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MEMORANDUM

ATTENTION	Senate	DATE	March 22, 2010
FROM	Jon Driver, Vice-President, Academic and Provost, and Chair, SCUP	PAGES	1/1
RE:	SFU Strategic Research Plan, 2010 - 2015 (SCUP 10-26)		

At its March 10, 2010 meeting SCUP reviewed the attached SFU Strategic Research Plan, 2010 - 2015. The plan is attached for the information of Senate.



OFFICE OF THE VICE-PRESIDENT, RESEARCH

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ATTENTION Sarah Dench
Director, University Curriculum & Institutional Liaison

FROM B. Mario Pinto, Vice-President, Research

RE SFU Strategic Research Plan 2010-15

DATE February 16, 2010

In September 2009, I instituted a University-wide consultation process to optimize the SFU Strategic Research Plan to guide us through 2010 to 2015. During the first round of consultation in the Fall of 2009, I worked closely with the Faculty Deans and Associate Deans, Research to solicit suggestions for new and revised strategic research themes and subthemes. I also invited input from the community through open fora held at the Burnaby, Surrey, and Vancouver campuses and email submissions. During the second round of consultation, I posted an initial draft of the Strategic Research Plan 2010-15 on my website on January 4, 2010: the draft became a living document as suggestions from the more than 60 individuals who submitted written comments were incorporated. On February 2, 2010, we posted a close-to-final version of the document and opened a third round of consultation for a further two-week comment period. Today, we posted the resulting SFU Strategic Research Plan 2010-15, as well as the shorter CRC/CFI Strategic Plan, for the information of the University community.

We now submit these two documents to SCUP for review, consideration, and approval before submission to the April 12th Senate and the May 27th Board of Governors' meetings.

/MDM
Attach (2)



SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

SFU
STRATEGIC RESEARCH PLAN

2010-2015

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**SIMON FRASER UNIVERSITY
STRATEGIC RESEARCH PLAN
2010-2015**

Introduction

In more than 44 years, SFU has gained an international reputation for its strengths in the liberal arts and sciences, as well as for its innovative interdisciplinary and professional programs. Now spanning many disciplines in eight faculties, SFU offers more than 100 undergraduate major and joint major programs and more than 45 graduate offerings. Mentored by faculty acclaimed for their research and teaching abilities and coached by dedicated advisors and employers in our work integrated learning program, our more than 100,000 graduates enjoy many career opportunities. The advancement of excellence in research is a defining feature of SFU, with leading individuals and well-recognized groups engaged in a wide variety of key research activities. We have been awarded more than 40 Canada Research Chairs in areas that complement our strategic research goals, including both Tier 1 Chairs for outstanding researchers who are world leaders in their fields, and Tier 2 Chairs for exceptional emerging researchers with the potential to lead in their field. SFU has 39 Royal Society of Canada Fellows, distinguished Canadian scholars who are selected by their peers for outstanding contributions to the natural and social sciences, the arts, and the humanities. *Our goal is to be the most research-intensive comprehensive university in Canada, competing effectively in defined areas with the top tier institutions in the country, and internationally renowned for the excellence of our scholarship.*

SFU is recognized for its high level of peer-reviewed scholarly output and its impact on the advancement and transfer of knowledge, the best measures of creative thought. According to Research Infosource, we rank highly in terms of the number of publications by our faculty members, and first among the comprehensive universities for the impact of our publications. Our community members are participating on research panels and on granting committees, and they are being increasingly recognized with prestigious awards.

SFU is one of the national leaders in the pipeline from ideas, to innovation, to commercialization. Out of creativity in fundamental activities comes innovation, and out of innovation, applications that have societal and economic impact. Our University / Industry Liaison Office (UILO) is recognized as one of the finest in the country, and has developed innovative new models for technology transfer such as the TIME (Technology, Innovation, Management, Entrepreneurship) Centre, Venture Connection, and WUTIF (Western Universities Technology Innovation Fund).

Our significant growth in research output has been made possible by a corresponding growth in research input, and we have made significant progress towards creating a supportive environment within which research and scholarship can flourish. In terms of total Tri-Council research funds per faculty member, we rank #14 in the country. Our researchers have consistently exceeded the national success rates in NSERC and SSHRC competitions, and in 2008/09 we also exceeded the national success rate in the CIHR operating grant program. Our astounding 126% growth in research income between 2002 and 2007—and ability to attract \$86 million in sponsored research funding in 2008—has put us into the top-20 group of Canadian post-secondary institutions in this measure. We have been successful in obtaining funding to seed key initiatives, in recruiting high-profile faculty members and students, in building our research infrastructure, and in developing extensive collaborative and international networks. SFU continues to optimize its Strategic Research Plan (SRP) to capitalize on its strengths in independent scholarly efforts and in cross-disciplinary initiatives. We are working actively to inform changes in federal government policy and administration and to ensure provincial investment in higher education and research.

Knowledge generation and knowledge transfer through research, scholarship, and teaching are fundamental to the mission of the University. It is imperative to recruit and retain outstanding scholars

who will attract highly qualified graduate and undergraduate students, champion bold initiatives, strengthen critical areas of research, develop new areas of excellence in research, and enhance synergies between teaching and research. Providing opportunities for research training to our undergraduate and graduate students is essential for the success of university-based research activities, and is central to the mission of a research-intensive university. SFU ranks #3 in the country, following the Universities of Toronto and Waterloo, for the number of NSERC doctoral prizes. Graduate students are important members of the research community, both as research assistants and independent scholars. Graduate degrees currently comprise about 18% of the total degrees that SFU awards per year. Our goal is to increase this to 22% by 2015 by improving rates of completion and time to completion through better funding and supervision practices. Emphasizing an interdisciplinary, theme-based approach that is firmly rooted in the study of fundamentals will strengthen graduate research and teaching. We propose also to increase opportunities for undergraduate research through independent study semesters and research assistantships. We are determined to augment SFU's talent pool and research infrastructure, thereby contributing to the productivity and international competitiveness of British Columbia and Canada.

As a comprehensive university, SFU champions the liberal arts and sciences and promotes individual and collaborative research. Our research environment has been developed and is sustained by the creativity and excellence of individual researchers, whose efforts the University will continue to support. Indeed, individual strength is a critical component of an effective thematic approach. We propose to build on these strengths to define particular strategic research directions that will define SFU and give us a competitive edge. The Strategic Research Plan (SRP) identifies distinctiveness as well as excellence. In keeping with the character of the University, collaboration and synergy are strongly advocated, while selective investment of resources will always be consistent with the advancement of excellence.

SFU engages communities in university research, e.g., the technology industry, the business community, the rural or urban community, the preschool-12 education sector, the francophone community, the immigrant community, or the Aboriginal community. Our track record of development of the Vancouver campus community should inspire bold urban renewal projects in Surrey and the Great Northern Way campus. We have a unique opportunity for the School for the Contemporary Arts to engage the Vancouver community with its cultural infrastructure, and to firmly ensconce SFU as the cultural and intellectual heart of the community.

We live in a pluralistic society: culturally, racially, and ethnically. SFU must provide leadership in educating students about human differences in an increasingly diversified world in order to help develop a civil citizen and a civil society. Through research initiatives, we must instill in our students appreciation of societal structures and social and scientific responsibility for a sustainable world.

Background and Process

In December 2004, the Vice-President, Research convened a Task Force to develop a Strategic Research Plan for the University. The Task Force comprised one representative from each of the Faculties of Applied Sciences, Business Administration, Education, Health Sciences and Science, and two representatives from the Faculty of Arts and Social Sciences. The Vice-President, Research and the Vice-President, Academic appointed four additional members. The Task Force was asked to identify research capacity and areas of strength across the University, with the goal of drafting a new plan. The Task Force generated a first draft of the SRP after consultation with selected researchers and presented it to the senior academic administrative group (Faculty Deans, Vice-Presidents Academic and Research, and the President). A revised draft, incorporating suggestions from this initial consultative process, was made available for general consultation throughout the SFU community, including faculty, staff and student organizations. Following the consultation phase, a final draft was prepared for submission to the Senate Committee on University Priorities (SCUP), Senate, and the Board of Governors for consideration, revision and approval. The five-year 2005-2010 Strategic Research Plan (SRP) served as a road map

towards establishing the focus, infrastructure, and capability to improve the research performance of the University. The SRP articulated the University's strengths by identifying five integrative research themes that cross disciplinary and administrative boundaries: Communication, Computation, and Technology; Culture, Society, and Human Behaviour; Economic Organization, Public Policy, and the Global Community; Environment; and Health. These themes represented frameworks for mapping an already healthy landscape of independent inquiry.

In September 2009, the Vice-President, Research communicated the plan for the optimization of the SRP to guide the University through 2015. All members of the University community were invited to provide input through the Faculty Deans, who were asked to provide written proposals to the Vice-President, Research. In November 2009, a series of public fora were held at all three campuses, and an email account was set up to provide the entire University community with another method to submit commentary. The Vice-President, Research drafted the 2010-2015 SRP with the assistance of this commentary, and with further input from inspired faculty. The draft articulated the University's strengths by amplifying the original integrative research themes and by adding two new themes: Origins and Pedagogy. In addition, the critical role of the fundamentals of research was stressed in the new plan. On January 4, 2010, a living draft of the SRP was posted on the Vice-President, Research Office website for a second round of public consultation via email submissions. The next draft was posted on February 1, 2010 for a third round of consultation, and the final draft was submitted for approval through the regular University channels beginning in March 2010.

Major Objectives of the Strategic Research Plan (SRP)

The SRP is intended to serve as a road map for establishing the focus, infrastructure, and capability that is necessary to improve the research performance of the University. The SRP articulates the University's strengths by identifying integrative research themes that cross disciplinary and administrative boundaries. New discoveries in Canada and around the world are being made by interdisciplinary teams of investigators organized to address research questions that are multidimensional and inspired by global societal, environmental, and economic change. The themes of research are consistent with the sub-priorities of the S&T Strategy of Canada.

The major objectives of the SRP are to:

- Maximize opportunities for discovery and innovation;
- Promote internationally competitive research and scholarship;
- Cultivate excellence through selective investment in emerging areas of research;
- Facilitate collaborations across disciplinary and institutional boundaries;
- Recruit and retain outstanding students, research fellows, and faculty;
- Encourage effective communication and dissemination of research results;
- Optimize use of our research and scholarship resources;
- Recognize the full value of intellectual property;
- Achieve thematic coherence in the expression of SFU's research interests;
- Engage all our communities for the benefit of society.

Research Environment

We seek to enhance a research environment at SFU that is responsive to new challenges and opportunities. We regularly offer social networking events to encourage the University community to share expertise from across the different sectors of the University. We expect that promising collaborative efforts will be seeded and will continue to develop. Selected areas will be fostered through further education, for example by inviting internationally renowned academics to SFU for limited periods ranging from one month to one year. These individuals will act as catalysts for further development of strategic initiatives, and serve as mentors for faculty, postdoctoral fellows, and graduate and undergraduate students. We will invest in key faculty positions and in the recruitment of exceptional students. We will be opportunistic, taking full advantage of special situations and resources as they develop. We will host colloquia and conferences to broaden our knowledge of leading-edge research around the world. We will continue to participate actively in global initiatives and build bridges to international partners of exceptional calibre, facilitating faculty, postdoctoral and student exchanges, and supporting student internship programs in partner countries.

In this context, SFU's Centres and Institutes will play a critical role. SFU has close to 50 research centres that fall under the direct authority of individual Deans. There are also 18 research institutes that report to the Vice-President Research, have a University-wide mandate, and represent SFU's activity as part of multi-university consortia. These Centres facilitate collaborative research, especially multi-disciplinary research; undertake specific types of teaching or training programs; facilitate multi-university initiatives, such as Centres of Excellence; and provide specific types of services to the community. Many of our Centres and Institutes also play an important role in disseminating the results of university-based research to the public sphere, and contributing significantly to public policy decisions.

Interplay of Research and Teaching

Investment in research enhances the teaching and learning experience for students, since research discoveries can be incorporated in curriculum topics and student queries sometimes inspire research questions. Recruitment of stellar faculty, who contribute not only to research programs but also to undergraduate and graduate teaching, will motivate the next generation of scholars and encourage student participation in research. Such individuals tend to spark students' interests by providing the latest research perspectives, and also attract outstanding undergraduate and graduate students. The top undergraduate students will "set the standard" for their peers, serving as role models, while the graduate students will advance knowledge as research assistants and provide valuable instruction to undergraduates as teaching assistants. Furthermore, research-intensive faculty will provide opportunities for undergraduate and graduate students to explore scholarly research, through focused course seminars, independent study semesters, and through thesis supervision. The combination of these memorable elements will heighten the experience of both students and faculty and will build loyal alumni.

