88	113	152	190	228	266	310
Cum Impact of Students	0	0	10	35	80	151	253	389	564	780
Cum Impact to Industry	8	12	22	33	45	68	93	119	148	185
Cum Economic Impact	33	50	95	156	238	371	536	737	977	1275

This scenario will also support moderate growth in our highly successful graduate student program. As shown in Table 4. That is, the slightly more than $2 million in funding for the GSS Programs in 2003 will continue to be increased gradually to $3.0 million in 2010. The total number of graduate students supervised by iCORE CPE award holders will be close to 600 with 2700 cumulative graduates by 2010.

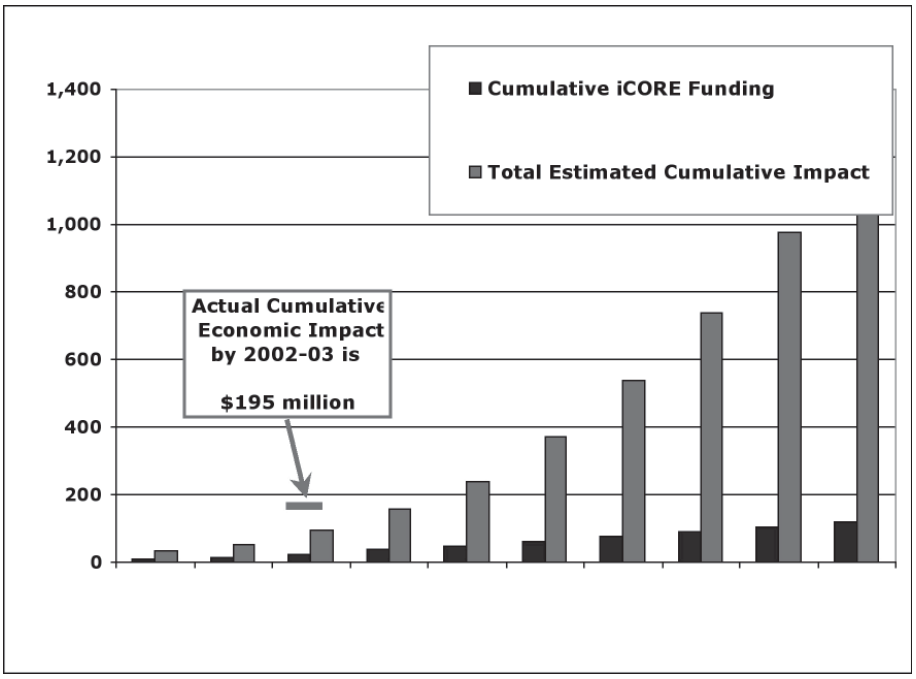
A moderate growth is also assumed in support of collaboration and visiting professor (VP) awards and in ICT Strategy Planning and Recruiting (ISPR) awards. These successful programs will enable continued recruiting of exceptional research leaders. The secretariat expenses, although they grow slightly, are still less than 6 percent of total funding. The estimated economic impact of this scenario is dramatic as seen from Table 4 and as illustrated in Figure 3.

The total, cumulative, iCORE awards made over the ten-year period is $121 million. The projected impact of this investment is $1.275 billion.

This might seem highly optimistic, however, the "actual direct and indirect funding" acquired by iCORE Chairs and Professors that received awards in our first 3 years, i.e., through 2002-03, is currently $195 million. This is double the amount projected by the economic model used in Table 4, that is, the model projects $95 million versus the $195 million that was actually acquired through 2003.

The actual leverage achieved as a result of major awards made in these three years is 8.0. Specifically, iCORE invested $27.8 million during the March 2000 through March 2003 period. The recipients of these awards have been principals in acquiring $73.4 million ($31.4 federal, $13.6 provincial, and $22.4 industry) and have participated in acquiring an additional $121.3 million ($61.3 federal, $60 provincial) to support their research programs (note: leverage = direct + indirect + iCORE) / iCORE). If iCORE Chairs and Professors continue to succeed at this rate the projection of $1.275 billion will be exceeded.

Figure 3: Cumulative Economic Impact for "Realize Goals" Budget



Partnerships and Technology Transfer: A Potential New Program

An additional $2 million per year enables iCORE to cost effectively support more industry-university linkages and technology commercialization projects.