Strategic Research Themes

The SRP articulates SFU's strengths by identifying integrative strategic research themes that cross disciplinary and administrative boundaries. In defining these themes, we intend to facilitate and encourage both individual initiatives and new collaborations within existing structures. However, through the process of identifying our research strengths and existing and potential synergies among them, we intend to encourage and support cross-disciplinary initiatives that build on our strengths and show potential for significant impact and leverage. Excellence in research and strategic investment of resources aligned with this thematic approach will give SFU a distinctive edge and comparative advantage, leading to our goal of being the most research-intensive comprehensive university in Canada, and competing effectively in selected areas on the international scene.

SFU recognizes the contributions of all researchers across the entire spectrum of scholarly inquiry at, and associated with, the University. We plan to maximize our strengths, building on themes that unify initiatives from the humanities to the sciences and engage our many communities. The strategic research themes encompass both cross-disciplinary teams and disciplinary or individual contributions to our collective achievements.

The following matrix summarizes SFU's seven strategic research themes, although we acknowledge that linkages might be established between these themes. The associated perspectives are intended to illustrate approaches to issues of scholarship within each theme, and transcend the themes. We anticipate that individual faculty will identify their own interests within certain cells in this matrix.

RESEARCH THEMES	PERSPECTIVES				
	Fundamentals	Constructs	Systems	Applications	Globalization
Origins					
Communication, Computation, and Technology					
Culture, Society, and Human Behaviour					
Economic Organization, Public Policy, and the Global Community					
Environment, Resources, and Conservation					
Health and Biomedical Sciences					
Pedagogy					

By way of example, with respect to the Health Informatics subtheme under "Health and Biomedical Sciences", Fundamentals might include basic research that spans the computational, cognitive, social/organizational and socio-technical disciplines. Constructs could include the development of models, tools, and policies, such as models for representing knowledge, new materials for information delivery, tools for electronic-based teaching, and policies for health care delivery. Systems research can include how people, communities, organizations, economies, and societies use and are impacted by information and information technologies. Applications in this area are diverse and might include health databases, molecular electronic devices, improvements to information system performance, etc., for clinical and administrative applications. Finally, globalization includes the study of the boundary-less transfer of information that impacts individuals, populations, and socioeconomic systems worldwide, including international exchanges of faculty and students, field schools, and training programs. Another example entails the study of materials science and engineering. Fundamentals span basic research in physics, chemistry and engineering science, such as condensed matter theory and the study of new materials, fuel cell theory, and microelectronics. Constructs could include the combination of new

chemical composites and microfabrication techniques to generate the next generation of fuel cells or biochips. Systems research might feature the interaction of nanomaterials with biological systems, including the public perception and ethical implications of the use of nanotechnology in living systems. As materials are required for just about every technology or industrial purpose, applications of this research are vast and include those in aviation and aerospace, alternative energies, the automotive industry, intelligent systems, fuel cells, solar cells, electronics and optoelectronics, nanotechnology and biotechnology, health care, information and communications, and design of green buildings. Finally, globalization will include the international dissemination of new tools for global health, security, communication, and environmental protection.

Research on public perception and on the ethical, economic, educational, political, and safety aspects of the introduction of new technologies and other applications, is critical, and spans all of the research perspectives. These areas are the subjects of inquiry of many of SFU's social sciences and humanities researchers, and their research informs practices and changes in public policy, business administration, education, international development and relations, security issues, and government.

Origins

The Nature, Origin, and Fate of the Universe

One of the most important questions that has occupied mankind since antiquity is: "What is the universe made of and how did it evolve?" Answering these questions is at the origin of most fields of scientific research. Mathematics provides a natural framework for drawing conclusions about deeper mechanisms from observed data. Physics and chemistry seek to identify the physical laws governing nature, while biology and medicine strive to understand life in the broadest sense. The subfields of physics, subatomic physics and astrophysics/cosmology deal with nature at widely differing scales, from the smallest to the largest. It is very interesting that there is such a large overlap between these two fields and that, in a sense, the loop is closed when considering the very high energy densities of particle physics and the origin of the universe, the Big Bang. In this connection, SFU researchers are critical players in the world's largest particle physics experiment, ATLAS, using the Large Hadron Collider (LHC) located in Switzerland. SFU led the proposal for the ATLAS Tier-1 data analysis centre at TRIUMF that is responsible for processing the data and relaying it to other secondary analysis centers. Experiments include the reconstruction of the first seconds of the universe and the search for dark matter produced in collisions of the LHC in order to construct theories of the origin and fate of the universe. Other SFU faculty members are involved in the development of accelerated radioactive beams at TRIUMF. At the ISAC (Isotope Separator and Accelerator) facility, it is possible to study nuclear reactions which otherwise occur only in high-temperature stellar environments. The aim is to understand the origins of the elements in the universe.

SFU's Telematics Research Laboratory (TRL) and PolyLAB for Advanced Collaborative Networking Unit has world-class expertise in the development and management of Information Communications Technology (ICT) test sites for human and robotic exploration of the solar system and beyond, with technologies ranging from wireless communications through to secure and life-critical collaborative networking, GIS, and virtual reality-based systems to support mission operations. The work at PolyLAB is internationally recognized as helping to define concept system architectures used by space agencies around the world for future surface lunar, Mars, and asteroid ICT infrastructures.

The RNA World and Molecular Evolution

Several SFU researchers are active in unraveling the puzzle of how life might have emerged. The molecule RNA (RiboNucleic Acid) that has recently been shown to have the ability to copy itself and to promote biological processes, may have played an ancestral role in the emergence of life by

building and powering the earliest organisms. New avenues of research are attempting to search the genome for thousands of active small RNA segments and to understand what these segments do. The principles of RNA evolution in the primordial RNA-world apply to modern cellular function. Understanding how changes in molecular building blocks alter their structure, dynamics and function is the foundation for the science of molecular evolution. Such understanding is required for the design of antibacterial and antiviral drugs against which pathogens cannot develop resistance, currently a major health issue worldwide. Correlating the molecular foundations of evolution at the organismal and societal levels requires an interdisciplinary effort between SFU's molecular and biological scientists, mathematical and computation scientists, behavioural ecologists and psychologists, and other social scientists.

Biodiversity

Understanding and conserving biodiversity are now widely recognized as crucial for human wellbeing. Several internationally renowned research groups at SFU, including those in wildlife and behavioural ecology and salmon conservation, are focusing on the ecology, evolution, and conservation of biodiversity. There is complementary strength in applied research on the ecology and conservation of forests and fisheries. SFU is unusual among North American universities in that its strengths in present-day biodiversity research are complemented by considerable expertise in past biodiversity and human-environment interaction. SFU has invested heavily in the infrastructure required to pursue research in biodiversity in multiple departments across several Faculties, and is now exceptionally well positioned to perform biodiversity research in an era of global change and unprecedented anthropogenic modification of natural ecosystems. Over the next five years, we will focus on ensuring that the benefits of SFU's ability to combine research and training on past, present and future biodiversity are fully realized.

Human Evolution

In recent years a number of disciplines have experienced a significant growth of interest in the application of Darwinian theory to questions concerning humans, and it is now clear that evolution provides a powerful framework for understanding not only our genes and anatomy, but also our cognition and behaviour. For example, evolutionary perspectives are increasingly used to understand economic behaviour with respect to risk, time preference, and social status. As well, interest in Darwin's impact on social history and subsequent cultural conditions continues to intensify. SFU is exceptionally well positioned to become a world leader in this rapidly growing area of interdisciplinary endeavour. Many of our researchers are using the conceptual and analytical tools of evolutionary ecology to understand key aspects of human biology. In addition, SFU has invested heavily in the infrastructure required to carry out research on human evolution, including the creation of laboratories for the extraction of ancient DNA and stable isotopes, research in the mathematical and algorithmic underpinnings of bioinformatics, and a facility for the capture and analysis of 3D shape data. Further investments will exploit the research and training synergies created by this combination of an unusually diverse group of human evolution researchers and first-rate research facilities.

The Development of Human Thought, Culture, and Institutions

SFU has long supported vigorous, historically grounded research into human societies, cultures, and ideas. The study of the past is critical to these endeavours because it is through narratives about and understanding of the past that we ground ourselves in the present. Human societies allot power and resources, create systems of justice, and ultimately project themselves into the future through stories about where we came from. We not only reveal the past through our work – we also explore the very basis upon which we make sense of the world today. Inquiry into the past reveals ways in which “ways of knowing” in the past and the present are conditioned by the value systems in which we live. The critical study of the past is thus essential to the research and teaching agendas of many departments and programs at SFU.

Researchers at SFU explore culture and human development in a variety of contemporary domains, including the links between social and cultural contexts that affect cognition, identity, values, family relations, artistic and literary creativity, and individual and social welfare. With broad areas of expertise including those in anthropology, business, english, first nations studies, history, humanities, international studies, literary studies, philosophy, political science, psychology, sociology, and women's studies. SFU is poised to emerge as Canada's foremost centre for the study of those factors that underlie individuals' perceptions of, influence over, and interactions with other people. Researchers in archeology, economics, and history are currently exploring the origins of social and economic institutions. In addition, SFU encompasses a number of research centres and individuals involved in the contemporary and historical study of justice and ethics. SFU's strengths can be found in the diversity of research methods used in both laboratory and field settings, and in its focus on both basic theoretical research and the application of theory to significant social issues. Such research demonstrates that rigorous social science can and should engage questions of basic human processes while also providing insights relevant to the society in which we live.

Communication, Computation, and Technology

SFU has a long history of leading-edge research in communication, computation and advanced technologies. Our expertise spans research issues from theory to applications to policy, with researchers from many disciplines involved, including chemistry and chemical biology, communications, computing science, criminology, economics, engineering science, interactive arts and technology mathematics, molecular biology and biochemistry, physics, psychology, and statistics.

Materials Science and Engineering

Materials Science at SFU has long enjoyed a strong national and international reputation. The effort spans the spectrum from curiosity-driven research leading to the discovery of new materials and new materials properties, to more applied research culminating in applications-driven engineering and development. The original research direction of Materials Science –making materials ever more pure and perfect – is ongoing. For example, SFU leads the world in the study of the novel properties of a new and more perfect form of silicon. More recent directions involve the study of complex materials, exemplified by the high temperature superconductors and the related field of highly correlated electron materials. Economic forces drive continuing efforts to reduce the cost of materials without reducing their functionality. Much new work is focused on understanding how the micro- and nanostructure of materials can change their properties, leading to new applications in electronics, communication, energy storage and conversion, and health sciences.

An interdisciplinary and collaborative approach by biochemists, biologists, chemists, engineering scientists, molecular biologists, and physicists will permit new materials to be integrated with existing technologies to create novel platforms and devices, such as biochips. An essential part of our strategy is participation by SFU in national and international joint ventures such as the Tri-University Meson Facility (TRIUMF) and the Canadian Light Source (CLS). For example, SFU researchers form bridges to the Centre for Molecular and Materials Science at TRIUMF, with research foci in environmentally friendly chemistry, superconductivity, and molecular magnetism, and are prominent in the multi-university consortium that is turning a cluster of beam lines and spectrometers into a national user facility for materials science. At SFU, 4D Labs provides an important centralized processing and analysis infrastructure in support of the Materials Science effort.

Intelligent Systems and Computer-Aided Design

Intelligent systems are an integral part of modern technological products and processes. They can be found in consumer products to advanced systems such as surgical robots and space stations. SFU has a long history in intelligent systems research and their industrial applications. This area includes

artificial intelligence, data mining, intelligent data processing, the semantic web, computer-aided vision, sensors and sensor networks, robotics, mechatronic systems, microelectronics, embedded computing and systems, and advanced instrumentation. Intelligent systems research is inherently interdisciplinary and has its foundation in computer science, computer and software engineering, electrical engineering, and mechanical engineering. SFU researchers are currently leading intelligent systems development for applications in biomedical technology, energy systems, communications, manufacturing, transportation, public safety and security and web-based applications. Our facilities include a range of well-equipped laboratories and a micro-fabrication facility that plays a unique role in training, research and specialized services to industry. Computer-aided design systems have matured into comprehensive environments that enable users to efficiently work with their designs. Research in this area explores the use of unified constraint and simulation-based modeling that enables designers to create designs adapted to context and to the physical forces; and constraints and simulation to establish a new design space in which histories enhance the ability to explore new alternatives for designs.

Automotive Technologies

SFU has invested significantly in the Mechatronics Systems Engineering (MSE) program. Mechatronics is the integration of mechanical, electronic, control, software, and computer engineering for the development of advanced electromechanical products and systems for a wide range of industrial applications. Research topics include next generation engine mounts, vibration-based energy harvesting, airbags, and intelligent systems for autonomous vehicles. These efforts are complemented by those of an internationally recognized group of researchers with expertise in polymer/electrochemistry, modelling structures and processes in fuel cells, bio-fuel cells, and novel methods for preparing proton-conducting membranes. This group has strong connections with the NRC Institute for Fuel Cell Innovation, and will develop collaboratively the next generation of nanostructured materials for fuel cell applications. SFU has also been a host node for a highly successful mathematical modelling initiative associated with hydrogen fuel cell design.

Imaging Science and Visual Analytics

Imaging research draws upon investigations across the disciplines and campuses of SFU, involving both foundational issues and applications. Investigation into the visual presentation of data and relationships is fundamental to this field, as is the study of how human beings perceive and use visualizations for communication, analysis and decision-making. The foundations of imaging research incorporate work in the areas of modeling, signal detection and processing, mathematics, statistics, data processing and storage, animation, language analysis, cognition and perception. Building on these foundations, imaging research then deals with human-computer interaction, reasoning, transformation and dynamic visualization in different manners, depending on the application area and the type of processes being investigated. Areas as diverse as finance, aircraft safety, crime reduction and public health all require information systems that support human cognitive processes—discovery, insight, problem solving, and communication—and enable innately human abilities to find meaning in information spaces composed of massive volumes of data that are dynamic, complex and uncertain in nature. Key applications of the research include medical imaging, visual analytics, data mining, business intelligence, finance, manufacturing, transportation, public safety, health and the environment.

Information, Communication, and New Media Technologies

A cluster of excellence exists in information and communication technology research at SFU. Areas of excellence are multimedia, wireless communications, RF/microwave communications, network systems and modeling, algorithms, information retrieval and web-based systems and natural language. Efforts are currently in progress to develop a formal collaboration with the Communications Research Centre in Ottawa. SFU research labs have strong industry connections in the above areas. In addition, research strengths exist in the areas of the IT sector of the economy, and

life and mission-critical ICT for disaster management and public safety, coastal surveillance, and disaster relief. Areas of expertise include ICT systems for extreme environments, early warning, and integrated multi-disciplinary response. Business researchers study knowledge, innovation and technology, with particular expertise in project management. ICT provides a necessary substrate for many areas of research, and SFU has and will continue to build strong links between ICT and the disciplines that use ICT in research.

Games, animation and new media are research areas in their own right and are also enabling technologies for many aspects of culture, society, and industry. Research at SFU covers the spectrum from technology to use in real contexts: from the use of multi-processor architectures for digital games and enabling algorithms for simulation, digital games for learning and training, play interfaces for culture, media-based pain therapy, believable character animation, and aesthetics of visualization. SFU plays a major role in the research and management of the Network of Centres of Excellence in Graphics, Animation and New Media (GRAND).

Communication, Collaboration, and Computation

SFU has internationally recognized expertise in communication, collaboration and computation, including computational security and safety. This subtheme builds on extensive expertise in combinatorial algorithm development and qualitative and quantitative modeling of complex social systems using advanced mathematical, statistical, and computational methods. The Interdisciplinary Research in the Mathematical and Computational Sciences (IRMACS) Centre provides critical infrastructure required to communicate and collaborate with remote and difficult to access communities, such as remote and Aboriginal communities in northern BC, as well as the ability to provide remote collaboration and visualization capabilities for both research and educational initiatives. SFU is a leader in the development and deployment of collaborative technologies in the support of research at the national level.

Technology and the Arts

Ongoing developments in media and computing technologies link interactive arts and technology with musicians, filmmakers, dancers, and other scholars in contemporary arts. In addition to enjoying an international reputation for interdisciplinarity in artistic practice, SFU researchers are studying historical and current dimensions of media culture in visual, filmic, aural, print, and digital formats. Researchers are focusing on studying and designing technologies that empower and enrich the users' experiences within interactive spaces, understanding current interactive media designs, and virtual environments to inform the design of next generation interactive media productions. We focus on expressive systems that augment the users' experience, including the development of expressive motion within visualization and virtual environments, expressive characters (both face and body movements), and expressive interactive performances. An allied research thread is the development of computational systems that produce or simulate creativity, and the construction of cognitive models of human creativity and creative expression that can be the basis for computational creativity. Another emerging area of research is the study of human-centered media and communication systems for museums. A coordinated initiative that merges theory and practice in the artistic uses of new technologies and the scholarly analysis of traditional media (including print and photography) builds on current strengths and creates a distinctive research environment.

Culture, Society, and Human Behaviour

As a comprehensive university, SFU champions the liberal arts and sciences and promotes pioneering interdisciplinarity. We enjoy the presence of hundreds of excellent researchers whose record of awards, grants and publications demonstrates the University's success in building a community of creative thinkers and practitioners, a combination exemplified by a cluster of scholar-poets who excel as both wordsmiths and socio-cultural theorists. Areas in which interdisciplinary innovation is receiving

particular attention include, but are not limited to, the following potential targets for strategic development. Alongside the role of humanities scholars in teaching and modeling critical thinking, the social impact of the University is further enhanced by the qualitative methodologies of experts in such specializations as anthropology, business, criminology, gerontology, political studies, psychology, sociology, and women's studies. In all these areas, the challenge is to develop focal points (individuals or groups) to enable dispersed researchers to cohere in creative research groups that will be distinctive to SFU.

Research in the Humanities

Philosophers, historians, classicists, literary critics and linguists investigate and describe the ever-changing realities of contemporary life, and teach us how to question and critique the political, social, sexual, economic, and historical frameworks within which we all live and work as world citizens. Scholars of English study the entire spectrum of literary and textual activity, from the genesis of a writer's creative spark through the various stages of a manuscript's development and dissemination. Those specializing in print culture put particular emphasis on the socio-cultural circumstances of a work's production and reception (transcription, printing, illustration, publication, branding, sales, adaptations), reception, and endurance over time. Others study the ways that literary and public texts shape nationalist, ethnic, and global power relations, while specialists in rhetoric analyze the conventions and subtleties of public discourse, covering the gamut from humour to political documents. Dramatic literature and theories of performance constitute another focal point, from medieval mystery plays to present-day film and theatre. Scholars of history, whose research strengths are social history and cultural history, grapple explicitly, profoundly, and critically with knowledge others often recognize only dimly or in passing: that the future was created yesterday. Specific research specialties share themes that overlap time and region: indigenous peoples; empire, colonialism, and postcolonialism; gender and sexuality; law and society; medicine and science; race and ethnicity; religious and intellectual history; and oral history. With their focus on people, communities, and culture, historians' study of trends, changes, and transitions renders them uniquely qualified to comment on new policies, planning, and resistance. Their knowledge that the past was complex, conflicted, and contested results in research and tools that enable understanding of the present and contribute to the future.

Foundations of Ethical Evaluation and Ethical Implications of Research

SFU possesses a broad range of research expertise both in the foundations of ethics and in applied ethics; this expertise can be found in areas including archaeology, business, criminology, education, environmental sciences, health sciences, philosophy, political science, and public policy. All research, from the fundamental discoveries of science to the development of new technologies, policies, strategies, and new ways of understanding, stand to have a significant impact on the way we lead our lives. For example, the "Intellectual Property Issues in Cultural Heritage" (IPinCH) international collaboration headed by SFU is working to explore and facilitate fair and equitable exchanges of knowledge, including the theoretical, ethical, and practical implications of commodification, appropriation, and other flows of knowledge about the past, and how these may affect communities, researchers, and other stakeholders. At SFU, researchers are concerned about the ethical implications of their research, and the university community as a whole takes seriously our ethical responsibilities. We take a leadership role in ensuring that research has a positive impact on human welfare, by pursuing the systematic investigation of our moral beliefs, from their philosophical foundations to their applications in the form of general principles, to public policy issues arising in the Canadian context.

Aboriginal Studies

Research into Aboriginal issues involves faculty members in anthropology, archaeology, economics, education, health, history, linguistics, literature, psychology, resource management, and sociology. SFU is conducting essential and leading-edge research on examining contemporary urban and rural issues in the Aboriginal community, preserving Aboriginal languages, partnering with bands and communities in Aboriginal education, examining classroom climate issues for Aboriginal/minority

students, resource management in Aboriginal communities, barriers to Aboriginal labour market success, and archaeological research. SFU researchers are well recognized for their critical analysis of issues dealing with Aboriginal sites; their work links the historical past to current concerns, as in a major collaborative research initiative to investigate the intellectual rights issues raised by archeological practice. Other researchers focus on the spectacular rise of Aboriginal and Métis writers and artists. With the appointment of a Director of the Office of First Nations and new space dedicated to Aboriginal studies, the time is opportune to integrate researchers across the University.

International Studies

Canada's Asia Pacific Gateway Strategy includes a focus on fostering strong relationships in education, research, and the exchange of innovative ideas and technologies. By lending our collective knowledge and building our research capacity through partnerships with Asia Pacific institutions, we can play a valuable role in this strategy. SFU has had an intellectual engagement with China for over two decades, and since then, we have expanded to create relationships with many other Asia Pacific institutions for mutually rewarding flows of highly qualified human capital. Given our geographical and demographic location, researchers at SFU are particularly interested in examining connections between Asia and Canada from a number of different disciplinary and interdisciplinary perspectives. This research emphasis is informed by a deep understanding of Asian countries, cultures, and economies. SFU has also augmented its commitment to internationalization of research through several important new initiatives. Research in this area includes international studies and international policy, advanced by new endowed research chairs in religion and cultural change, and international law and human security. The Human Security Report project analyses global and regional trends in political violence and their causes and consequences, and has put SFU on the map internationally as a resource for governments and nongovernmental organizations alike. The Centre for the Comparative Study of Muslim Societies and Cultures represents another interdisciplinary collaboration that has few Canadian counterparts. The World Literature program is focusing on the way aesthetic forms and topoi pass from one culture or time to another, most often in defiance of political and social boundaries.

Safety, Security, Criminal Behaviour Assessment and Treatment, and Forensic Studies

SFU has significant strength in the analysis of criminal behaviour and forensic studies. The Institute for Canadian Urban Research Studies (ICURS) is one of three main centres for environmental criminology, as well as computational security and safety. Together with IRMACS, internationally recognized expertise exists in security research in computational criminology and the criminal justice system. The Criminology Research Centre studies youth crime, violence against women, and the role of some mental disorders in criminal behaviour. The Mental Health Law and Policy Institute, with members from numerous countries, promotes interdisciplinary collaboration in research and training in areas, e.g. psychology and criminology, related to mental health and policy. The Centre for Restorative Justice is unique in Canada, and there are only a handful of such research centres worldwide. The Centre for Forensic Studies links archaeology and biology in state-of-the-art labs with a focus on forensic science and technology. These groups provide a powerful hub around which crime-related research in other units can be focused. The newly appointed LEEF Chair in the Reduction of Youth Violence partners with Children's Hospital to reduce violence and victimization among youth.

Another significant research focus builds on SFU's existing strengths in security and health research. Its aim is to establish new research capabilities that will enable SFU to be recognized internationally as a leader in public safety, security, and health science. Specifically, this initiative builds on expertise in security research in ambient assistive living, disaster relief, violence risk reduction, public health monitoring and intervention, public policy and health, the social and psychological influences of health, and homelessness and addiction. SFU has invested in significant infrastructure for secure computing facilities for research that involves highly sensitive datasets. This infrastructure consists of a central, high-security computer lab coupled to secure networks, secure

data storage, and secure satellite labs with data processing and visualization facilities. Strong regional, national and international partnerships are in place, with access to highly secure datasets from these stakeholders—a combination that places SFU in a leadership position in security and health research.

SFU researchers are developing strengths in other aspects of security, such as polymer chemistry, microelectronics, optics and nano-fabrication of new materials for new high-tech security technologies. For example, research and training programs in advanced materials and engineering take advantage of collaborative initiatives in materials science and business to foster and cultivate a culture of innovation, by bringing safety and security technologies from the bench-top to the marketplace and producing graduates with knowledge in entrepreneurship. The core expertise in optical, electronic, magnetic, polymeric and nanomaterials puts SFU in an ideal position to target key technologies including security inks and taggants for surveillance and identification, and sniffers for pathogens, pollutants, toxins, contaminants and explosives. SFU researchers are also leading the Human Security Report Project, researching global and regional trends in political violence and their causes and consequences. SFU researchers are working on ways to increase the safety, health and welfare of employees, and by extension to those who are impacted by safety issues in the workplace (family members, employers, customers, suppliers, and nearby communities).