In addition to the *Realize Goals* plan and budget outlined in the above two tables, iCORE could accelerate the transfer of university-created technology through support of research partnering relationships with industry. A new collaborative research and development awards program is envisioned that further leverages industry and federal (NSERC) funding. This type of program has been demonstrated to be a highly cost effective approach to fostering early technology commercialization. The objective of such a program is to build partnerships between Alberta industry and iCORE teams and other university researchers. An additional $2 million per year, that is, a total annual budget of $16.5 million, would enable a more effective transfer of research results into commercial ventures and accelerate a key part of the *Alberta Innovation System*.

4. Performance and Accountability

iCORE has been collecting data on its programs since its inception. Each spring, beginning in 2000, the departments of Computer Science and Electrical and Computer Engineering are surveyed to determine the number of current faculty, open positions, new hires, graduates students, and sponsored research funding. This helps us understand the overall impact on our key "clients" – the informatics departments within the universities.

Each summer, beginning in 2002 with six research teams having completed one full year, a comprehensive report on the activities and results of the iCORE researchers is produced by iCORE. This report, the iCORE Annual Research Report, collects information from the annual research reports that are produced by each research team. This information is also further summarized and used in an annual Performance Measures report that comes out in bulletin form in the fall.

Each summer, beginning in 2002 after our first graduating class of graduate students, we survey new, current and past graduate students. This longitudinal study surveys the reasons the students chose Alberta, asks questions about their education experience, and tracks their location and place of employment after graduation.

iCORE also participates on the provincial and national committees of "users of science and technology statistics," in order to understand the broader context of iCORE and to promote the need for the collection and analysis of statistics related to research and informatics in particular.

iCORE also measures and reviews its internal processes, such as evaluating proposals and hosting distinguished lecturer seminars, and is regularly seeking to improve the operations of iCORE.

Our choice of performance measures, their collection, and analysis, are reviewed and improved annually, in order to improve their definition, precision and fit with other methodologies.

In 2005-06, after 5 full years of operations, iCORE will strike an arms-length international review committee to evaluate iCORE's programs and performance and comment on Alberta's performance in achieving its ICT goals.

Table 5: iCORE Measures and Targets for "Realize Goals" Strategic Plan

Measure	Annual Target	Total Actual To Date	Long-Term Target
High Quality People			
Number of iCORE Chairs and Professors	4 per year	13 active	28 active
Number of additional faculty on iCORE research teams	10 per year	33 active	60 active
Number of graduate students and postdocs on iCORE research teams	100 per year	203 active	300 active
Number of graduate student scholarships awarded `	100 new per year	196 cumulative	200 active
Percentage of graduate students who stay in Alberta after graduation	50%	No valid data	50%
Economic Impact			
iCORE investment	$10 million/year	27.8 million	$16 million/year
Funding acquired directly by iCORE research teams, excl. iCORE funds	$30 million/year	$73.4 million	$54 million/year
Funding acquired with iCORE research team collaboration	n/a*	$121.3 million	n/a*
Spinout companies	n/a*	4 to date	n/a*
Licenses	n/a*	$2.55 million	n/a*
Partnerships			
Number of collaborations with researchers nationally and internationally	n/a*	84 active	n/a*
Partnerships with industry	n/a*	49 active	n/a*
Leadership in large-scale multi-partner collaborations	n/a*	2 active	n/a*
Awards			
Number of major awards by iCORE researchers	n/a*	14 active	n/a*
Intellectual Property Produced			
Refereed publications	n/a*	360 this year	n/a*
Patents	n/a*	10 lifetime	n/a*

This table of long-term targets is based on the "realize goals" budget.
** In some cases annual and long-term targets make sense and these are provided. In other cases, the nature and/or precision of the measure or the desired target are not known at this time. In many cases, "targets" are not appropriate, but measures will be collected as indicators of iCORE's overall performance and impact.*

5. Conclusion

iCORE believes that Alberta's ICT goals can be achieved if there is a coordinated commitment to focus on high-growth segments of ICT.

iCORE's role is to attract and support the leaders who will enable Alberta to achieve economic diversity and reach the goals defined in Alberta's 1998 strategy for ICT. Sustaining our attraction of, and investment in, exceptional research leaders and graduate students, and in building early collaborative relationships between Alberta industry and these university researchers, is central to achieving Alberta's goals.

Information and communications technology plays a key role in Alberta's economic future as an enabler of innovation across disciplines. These technologies enhance our natural resource development, enable more effective and efficient health care and learning opportunities, and are central to the diversification of the Alberta economy.

Because ICT will continue to exert an ever-increasing role in an extraordinarily competitive global environment, and in all industry sectors that are central to Alberta's future prosperity, a special case exists for increased funding. If we are to protect past investment and maintain the momentum already achieved, iCORE's base annual budget must grow to $14.5 million in 2006.