Evolution, Cognition, and Culture

The relationship between the sciences and humanities has long been fraught with difficulty—a tension captured by C.P. Snow in the phrase "The Two Cultures." Recently, researchers on both sides of the sciences/humanities divide have recognized that the evolutionary and cognitive sciences have advanced to a point where it is now possible to move beyond the two cultures and develop an approach to the study of traditional humanities subjects such as ethics, religion, and literature that is compatible with, but not reducible to, the way in which scientists approach their subject matter. SFU is in an excellent position to become a world leader in this ambitious, interdisciplinary plan to integrate the sciences, social sciences and humanities. For example, researchers in archaeology, biological sciences, business administration, linguistics, and psychology, including the CRCs in Human Evolutionary Studies and Management of Technology, are using phylogenetic methods from biology to understand the evolution of a range of social and cultural phenomena, while researchers in English are carrying out work in the area of biosemiotics, which focuses on the wide variety of forms of communication in biological systems, and research in psychology focuses on the development of communication in infancy. Through participation in the influential Centre for the Evolution of Cultural Diversity currently sponsored by the UK Arts and Humanities Research Council, SFU is poised to bring focus to this area of evolution, cognition, and culture in an international context.

Urban Communities

Located in one of the best-known "livable" cities in the world, SFU has research strengths covering a wide variety of urban issues, from urban design and planning to the study of the individual resident, including the social, artistic, and environmental aspects of urban life. Specific strengths exist in the areas of urban studies, geography, computing science, mathematics, criminology, computing science, economics, and forensic psychology. The Metropolis British Columbia Centre of Excellence for Research on Immigration and Diversity is part of an international network that supports studies of the economic, social and political dimensions of immigration, with British Columbia emphasized as a case study in ethnic diversity. Cultural researchers are probing key and complex issues of social cohesion, antiracist education, violence in society, multiculturalism and cultural adaptation, citizenship, diasporic cultures, and nationhood. There are promising possibilities for interdisciplinary research focusing on second-language learning, public education and the wellbeing of communities. French language researchers in the Faculty of Education, for example, conduct research that focuses on multilingual students from diverse origins and a growing population from Francophone Africa to understand their linguistic and cultural practices and examine how the education system responds to

their needs. The CTEF-funded “Modelling of Complex Social Systems” (MoCSSy) program brings together extensive expertise in criminology, health science, urban dynamics, computer science, and mathematical modelling, under the unifying theme of modelling the complex dynamics that drive the linked epidemiologies of crime, disease, homelessness and other social ills in urban neighborhoods.

Intervention Impact Assessment

Rapid change in our underlying economic and technological world has led to rapid change in the stratification of our society, with increasing inequality and poverty accompanying vast increases in wealth. What are the social and economic impacts of effective transition programs for immigrants? What happens when we do a better job of providing educational opportunities for Aboriginal peoples? What role does effective Labour Market Information play in individual decision-making, and ultimately, on the economy? How might the use of technology improve access to learning and/or opportunity for disadvantaged groups? These are all examples of research questions that might fall outside the traditional Tri-Council research programs, but that have large-scale implications. In general, funding for most forms of service delivery, including educational and social programs, is increasingly linked to the ability of the service provider to demonstrate results. Despite the increased attention being paid to “accountability”, the mechanisms, tools and practices for effective impact assessment remain, at best, blunt instruments (consider for example, the Fraser Institute ranking of schools or the Macleans’ ranking of universities). An interdisciplinary approach, harnessing the research approaches of economists, sociologists, psychologists and educators, would provide a framework for significant advances. SFU researchers currently possess great strengths in each of these areas, and are in an excellent position to develop more sophisticated research methods for impact assessment and to subsequently apply those methods to a wide range of social interventions. By doing so, SFU can capitalize on its acknowledged strength and leadership in the social sciences and humanities, and position itself at the forefront of an emerging research need.

Economic Organization, Public Policy, and the Global Community

This theme covers a vast amount of research in the social sciences, business, and other areas. It includes individuals and families, firms and markets, governments, and the global community.

Economic Organization

SFU has significant strengths in the theoretical analysis of firm organization, law and economics, public economics, the study of economic institutions, and econometric analysis. Expertise in these fields is complemented by strengths in computational, experimental, and evolutionary methods, which are reflected in the Centre for Research on Adaptive Behaviour in Economics and the Canada Research Chair in Economic Theory and Evolution. There are also strengths in a number of applied fields including strategic change, corporate governance, capital and risk management, biotechnology management, art management, and the environmental, ethical, and sustainable management of organizations. Current efforts include concentrations in the CMA Centre for Strategic Change and Performance Measurement, the Centre for Corporate Governance and Risk Management, and the Global Asset and Wealth Management Centre.

Public Policy

The role of the public sector in our economic and social lives has increased as our private wealth has grown over the past decades. This has spurred research on how policy is formed, what policies are good and in what contexts, and on the unintended consequences of policy decisions. Such research is carried out in economics and the Public Policy Program. For instance, the Centre for Public Policy Research CPPR in the Public Policy program is unique in western Canada, with research drawn from economics, political science, women’s studies, business, education, criminology, resource and environmental management, and communications. It has current or planned strengths in tax policy, Aboriginal policy, labour markets, environmental and natural resource policy both in Canada and

developing countries, and governance issues in developing countries. Policy-related research is also pursued in the CURA Economic Security Project, the Learning City project, the Institute of Governance Studies, and the Mental Health Law and Policy Institute, among other venues. Expansion of the CPPR would complement existing or projected policy research in health sciences, urban studies, international studies, and communications.

The Global Community and Emerging Markets

SFU has several research groups concerned with international economic relations, transnational organization, and global culture. One group focuses on issues of trade, international finance, and economic development in low-income countries; another investigates the management of global enterprises. The new Centre for Global Workforce Strategy carries out multidisciplinary research on issues surrounding effective workplace management strategies. The Jack Austin Centre for Asia Pacific Business Studies has a mandate to examine a broad range of issues relevant to the Asia Pacific region, particularly Canada's role in the area. The Centre for Global Political Economy addresses the intersection between global and domestic political economy, while the MCRI Globalism Project studies the effects of globalization on people in a range of individual countries. SFU researchers examine issues of knowledge, innovation and technology, including issues related to the formation, operation and growth of biotechnology firms and on the IT sector of the economy. The Global Asset and Wealth Management Centre focuses on markets and risk management, to bridge the gap between traditional finance theory and the growing field of behavioural finance. Research on global institutions will focus on peace and security studies; development, environment, and international economic relations; governance and civil society; and human rights and international law.

The Creative Economy

The Creative Economy, defined to include the whole of the creative chain for core cultural goods and services, including their creation, production, manufacturing, distribution, and support, has emerged as both a substantial and an expanding sector of the Canadian economy. It now accounts for 7.4 percent of GDP and 1.1 million jobs. Growing more quickly than the economy in general, creative enterprise has become an economic driver in the contemporary world. Employment in the creative economy is growing at a faster rate than other kinds of employment, and requires new patterns of work built on flexibility and innovation from workers, employers, government and educators. The creative economy also generates the social capital that is fundamental to social cohesion. Understanding the nature and dynamics of the creative economy is critical to Canada's social, cultural and economic future, and SFU's strengths in the contemporary and interactive arts, literary and publishing studies, and technology position it to play a leading role in research in this area.

Environment, Resources, and Conservation

SFU has an excellent record of high-profile research related to the environment. This research is conducted throughout the University. The research approaches and topics span a range of sectors from theoretical and mechanistic studies to applied management strategies. Mirroring the major natural resources of British Columbia, research clusters at SFU focus on the relationships between economic development, conservation and biodiversity in terrestrial and aquatic ecosystems, as well as on natural hazard prediction and prevention. Our research includes not only chemical, molecular biological, toxicological, physiological, and behavioural studies, but also risk assessment, management, and historic and economic considerations. The ultimate goal of this multifaceted approach is to provide a sound basis for sustainable development and the responsible use of our natural resources.

Planning, Development, Management, and Sustainability

SFU will pursue research in a number of areas related to the development, planning, management, and sustainability of human settlements and the impact of human and natural disturbances on environments and communities. Research foci include governance and equity issues, spatial and labor

market dynamics, consumption patterns, industrial restructuring, and ecological, economic and social sustainability. Related foci include sustainable development policy; sustainability and quality of life indicators, assessment and evaluation; public space and urban/regional livability; health care and access; property rights and spatial inequities; local economic development; and the development of mathematical tools in resource allocation and management. Research related to development and the environment in selected world regions, especially Latin America and Asia, will include health and water use, property rights in natural resources, land use conflicts, tourism development and management, shifting cultivation and cash cropping, environmental governance and co-management, environmental policy at local level (including protected area issues), various applications of economics and social theory to conservation and management, and the role of foreign investment in development. SFU research integrating the social and natural sciences focuses on the impacts of human development and natural disturbances on natural and urban environments and communities. Emphasis is placed on the causes of and responses to natural hazards, such as earthquakes and landslides, and on sustainable development strategies that integrate economic, social, and environmental objectives. Research on both geoscientific and biological phenomena in the ocean environment is integrated within the SFU-supported Neptune Canada project. Research in environmental education and education for sustainable development will be key to understanding human interactions with the environment.

Ecosystems and Resources

In the 21st century, environmental research has broadened to encompass concerns such as species at risk, biodiversity, sustainability and endangered habitats. SFU researchers, including those in the Centre for Wildlife Ecology (CWE) and the Cooperative Resource Management Institute (CRMI), conduct basic and applied research in wildlife, fisheries and forest ecology and provide knowledge and personnel that will help meet the challenges of conservation. Information, ideas, expertise, resources and opportunity flow back and forth from SFU to government agencies such as Environment Canada (EC) and Fisheries and Oceans Canada (DFO), as well as FORREX (the Forum for Research and Extension in Natural Resources) to help inform policy and decision-making, while SFU faculty and students benefit from enhanced opportunities for discovery and applications-based research. SFU will partner with EC, DFO, and FORREX to accommodate new research areas under their broadened mandates.

SFU continues to be a major player in research aimed at the understanding and management of fish populations in their marine and freshwater habitats, as well as the broader management of the coastal zone. Such research encompasses the genomic analysis of salmon, fish disease prediction and management, socio-economic studies on fishing communities, stock and risk assessment, sustainable management of wild and farmed species, coastal tourism and socio-economic studies of fishing communities. Strategic initiatives will strengthen the links between applied ecological approaches and coastal management. SFU researchers are also investigating the ecosystem science of large rivers, carbon and nutrient cycling in lakes, hydrology of lakes and river floodplains, biogeochemical mass fluxes to the ocean from small catchments, plant water interactions, glacial processes and soil erosion. Marine investigations focus on understanding natural variability and biogeochemical linkages within the ocean and climate system and responses to perturbations.

SFU research related to terrestrial ecosystems includes ecological, institutional and economic approaches to the conservation of ecosystem services, biodiversity conservation and invasive species, and ecosystem-based forest management (including an understanding of natural disturbance regimes and forest dynamics) and industrial forestry issues. Energy and materials management is also emphasized, through developing and applying sustainable policy models that are both technologically explicit and behaviorally realistic. Management of protected areas, advisory and advocacy issues in the environmental policy process and the valuation of ecosystem goods and services are key interests. SFU researchers also study the modern and ancient geological

environments, natural hazards, and geological resources. Fundamental research on Earth materials is connected to the overall Earth system and relevance to society. Tracking Earth conditions from past conditions to the present and into the future is providing an improved view of the changing environment and climate. Understanding temporal changes in water resources and ice conditions, and the nature and mitigation of geological hazards, are key foci. Geological resources presently under study include metallic mineral occurrences, gemstones, oil and gas deposits, and subsurface water. Investigations range from direct studies of the resource commodities to methods of ore extraction, establishment of scientific infrastructure, and predictive models for resource exploration. SFU will also focus on geoscience research linked to the exploration and development of BC shale gas, and BC hydrocarbon resources in general.

SFU has a strong spatial research emphasis in health and environment, including optimal location of health services and population health. This concentration is augmented with visualization approaches, such as multi-dimensional geovisualization and geospatial interface research. Modeling of complex spatial environmental systems, land use, land cover and urban growth continue to be important activities, together with modeling of dynamic spatial phenomena in forestry and landscape ecology.

Climate Change Solutions

As a founding member of the Pacific Institute for Climate Solutions (PICS), SFU researchers are well positioned to contribute to the development of innovative climate change solutions, seek new opportunities for positive adaptation to climate change solutions, and lead the way to a vibrant low-carbon economy in BC and globally. PICS seeks to support transformative change in response to the many challenges raised by climate change through multidisciplinary research conducted in partnership with governments, the private sector, other researchers and civil society, in order to undertake research on, monitor, and assess the potential impacts of climate change, and to assess, develop and promote viable mitigation and adaptation options to better inform climate change policies and actions. The Institute's research strategy is currently focused on four key interdisciplinary themes: a low carbon-emissions economy, sustainable communities, resilient ecosystems, and social mobilization.

Researchers involved with SFU's Adaptation to Climate Change Team (ACT) are studying critical climate change impact topics: biodiversity, extreme weather, energy, water security, crop and food supply, population displacement, health risks, new technologies, and sea level rise. Working in conjunction with leading experts, ACT will explore these issues and the linkages between them, the problems they pose as well as potential solutions, and produce policy recommendations for adaptation. Researchers in SFU's CTEF-funded "Climate Change Impacts Research Consortium" are taking a risk-based approach to the study of the secondary effects of climate change on human and ecosystem health.

Alternative (Green/Clean) Energy Technology

SFU is well positioned to become a leader in green energy technology research. Interdisciplinary initiatives in this area will focus on energy production, distribution, and utilization, along with related manufacturing technology and green IT. Current research includes fuel cell materials, design and diagnostics, energy management and harvesting, new generation fuel injectors for hydrogen technology, green IT technology, green computing, smart grids and smart houses. Another key area of research involves investigating human-centered sustainable systems at the intersection of conservation, sustainable design, alternative energy production and social behaviour around our ecological footprint. The rise of ubiquitous computing, smart environments and the widespread use of mobile devices offers an opportunity to enable occupants to dynamically interact with building technologies through digital media.

Aboriginal Communities and the Environment

Aboriginal issues in relation to the environment have been a significant focus at SFU and will grow in importance over the coming years. We have substantial research strengths in applications of resource management and resource planning to Aboriginal communities, with a particular focus on Aboriginal and place-based community co-management, forest management, fisheries and aquatic management, protected areas and heritage planning, and strategic land-use planning. Other areas with a strong Aboriginal focus include heritage tourism, and coastal zone management and planning, geographic information science, and community planning and development. Commensurate with increasing control over lands, waters, and resources by Aboriginal people in Canada and worldwide, we will continue to develop our strengths in issues related to resource and environmental management and planning by Aboriginal people on their traditional lands. This will focus on applications related to sustainable community development, economic strategies and resource use as well as conservation strategy and heritage protection. These activities will draw both on our existing strengths in management and planning, and analytical tools such as geographic information systems, but also on existing strengths at SFU in Aboriginal resource management practices and traditional ecological knowledge. We will also develop our engagement with Aboriginal peoples, both in a research context and an educational context, through collaborative research projects and field-schools especially with local Aboriginal communities (First Nations and Métis), and increased Aboriginal curriculum throughout our programming.

Health and Biomedical Sciences

A common goal for health-related cross-disciplinary research at SFU is to describe human health in its full context, including the diverse impacts that social inequities have on health. SFU has developed a reputation for excellence and innovation in health research, involving faculty from across the spectrum of disciplines and organizational units at the University. With such a wide array of health sciences interests, SFU seeks to strengthen a number of interrelated research areas that impinge directly on human health. We have particular strength in genomics, bioinformatics, and health informatics, biostatistics, biomedical sciences, neuroscience, medicinal chemistry and drug development, biomedical devices, biomedical imaging, mental health and addictions, as well as in health policy and cultural and population studies, from basic investigations to clinical applications. The establishment of the Faculty of Health Sciences and its state-of-the-art facilities provided a special opportunity for innovative new multidisciplinary research initiatives and graduate programming. Novel research and graduate programs have or are being developed in population and public health, global health, infectious diseases, aging and chronic illness, and brain function and development. Partnerships between SFU and the hospitals and health authorities in the Lower Mainland enhance these opportunities. SFU is a leader in the secure analysis of sensitive data. Population Data BC, a platform for supporting research on human health, wellbeing and development run by a consortium of researchers from institutions around BC including SFU, will provide researchers with access to linkable individual data for integrated analysis of health outcomes using a range of secondary sources. Our goal is to develop interdisciplinary collaborations and partnerships that bridge the biomedical, clinical, and social sciences and involve the wider community, building on SFU's tradition of innovative and effective outreach. Examples are the new Institute for the Reduction of Youth Violence, a joint partnership between SFU and Children's Hospital that aims to reduce adverse health and mental health consequences of youth violence; and the Centre for Research on Early Child Health and Education, that links scholars in universities and research centres to increase access to universal health and education programs for young children.

Genomics, Bioinformatics, Health Informatics, and Biomedical Technologies

The completion of the Human Genome Project in 2003 produced the first DNA sequence of a human genome and has stimulated the functional genomic analysis of thousands of additional organisms and the development of higher throughput and cheaper sequencing technologies. Genome structural variations among individuals are being revealed at single base-pair resolution, promoting exploration

of the relationship between genotypes and phenotypes. Genomic sciences are redefining the research landscape of the fundamental life and biomedical sciences and their applications, including cell and molecular biology, structural biology, population and evolutionary biology, microbiology, aquaculture, agriculture, fisheries management, forestry, environmental sciences, drug discovery and assessment, neuroscience, and biotechnology. The concept of personalized medicine is being realized based on the application of the genomics of cancer, aging, mental health, chronic and infectious diseases to the diagnosis and treatment of patients. Genomic technologies have important applications in disciplines such as anthropology (e.g., tracing human migrations), conservation biology (e.g., assessment of biodiversity), and forensics. The explosive development of genomics has created demand for more effective computational data management systems and bioinformatic tools for data analysis and interpretation, and has spawned new fields including transcriptomics, proteomics, and systems biology. SFU already has considerable expertise in genomics, bioinformatics, and data mining, spread across several Faculties, and is developing interdepartmental teaching and training programs. SFU has taken a leading role in the development of a regional Genome Sciences Institute that builds on its partnership with the Genome Sciences Center based at the B.C. Cancer Agency.

SFU also has significant strengths in biomedical technologies. Current research focus areas are medical imaging, radiopharmaceuticals, computational anatomy, bio-sensors, biomedical optics, signal processing, biomechanics, assistive technologies, haptics, micro / nanotechnologies for medical applications, micro-fluidics, biochips, bioinformatics, computational biology, health informatics, and chronic disease management. Research in this area is highly interdisciplinary and involves computer scientists, engineers, interactive arts researchers, biomedical scientists, kinesiologists and psychologists from SFU working in teams with clinicians to develop new tools and products. The combined effort is intended to address issues of individual human health, ranging from molecular, cellular, and systems biology to population health and its modeling.

GE3LS Analysis

The consequences of scientific and technological innovation are significant, especially when it comes to genomics and its Ethical, Economic, Environmental, Legal, and Social aspects (commonly called GE3LS). Research will inform new legislation to control innovative growing practices in agriculture, and economic and environmental practices in fisheries and forestry, where genomics techniques can be used to select fish or trees able to withstand the effects of climate change. Genomics research has economic and social implications in such applications as bee colony collapse, bioremediation for industrial waste from Canada's resource industries, and diagnostic tools for disease and mental disorders. As whole genomes of organisms become known, together with their subtle variations and functional characterizations, there will arise issues of intellectual property and ownership of such information. What's more, genomic information is published in publicly available databases, and questions arise as to the social impacts of how the public will use this information. Such information can be used by experts in risk communication of health-related genomic information, both for public health events such as pandemics, and for individual's health-related information. It can also be used in repatriation and other claims of cultural relationships and affiliation. Issues of cost-benefit and potential quality of life benefits associated with early diagnoses will have to be explored. Finally, research can ultimately extend to the choice of a partner in a world where a mate's genome can predetermine life expectancy, personality, and mutual compatibility. How society deals with such a brave new world will be the focus of research in this subtheme.

Chronic and Infectious Diseases

SFU has outstanding researchers studying both chronic and infectious diseases. Considerable strength exists in the realm of genomics, bioinformatics, biomolecular interactions, psychological and psychiatric disorders, and we are developing strength in proteomics and metabolomics. Researchers on the CTEF-funded "Bioinformatics for Combating Infectious Diseases" project are

focused on the development of more accurate and faster bioinformatics algorithms and tools for identifying anti-infective drug targets, candidate drugs and potential vaccines. The interdisciplinary team is capitalizing on SFU's unique strengths in computational, physical, chemical and biological sciences to discover potential new therapeutic targets and test them first *in silico* and then in the laboratory. Another CTEF-funded team of researchers with expertise in organic and inorganic materials, bio-organic chemistry, molecular biology, biochemistry, biomedical physiology and kinesiology and computer sciences are working together with experts in ethics, medicine and medical imaging to take novel molecules and nanomaterials from the chemistry lab into the clinical setting, and to develop new and innovative strategies for medical imaging, diagnostics, surgery and drug delivery. The team is working synergistically to create, apply and test novel approaches for the diagnosis and treatment of prostate cancer and kidney stones as their first targets.

Significant investment in personnel and physical infrastructure at SFU has ensured that the drug development pipeline from genomics input to pharmaceutical output is well represented at SFU. SFU, with its strength in medicinal chemistry, is an important node of the Centre for Drug Research and Development (CDRD), focusing on the development and evaluation of new drug candidates. Since one-third of approved drugs will go off patent by 2012, SFU is well poised to discover the next-generation of drugs and to partner with pharmaceutical companies. Additional strengths exist in virtual reality therapy and training, visualizations and accessible tools for managing pain over time, and the extension of these tools to the community via social media and mobile technologies.

Continued growth in this area will require strengths in clinical and health psychology, developmental biology, environmental toxicology and receptor biology, climate change, cardiovascular disease, healthy aging and the social determinants of health, and support for emerging strengths in neuroscience and mental health, HIV/AIDS and addiction research, violence reduction research, vaccine and drug development, bioinformatics, and genetic and epigenetic studies, infectious disease modeling at both molecular and population levels, microbial epidemiology, ecology and evolution, the innate immune response to infection and the cellular/molecular basis of infectious disease pathogenesis.

Strategic research that bridges nutrition, biomedical and behavioural science would complement existing strengths. Collaborations in this area require support of a wide range of technologies including biomarkers, transgenic animals, nanotechnology, novel imaging and visualization modalities, province-wide comprehensive data and geographic information systems, and complex social modeling.

Human Development and Aging

Research strength in human development and aging exists in basic biomedical, population, and social sciences. These include the areas of children's social, emotional, and mental health, brain development, brain function and problem-solving, mammalian developmental biology, birth defects, molecular-genetics, epigenetics of cellular differentiation, health policy, adolescent mental health, health behaviour and risk, youth crime and violence, gender and aggression, and longitudinal studies on aging. The broad field of neuroscience offers an exciting area for strategic investment, especially in areas focusing on aging and degenerative diseases of the nervous system and its connection to behavior and health. SFU strength exists in clinical psychology, neurobiology of addiction and of age-related degenerative disease, and psychological mechanisms underlying youth aggression. SFU will apply its combined strength in imaging, neuroscience, genetics, epigenetics, and cellular physiology to the study of development and aging.

Population and Public Health and Health Services

Population and public health is a major focus of SFU research. There are many areas of overlap with the other two focus areas, for example cardiovascular and chronic disease management and

environmental and occupational health. Another important crosscutting element is the flagship program in Global Health. Expansion of population sciences and public health practice across areas of shared research focus, such as in infectious diseases and global health, mental health, environmental, occupational health and earth systems, and Aboriginal health and the impact of social disparities on health could increase synergies in emerging areas of cross-disciplinary strength at SFU. Bridging SFU's substantial strengths in biomedical sciences and health services to population and public health would result in a competitive advantage. Such an approach would build on newly established research strengths focused on population level interventions and health policy sciences, such as: research chairs in Children's Health Policy, Applied Public Health, Cardiovascular Health, Reduction of Youth Violence; the research centres, including the Centre for the Study of Gender, Social Inequities and Mental Health, the Centre for Children's Health Policy, and the Centre for Applied Research in Mental Health and Addictions; the Canadian Multi-site Research Demonstration Project in Mental Health and Homelessness; emerging research capacity in toxicology and environmental and occupation health with faculty recruitment in the area of Children's Environmental Health, and partnerships with BC Children's Hospital, Health Canada, Environment Canada, and the Pacific Institute for Climate Solutions; and SFU's Community Trust Endowment Fund investment in two cross-Faculty interdisciplinary teams, the Modeling of Complex Social Systems and Secondary Effects of Climate Change on Human and Ecosystem Health.

Continued growth to support this subtheme would include bridging areas in social inequities of health, global and Aboriginal health, ethics, health economics and health policy including new health services models, intervention trials and uptake of best practices in primary health care. Growth of research strength in environmental and occupational health would include a focus on molecular toxicology, genomics, proteomics, and metabolomics that study the cellular and molecular responses to drugs and to xenobiotics associated with environmental exposures, and would include the development and use of biomarkers, medical imaging, and basic neuroscience.

Health Systems

There is a growing need to understand how health systems function, and this presents an important and exciting area of research that is largely neglected in Canada. Foci include comparative studies of international primary health care systems, explorations of the cost effectiveness of chronic disease prevention and management approaches, estimates of health resource needs and mix of specialists, organizational studies of inter-professional training and practice structures, performance outcomes of innovations in primary care practice and incentive structures, organizational studies of leadership and processes in health system change management, forecasts of health care needs and health system responses, assessments of the impact of primary care interventions on indicators of population health, community assessments of the social determinants associated with chronic disease distribution, and the issues of health equity, social justice, and ethics in health care. The resulting research outcomes will provide objective information to aid decision-making by Canadian provincial and federal government agencies and ministries. It also provides an opportunity for global outreach, as comparative studies will form a significant component of the research activities. SFU would be a vital hub in a network of similar endeavours, providing the opportunity for research collaboration and faculty and student exchanges. Global organizations with an interest in the strengthening of health systems, e.g. the World Health Organization and the World Bank, are potential clients and partners.

Pedagogy

Pedagogy stresses the mutually constitutive and intersecting activities of scholarship, teaching, and engagement. It concerns both the art and the science of teaching, and involves teachers engaging learners spontaneously and methodologically. Boundaries between teachers and learners are not always fixed. Research in this theme is conceptualized as a framework of four essential components: understanding,

research use, knowledge mobilization, and reciprocity. *Understanding* involves fundamental explorations to map what is and can be in education, what we value of education practices, and how processes of education unfold and can be transformed to benefit individuals and society. *Research use* refers to investigations about how understanding may be applied to address education issues. It includes, but goes beyond, developing and refining methods across the spectrum of educational practices and forms of educational inquiry. *Knowledge mobilization* refers to critical and self-reflective occasions where we apply research in practice, for example, determining the impact of educational interventions across individual and systemic levels. Finally, the notion of *reciprocity* concerns our studies of collaborations with the educational community, the settings for research mobilization, with an emphasis on designing and using feedback loops to inform and refine future research throughout the framework. Future research vitality lies in actively inter-relating these four framework components, and these components individually and together represent significant foci for emerging scholarship.

As represented in the draft recommendations of the SFU Task Force on Teaching and Learning, one of the principles of teaching and learning is to “engage in inquiry about teaching, and support pedagogical innovation to enhance our practices and student learning.” This leads in turn to the recommendations that relate to research, including determining mechanisms to develop, recognize and integrate more research, experiential and international learning opportunities into the curriculum and recognize these with academic credit. Evaluation of alternative approaches to learning opportunities should be examined critically. The pilot program LUCID (Learning for Understanding through Culturally Inclusive Imaginative Development) is an example of imaginative education that incorporates culturally relevant stories, games, and images to promote imaginative thinking in the K-12 curriculum beyond the standard modalities of textbooks, worksheets and testing. The program has been shown to also strengthen children’s language and collaborative learning skills.

Foundations for Success

We have been extraordinarily successful in designing and implementing the Foundations of Academic Literacy program. There is urgent need to better understand the short- and long-term impacts of this particular program, as well as complementary programs in other areas key to success in academe and the workplace. For example, there is significant need to amplify research in mathematics education that advances our understandings about cognitive and affective mechanisms in learning mathematics, that designs and tests strategies for learning mathematics, and that invents supports for teaching mathematics. SFU researchers are exploring the professional development of teachers; designing and teaching “Q courses”; the role of technology in teaching, collaborative group teaching and problem solving; virtual worlds for course delivery; understanding student mathematical cognition and learning, including studies into the aesthetics of mathematics, the nature of insight, concept formation, and anxiety; investigating ways in which the brain and body are implicated in learning and understanding mathematics; developing approaches to teaching mathematics that are responsive to cultural differences; and Masters and Ph.D. programs in mathematics education. Another cornerstone for success in today’s world is technical literacy. This arises in the context of fast-paced evolution and occasional revolutions in technologies that affect education and people’s readiness for new jobs. Research should be conducted on the benefits of the Undergraduate Curriculum Initiative through ongoing inquiry into the effectiveness of writing-intensive, quantitative and breadth courses.

Education and Human Development

Education is central to focusing and fostering human growth and development. These terms are used in a broad sense, to encompass: acquiring knowledge, developing skills, becoming prepared to apply and transfer achievements, exploring and articulating attitudes, generating and controlling motivation, and nurturing a positive sense of self in a context of connection to others. SFU pursues this research across the lifespan from early childhood through later adulthood in a variety of settings within and beyond schools. Research in this subtheme will enable us to better understand how

development happens, to identify factors affecting it, and to determine how to best intervene for the benefit of individuals and their social groups.

Education for Diverse Populations

SFU has significant expertise in second language acquisition and pedagogy, civics (in a broad sense grounded in ethical and moral considerations), issues in international education, and working in close and productive partnership in multi-cultural or cross-cultural contexts. For example, SFU researchers associated with the Metropolis British Columbia Centre of Excellence for Research on Immigration and Diversity have made significant contributions to the study of immigrant education at the urban and regional levels. Another example is the Imaginative Education Research Group and its projects such as “Building Culturally Inclusive Schools” that have furthered our understanding of successful educational practices in diverse cultural settings. The CTEF-funded research team, “Education Systems and Outcomes in Diverse Communities,” brings thematic coherence to the work of a diverse set of researchers in areas of public policy, economic organization, aboriginal learning, immigration, urban studies, and population health. It builds on well-established strengths in economics, psychology and education, integrating them with one another and with emerging strengths in public policy, dialogue, and health sciences. Similarly, the Centre for Research on Early Child Health and Education represents an interdisciplinary approach to improving the lives of young children who are vulnerable to poor developmental outcomes due to biological and/or economic disadvantage. SFU research has also led to advances in our understanding of areas such as multicultural practices, philosophies of language, and the roles that language and culture play in pedagogical practice. SFU researchers have taken a leading role in the development and testing of innovations in the uses of media (e.g., video), technology (e.g., web-assisted learning) and pedagogical methods (e.g., applications of cognitive neuroscience to mathematics learning) to support education for diverse populations. For example, an exciting area of research is the role of mathematics and music, and interactive arts technologies, for instruction of autistic children.

In Canada, there is a clear need to improve both the participation and success rates of Aboriginal peoples at all levels of education. Accomplishing this goal will require new ways of understanding Aboriginal educational issues, exploring the current roadblocks and problems in the system that exacerbate the problem of low Aboriginal graduation rates, and new modalities of learning and new forms of engagement for Aboriginal Education. The central vision of the Accord on Indigenous Education (Association of Canadian Deans of Education) is that “indigenous identities, cultures, languages, values, ways of knowing, and knowledge systems will flourish.” A strong foundation for this critical work exists at SFU. Our research builds on an almost 40-year tradition of engagement with Aboriginal communities in teacher education, Masters’ programs and other credit- and non-credit ventures. The LUCID pilot program has shown that the gap in learning between Aboriginal and non-Aboriginal cultures in schools can be reduced, and this could result potentially in increased high-school graduation rates among Aboriginal populations. Other work has explored Aboriginal knowledge, Aboriginal pedagogies, Aboriginal science, Aboriginal language and culture revitalization, and intergenerational teaching and learning, among other topics. Critical components of this research agenda include the further development and refinement of respectful and culturally appropriate research methodologies, the development, implementation and assessment of new pedagogical strategies, and the incorporation and mobilization of Aboriginal knowledge and philosophies into the mainstream educational system.

New Models for the Delivery of Medical Education

Alternative models of medical education are necessary to better manage Canada’s health care system. SFU will explore a system of integrated care, built around integrated clinical disciplines that reflect patient care needs such as mental health, developmental health, acute care, chronic disease

management, rehabilitation, and palliation. A program based on preventive medicine, generalist training, primary care, community health, and innovative practice models such as integrated diagnostic services for primary care physicians could be developed. Activities would also build on the current pedagogical strengths of SFU in the areas of e-health and health promotion, nutrition and metabolism, virology, immunology, physiology, genetics, epigenetics, epidemiology, biostatistics, demography, mathematical modeling, virtual reality, social and policy science, and ethics, as well as in the complementary areas of molecular biology and biochemistry, chemical biology, biological physics, cognitive (neuro) sciences, biomedical engineering, and imaging sciences.

Technology and Education

Much is being made of the “21st Century Learner” who has both intention and capacity to gain maximum benefit from technologies in formal and self-directed education. We need to better understand the pedagogical basis of this online and blended learning, and are poised to take a leadership role in this research domain. A necessary but not sufficient component of this research naturally focuses on transformative tools; such as hardware and software that help learners study and learn more effectively. However, “technology” is not isolated from or independent of the people and settings in which it is used, nor should the concept of “technology” be falsely limited to machines and software. The goal in this area of research is to enhance, not replace, the human interactions that are the foundation of education.

Research in this area entails the active pursuit of knowledge about a range of mechanisms, designs, and means for achieving societally-valued and personal educational goals. Important topics for research therefore include mechanisms of learning, models of teaching, designs for curricula, policy assessment and development, leadership, and professional conduct in technologically-enhanced teaching and learning, among a wider array of factors.

SFU is an important centre of innovation in the study of learning and the development of educational technologies. Major research initiatives are underway in education, communication, and computing science, with psychology, statistics, and engineering science planning further involvement. Current projects build on a distinguished record of accomplishment in educational technology. For example, there is conceptualization of a research centre that will provide infrastructure and a locus for scholars to pursue groundbreaking research about education and new technologies across the spectrum of education settings, including tools that support administering and instructing online, research on virtual and blended methods of discussion, the development of research tools and software for personal study, and investigations about how simulations, learning objects and digital games can be used to achieve best practices.

Education for Sustainable Development

Education enables us to understand ourselves and others as well as our links with the wider natural and social environment, and this understanding serves as a durable basis for building respect. Along with a sense of justice, responsibility, exploration and dialogue, education for sustainable development aims to move us to adopting behaviours and practices that enable all to live a full life without being deprived of basics. Sustainability is a concept, a goal and a strategy. The concept speaks to the reconciliation of social justice, ecological integrity, and the wellbeing of all living systems on the planet. The goal is to create an ecologically and socially just world within the means of nature without compromising future generations. Sustainability also refers to the process or strategy of moving towards a sustainable future. What we teach, what we don't teach, and how we teach are all considered when creating sustainability education. Sustainability education is a process of creating a space for inquiry, dialogue, reflection, and action about the concept and goals of sustainable development. The research agenda includes the development, monitoring, and evaluation of environmental learning initiatives and the ongoing identification of sustainability indicators and evaluation tools. Such work includes: (1) developing and validating instruments for measuring

learning environments in community or ESD oriented programs, (2) creating rich descriptions of how these learning environments are characterized quantitatively and qualitatively, and how they differ from other educational settings, and (3) developing, implementing and testing a variety of program interventions in these learning environments while accounting for variations in learning, teacher engagement and other effects.

Institutional Support for Research

SFU provides critical personnel infrastructure support to facilitate research endeavours. Faculty mentors and grants facilitators provide aid to faculty in the preparation and critical evaluation of research grant proposals. The Vice-President, Research Office facilitates nominations for major national and international award opportunities, and enhances the profile of research at SFU by producing communications reflecting the value of our contributions in research and technology transfer activities. The Office of Research Services provides support in the identification, application and negotiation of research grants and contracts. Support is provided for research safety (Environmental Health and Safety), and for the approval of research involving animals (Animal Care Services) and human subjects (Office of Research Ethics). The University / Industry Liaison Office provides intellectual property and commercialization support. The Office of Research Accounting administers grants and contracts, and provides oversight and audit functions.

SFU recognizes that external funding of scholarly research through traditional avenues might be biased towards science and technology. Therefore, in the past five years, SFU has augmented its efforts to ensure that scholarly endeavours in the social sciences and humanities not be compromised and be supported adequately. Support for SSHRC small grants and travel grants, support for SSHRC 4A grants, publications, and safeguarding library collections are a top priority. To increase our participation in programs for major projects such as the Major Collaborative Research Institute (MCRI) and Community University Research Alliance (CURA) through SSHRC, as well as in social science research funded by provincial and federal ministries, support for grant preparation and administration is provided. Support for exhibitions and performances is also provided.

In addition, through SFU's Community Trust Endowment Fund (CTEF), we will continue to invest in major initiatives under the seven integrative research themes. The expectation is that the CTEF funding will enable these research initiatives to advance to a level that makes them competitive for major external awards. In keeping with this concept, funding will be ramped down over the years of a particular project. We propose also to provide CTEF networking grants to bring together faculty from different disciplines in workspaces to pursue interdisciplinary thematic research projects. We expect that these efforts will result in major cogent proposals submitted to external agencies.

Institutional Support for Students

SFU provides financial support for graduate students to facilitate their contributions to the research enterprise of the University in the form of entrance awards, fellowships, scholarships, bursaries, and teaching assistantships. In addition, SFU has an extensive array of private awards to support its graduate students. Fifteen SFU Community Trust Endowment Fund Graduate Fellowships in the Humanities for one semester of study will be granted to doctoral students in the humanities each year. These fellowships were created in recognition that research in the humanities in general is an essential element of the fabric of a research-intensive university. Another unique program supported by SFU is the Graduate International Research Travel Awards. These awards provide support for students to travel and live abroad to conduct their research. The Dean of Graduate Studies Office also provides support in terms of applying for and administering external graduate scholarships. The Dean of Graduate Studies works with the Office of Research Services to develop and administer policies related to intellectual property, and non-disclosure agreements related to externally funded contractual support for graduate students. A large

number of programs exist at SFU and are expanding to address the critical professional skills sets needed to participate in collaborative and interdisciplinary research. SFU is committed to using the resources at its disposal to attract and train outstanding international and domestic graduate students to SFU, including Vanier and other Tri-Council award holders, through the creation of special awards such as the "Provost Prize of Distinction" and the "Provost International Fellowship", and through enhancing the opportunity for scholarly activity. In addition, SFU is committed to provide opportunities for undergraduate students to engage in scholarly research and to support these activities through provision of research assistantships and internships.

Library Services

The library is a core service that supports research in all disciplines in a variety of ways. Foremost are the library collections. In addition to the book collection, the library has close to four million digital items, including seventy-two thousand online subscriptions. Primary research materials used by all disciplines are provided through special collections and membership access to the Centre for Research Libraries, as well as the online data library and memberships in data organizations such as the Inter-university consortium for political and social research (ICPSR). ICPSR maintains and provides access to a vast archive of social science data for research and instruction and also offers training in quantitative analysis. The Library offers services to digitize and permanently house online collections of data, electronic content, and reports, theses and articles related to specific research projects in all disciplines. About 825,000 print items are circulated or used in the library and about 3 million journal database connections are made every year. This published collection (both online and print) of secondary research receives significant usage from all disciplines. The Library works with researchers and publishers on initiatives such as the Public Knowledge Project, Synergies, Canadiana.org and the Canadian Research Knowledge Network to transform scholarly communication. Finally, the library works to control the cost of publication of research results through funding submission costs associated with Open Access journals and undertaking events and communications to raise awareness of publication options. These library services are highly valued and must be supported.

Librarians work with researchers to identify and retrieve primary materials essential to research and scholarship. Librarians also work with faculty during grant proposal preparation to develop proposals relating to data and information storage and, as research progresses, provide advice and facilities to store research papers, data, and information in secure and reliable institutional repositories.

Government Support for Research

In addition to the support that the federal government provides to the three national granting agencies, it has made a strong commitment to university-based research by investing in the Canada Research Chairs (CRC) program, the Canada Foundation for Innovation (CFI), the Networks of Centres of Excellence, the Centres of Excellence in Commercialization and Research, Genome Canada, Western Economic Diversification, and the Indirect Costs of Research program. These investments have rejuvenated Canadian research by attracting and focusing the efforts of stellar researchers, providing state-of-the-art infrastructure, and providing critical support to the universities to augment resources for research and technology transfer activities. This investment has significantly enhanced Canada's international competitiveness, and has caused other countries to examine the new Canadian model of research. While this progress is admirable, continued and increased support for discovery research is essential to creating knowledge that is the foundation for translation of ideas to innovation and new ventures.

The provincial government provides support through the BC Knowledge Development Fund (BCKDF), Genome BC, the Michael Smith Foundation for Health Research (MSFHR), the Pacific Institute for Climate Solutions (PICS), the Centre for Drug Research and Development (CDRD), through provincial ministries such as the Ministry of Health, the Ministry of Public Safety and the Solicitor General, the

Ministry of the Attorney General, and the Ministry of Children and Family Development, and through the Health Authorities. The provincial government also provides support through the Leading Edge Endowment Fund (LEEF) Leadership Chairs. To date, SFU has appointed four LEEF chairs in critical strategic areas: the Tom Buell Chair in Salmon Conservation and Management, the Chair in Pharmaceutical Genomics and Drug Development, the Chair in Cognitive Neurosciences, and a Chair in Prevention of Youth Violence. An additional search is underway for a Chair in Medical Imaging. The CRCs, LEEF, and other prestigious Chairs at SFU serve to seed and catalyze new initiatives as well as strengthen existing programs. We recognize the future value of further investment in selected areas that complement the resources of the Chairs. To this end, SFU has been highly proactive in providing or seeking matching funds for some of these initiatives.

Implementation

The Vice-President, Research, in conjunction with the Vice-President, Academic and the Faculty Deans, coordinates strategic investment in the thematic areas through major granting opportunities such as those provided by the Canada Foundation for Innovation, Major Collaborative Research Institutes Grants, Community University Research Alliance Grants, National Centres of Excellence, CIHR Team Grants, and Genome BC. Investments may also take the form of strategic faculty positions, seed funding for workshops and conferences, distinguished scholar visits, research support for undergraduate students, and other initiatives as opportunities arise. Initiatives that are demonstrably cross-disciplinary will receive higher priority, as we believe that promising research areas which cross Faculty and departmental boundaries will benefit most from targeted investments coordinated by the Vice-President, Research.

Impact of the Strategic Research Plan

We will undertake a periodic evaluation of research outputs using metrics appropriate to the diverse individual and interdisciplinary activities, as determined in consultation with the Faculty Deans. These data could include publications, conference proceedings, books, monographs, patents, government and public panel contributions, workshops, policy papers, performances, exhibitions, other forms of research, and awards and distinctions. This task is most readily accomplished by soliciting data from faculty through the Deans' offices once a year at the time of review of faculty for progress through the ranks. A common framework for reporting will establish a baseline from which we can gauge advancement in a particular discipline. Measures of output will also be obtained through the use of bibliometric analysis tools such as Thomson-Reuters' *InCites* using data from *Web of Science*, or Elsevier's *SciVal* that produces graphical representations of an institution's research performance using data from *Scopus*. Annual data from ReSearch Infosource and CAUBO will be used to evaluate SFU's research performance relative to other Canadian universities, including measures of research income, publication intensity, and publication impact. Data to evaluate the growth of SFU's internationalization efforts as they pertain to research will also be solicited, for example, the number of international research grants, the number of publications co-authored with international scholars, the number of international graduate students and visiting international faculty engaged in research at SFU, and the number of international awards received by SFU faculty and students. Together, these data will be used to monitor our progress towards achieving the objectives of this Plan, and to evaluate our overall research performance and research capacity.



The advancement of excellence in research is a defining feature of SFU, with leading individuals and well-recognized groups engaged in a wide variety of key research activities. We are recognized for our high level of peer-reviewed scholarly output and our excellence in technology transfer. Our significant growth in research output is matched by an astounding 126% growth in research input between 2002 and 2007. We attracted \$86 million in research funding in 2008, putting us into the top-20 group of Canadian post-secondary institutions on this measure. We have been awarded more than 40 Canada Research Chairs in areas that complement our strategic research goals, including both Tier 1 Chairs for outstanding researchers who are world leaders in their fields, and Tier 2 Chairs for exceptional emerging researchers with the potential to lead in their field. SFU has 39 Royal Society of Canada Fellows, distinguished Canadian scholars who are selected by their peers for outstanding contributions to the natural and social sciences, the arts, and the humanities. *Our goal is to be the most research-intensive comprehensive university in Canada, competing effectively in defined areas with the top tier institutions in the country, and internationally renowned for the excellence of our scholarship.*

MAJOR OBJECTIVES

The SRP is intended to serve as a road map for establishing the focus, infrastructure, and capability that is necessary to improve the research performance of the University. Its major objectives are to:

- Maximize opportunities for discovery and innovation;
- Promote internationally competitive research and scholarship;
- Cultivate excellence through selective investment in emerging areas of research;
- Facilitate collaborations across disciplinary and institutional boundaries;
- Recruit and retain outstanding students, research fellows, and faculty;
- Encourage effective communication and dissemination of research results;
- Optimize use of our research and scholarship resources;
- Recognize the full value of intellectual property;
- Achieve thematic coherence in the expression of SFU's research interests;
- Engage all our communities for the benefit of society.

STRATEGIC RESEARCH THEMES

The SRP articulates SFU's strengths by identifying integrative strategic research themes that cross disciplinary and administrative boundaries. In defining these themes, we intend to facilitate and encourage both individual initiatives and new collaborations within existing structures. Through the process of identifying our research strengths and existing and potential synergies among them, we intend to encourage and support cross-disciplinary initiatives that build on our strengths and show potential for significant impact and leverage. Excellence in research and strategic investment of resources aligned with this thematic approach will give SFU a distinctive edge and comparative advantage, leading to our goal of being the most research-intensive comprehensive university in Canada and competing effectively on the international scene. The strategic research themes encompass both cross-disciplinary teams and disciplinary or individual contributions to our collective achievements. They are consistent with the sub-priorities of the S&T Strategy of Canada. Please refer to the [SFU Strategic Research Plan 2010-15](#) for details on each of the following themes and sub-themes.

Origins

The Nature, Origin, and Fate of the Universe. Answering questions about the nature, origin, and fate of the universe is at the origin of most fields of scientific research. This theme brings together the many disciplines that are occupied with these fundamental research questions, especially mathematics, physics, chemistry, biology and medicine. A particular focus is SFU's role in ATLAS, the world's largest particle physics experiment to reconstruct the first seconds of the universe.

The RNA World and Molecular Evolution. Several SFU researchers are active in unraveling the puzzle of how life might have emerged. Understanding how changes in molecular building blocks alter their structure, dynamics and function is the

foundation for the science of molecular evolution. Such understanding is required for the design of antibacterial and antiviral drugs against which pathogens cannot develop resistance. Correlating the molecular foundations of evolution at the organismal and societal levels requires an interdisciplinary effort between SFU's molecular and biological scientists, mathematicians and computational scientists, behavioural ecologists and psychologists, and other social scientists.

Biodiversity. Understanding and conserving biodiversity are now widely recognized as crucial for human wellbeing. Several research groups at SFU, including those in wildlife and behavioural ecology and salmon conservation, are focusing on the ecology, evolution, and conservation of biodiversity. There is complementary strength in applied research on the ecology and conservation of forests and fisheries. SFU's strengths in present-day biodiversity research are complemented by expertise in past biodiversity and human-environment interaction. Over the next five years, we will focus on ensuring that the benefits of SFU's ability to combine research and training on past, present and future biodiversity are fully realized.

Human Evolution. In recent years, a number of disciplines have experienced a significant growth of interest in the application of Darwinian theory to questions concerning humans, and it is now clear that evolution provides a powerful framework for understanding not only our genes and anatomy, but also our cognition and behaviour. Interest in Darwin's impact on economic behaviour, social history, and subsequent cultural conditions continues to intensify. SFU will exploit the research and training synergies created by its combination of an unusually diverse group of human evolution researchers and first-rate research facilities.

The Development of Human Thought, Culture, and Institutions. SFU researchers explore culture and human development in a variety of contemporary domains, including the links between social and cultural contexts that affect cognition, identity, values, family relations, artistic and literary creativity, and individual and social welfare. Broad areas of expertise include anthropology, business, English, first nations studies, history, humanities, international studies, literary studies, philosophy, political science, psychology, sociology, and women's studies. SFU's strengths can be found in the diversity of research methods used in both laboratory and field settings, and in its focus on both basic theoretical research and the application of theory to significant social issues.

Communication, Computation, and Technology

SFU expertise spans research issues from theory to applications to policy, with researchers from many disciplines involved, including chemistry and chemical biology, communications, computing science, criminology, economics, engineering science, interactive arts and technology mathematics, molecular biology and biochemistry, physics, psychology, and statistics.

Materials Science and Engineering. SFU materials science research spans the spectrum from curiosity-driven research leading to the discovery of new materials and new materials properties, to more applied research culminating in applications-driven engineering and development. An interdisciplinary and collaborative approach by biochemists, biologists, chemists, engineering scientists, molecular biologists, and physicists will permit new materials to be integrated with existing technologies to create novel platforms and devices. An essential part of our strategy is participation in national and international joint ventures such as the Tri-University Meson Facility (TRIUMF) and Canadian Light Source (CLS).

Intelligent Systems and Computer-Aided Design. Intelligent systems research is inherently interdisciplinary and has its foundation in computer science, computer and software engineering, electrical engineering, and mechanical engineering. Research foci include artificial intelligence, data mining, intelligent data processing, the semantic web, computer-aided vision, sensors and sensor networks, robotics, mechatronic systems, microelectronics, embedded computing and systems, and advanced instrumentation. Computer-Aided Design explores the use of unified constraint and simulation-based modeling that enables designers to create designs adapted to context and to the physical forces; and constraints and simulation to establish a new design space in which histories enhance the ability to explore new alternatives for designs.

Automotive Technologies. Mechatronics is the integration of mechanical, electronic, control, software, and computer engineering for the development of advanced electromechanical products and systems for a wide range of industrial applications. Research topics include next generation engine mounts, vibration-based energy harvesting, airbags, and intelligent systems for autonomous vehicles. Researchers complement these efforts with expertise in polymer/electrochemistry, modelling structures and processes in fuel cells, bio-fuel cells, and novel methods for preparing proton-conducting membranes. This group has strong connections with the NRC Institute for Fuel Cell Innovation, and

will develop collaboratively the next generation of nanostructured materials for fuel cell applications.

Imaging Science and Visual Analytics. Investigation into the visual presentation of data and relationships is fundamental to this field, as is the study of how human beings perceive and use visualizations for communication, analysis and decision-making. The foundations of imaging research include modeling, signal detection and processing, mathematics, statistics, data processing and storage, animation, language analysis, cognition and perception. Building on these foundations is research on human-computer interaction, reasoning, transformation and dynamic visualization. Key applications of the research include medical imaging, visual analytics, data mining, business intelligence, finance, manufacturing, transportation, public safety, health and the environment.

Information, Communication, and New Media Technologies. Areas of excellence are multimedia, wireless communications, RF/microwave communications, network systems and modeling, algorithms, information retrieval and web-based systems, natural language, and games, animation and new media. Research strengths also exist in the areas of the IT sector of the economy, and life and mission-critical ICT for disaster management and public safety, coastal surveillance, and disaster relief. Business researchers study knowledge, innovation and technology, with particular expertise in project management. ICT provides a necessary substrate for many areas of research, and SFU has and will continue to build strong links between ICT and the disciplines that use ICT in research.

Communication, Collaboration, and Computation. SFU has expertise in communication, collaboration and computation, including computational security and safety. This subtheme builds on extensive expertise in combinatorial algorithm development and qualitative and quantitative modeling of complex social systems using advanced mathematical, statistical, and computational methods. SFU is a leader in the development and deployment of collaborative technologies in the support of research at the national level, such as that offered by the Interdisciplinary Research in the Mathematical and Computational Sciences (IRMACS) Centre.

Technology and the Arts. Developments in media and computing technologies link interactive arts and technology with musicians, filmmakers, dancers, and other scholars. SFU researchers study historical and current dimensions of media culture in visual, filmic, aural, print, and digital formats. Research foci include the study and design of interactive media technologies, virtual environments, and expressive systems; the development of computational systems that produce or simulate creativity, and the construction of cognitive models of human creativity and creative expression; and the study of human-centered media and communication systems for museums. A coordinated initiative that merges theory and practice in the artistic uses of new technologies and the scholarly analysis of traditional media builds on current strengths.

Culture, Society, and Human Behaviour

As a comprehensive university, SFU champions the liberal arts and sciences and promotes pioneering interdisciplinarity. In all these areas, the challenge is to develop focal points (individuals or groups) to enable dispersed researchers to cohere in creative research groups that will be distinctive to SFU.

Research in the Humanities. Philosophers, historians, classicists, literary critics and linguists investigate and describe the ever-changing realities of contemporary life, and teach us how to question and critique the political, social, sexual, economic, and historical frameworks within which we all live and work as world citizens. Scholars of English study the entire spectrum of literary and textual activity, from the genesis of a writer's creative spark through the various stages of a manuscript's development and dissemination. Scholars of history, whose research strengths are social history and cultural history, grapple with knowledge others often recognize only dimly or in passing: that the future was created yesterday. Specific research specialties share themes that overlap time and region: such as indigenous peoples; law and society; and medicine and science.

Foundations of Ethical Evaluation and Ethical Implications of Research. SFU possesses a broad range of research expertise both in the foundations of ethics and in applied ethics; this expertise can be found in areas including archaeology, business, criminology, education, environmental sciences, health sciences, philosophy, political science, and public policy. All research, from the fundamental discoveries of science to the development of new technologies, policies, strategies, and new ways of understanding, stand to have a significant impact on the way we lead our lives. SFU researchers take a leadership role in ensuring that research has a positive impact on human welfare, by pursuing the systematic

investigation of our moral beliefs, from their philosophical foundations to their applications in the forms of general principles, to public policy issues arising in the Canadian context.

Aboriginal Studies. Research into Aboriginal issues involves anthropology, archaeology, economics, education, health, history, linguistics, literature, psychology, resource management, and sociology. Research foci include examining contemporary urban and rural issues in the Aboriginal community, preserving Aboriginal languages, partnering with bands and communities in Aboriginal education, examining classroom climate issues for Aboriginal/minority students, resource management in Aboriginal communities, barriers to Aboriginal labour market success, archaeological research, and rise of Aboriginal and Métis writers and artists. We are recognized for our critical analysis of issues dealing with Aboriginal sites, as in a collaborative research initiative to investigate the intellectual rights issues raised by archeological practice.

International Studies. Research in this area includes international studies and international policy, advanced by new endowed research chairs in religion and cultural change, and international law and human security. The Human Security Report project analyses global and regional trends in political violence and their causes and consequences, and has put SFU on the map internationally as a resource for governments and nongovernmental organizations alike. The new Centre for the Comparative Study of Muslim Societies and Cultures represents another interdisciplinary collaboration that has few Canadian counterparts. The World Literature program is focusing on the way aesthetic forms and topoi pass from one culture or time to another, most often in defiance of political and social boundaries.

Safety, Security, Criminal Behaviour Assessment and Treatment, and Forensic Studies. SFU has significant strength in the analysis of criminal behaviour and forensic studies, with a number of research centres and institutes and a LEEF Chair in the Reduction of Youth Violence providing a powerful hub around which crime-related research in other units can be focused. Another focus builds on SFU's existing strengths in security and health research to establish new capabilities in public safety, security, and health science. SFU researchers are developing strengths in other aspects of security, such as polymer chemistry, microelectronics, optics and nano-fabrication of new materials for new high-tech security technologies. The Human Security Report Project researches global and regional trends in political violence and their causes and consequences; SFU researchers are also studying ways to increase the safety, health and welfare of employees.

Evolution, Cognition, and Culture. SFU is in an excellent position to become a world leader in an interdisciplinary plan to integrate the sciences, social sciences and humanities. Researchers in archaeology, biological sciences, business administration, linguistics, and psychology, including the CRCs in Human Evolutionary Studies and Management of Technology, are using phylogenetic methods from biology to understand the evolution of a range of social and cultural phenomena. Researchers in English are working in biosemiotics, focusing on the wide variety of forms of communication in biological systems; research in psychology focuses on the development of communication in infancy. Through participation in the Centre for the Evolution of Cultural Diversity, SFU is poised to bring focus to this area in an international context.

Urban Communities. SFU has research strengths from urban design and planning to the study of the individual resident, including the social, artistic, and environmental aspects of urban life. Specific strengths exist in the areas of urban studies, geography, computing science, mathematics, criminology, computing science, economics, and forensic psychology. Researchers are probing issues of social cohesion, antiracist education, violence in society, multiculturalism and cultural adaptation, citizenship, diasporic cultures, and nationhood. There are promising possibilities for research on second-language learning, public education and the wellbeing of communities. The CTEF-funded "Modelling of Complex Social Systems" program brings together extensive expertise under the unifying theme of modelling the complex dynamics that drive the linked epidemiologies of crime, disease, homelessness and other social ills in urban neighborhoods.

Intervention Impact Assessment. Funding for most forms of service delivery, including educational and social programs, is increasingly linked to the ability of the service provider to demonstrate results. Despite the increased attention being paid to "accountability", the mechanisms, tools and practices for effective impact assessment remain blunt instruments. An interdisciplinary approach harnessing the research approaches of economists, sociologists, psychologists and educators, would provide a framework for significant advances. SFU researchers currently possess great strengths in each of these areas, and are in an excellent position to develop more sophisticated research methods for impact assessment and to apply those methods to a wide range of social interventions. By doing so, SFU can capitalize on its acknowledged strength and leadership in the social sciences and humanities, and position itself at the forefront of an emerging research need.

Economic Organization, Public Policy, and the Global Community

Economic Organization. SFU has significant strengths in the theoretical analysis of firm organization, law and economics, public economics, the study of economic institutions, and econometric analysis, complemented by strengths in computational, experimental, and evolutionary methods which are reflected in the Centre for Research on Adaptive Behaviour in Economics and the CRC in Economic Theory and Evolution. There are also strengths in a number of applied fields including strategic change, corporate governance, capital and risk management, biotechnology management, art management, and the environmental, ethical, and sustainable management of organizations. Current efforts include concentrations in the CMA Centre for Strategic Change and Performance Measurement, the Centre for Corporate Governance and Risk Management, and the Global Asset and Wealth Management Centre.

Public Policy. The role of the public sector in our economic and social lives has increased as our private wealth has grown over the past decades. This has spurred research on how policy is formed, what policies are good and in what contexts, and on the unintended consequences of policy decisions. Such research is carried out in economics and the Public Policy Program, for example, the Centre for Public Policy Research that complements existing or projected policy research in health sciences, urban studies, international studies, and communications. Other examples include the CURA Economic Security Project, the Learning City project, the Institute of Governance Studies, and the Mental Health Law and Policy Institute, among other venues.

The Global Community and Emerging Markets. SFU has several research groups concerned with international economic relations, transnational organization, and global culture, including the Centre for Global Workforce Strategy, the Jack Austin Centre for Asia Pacific Business Studies, the Centre for Global Political Economy, the Global Asset and Wealth Management Centre, and the MCRI Globalism Project. One research area focuses on issues of trade, international finance, and economic development in low-income countries; another investigates the management of global enterprises. Researchers are examining issues of knowledge, innovation and technology, including the formation, operation and growth of biotechnology firms and the IT sector. Research on global institutions focuses on peace and security studies; development, environment, and international economic relations; governance and civil society; human rights and international law.

The Creative Economy. The Creative Economy, defined to include the whole of the creative chain for core cultural goods and services, including their creation, production, manufacturing, distribution, and support, has emerged as both a substantial and an expanding sector of the Canadian economy. The creative economy also generates the social capital that is fundamental to social cohesion. Understanding the nature and dynamics of the creative economy is critical to Canada's social, cultural and economic future, and SFU's strengths in the contemporary and interactive arts, literary and publishing studies, and technology position it to play a leading role in research in this area.

Environment, Resources, and Conservation

SFU has an excellent record of research related to the environment, spanning a range of sectors from theoretical and mechanistic studies to applied management strategies. Research clusters at SFU focus on the relationships between economic development, conservation and biodiversity in terrestrial and aquatic ecosystems, as well as on natural hazard prediction and prevention. Our research includes not only chemical, molecular biological, toxicological, physiological, and behavioural studies, but also risk assessment, management, and historic and economic considerations. The ultimate goal of this multifaceted approach is to provide a sound basis for sustainable development and the responsible use of our natural resources.

Planning, Development, Management, and Sustainability. SFU will pursue research in areas related to the development, planning, management, and sustainability of human settlements and the impact of human and natural disturbances on environments and communities. Foci include governance and equity issues; spatial and labor market dynamics; consumption patterns; industrial restructuring; ecological, economic and social sustainability; sustainable development policy; sustainability and quality of life indicators, assessment and evaluation; public space and urban/regional livability; health care and access; property rights and spatial inequities; local economic development; the development of mathematical tools in resource allocation and management; and global environmental issues. SFU research integrating the social and natural sciences focuses on the impacts of human development and natural disturbances on natural and urban environments and communities. Emphasis is placed on the causes of and responses to natural hazards, and on sustainable development

strategies that integrate economic, social, and environmental objectives. Research on both geoscientific and biological phenomena in the ocean environment is integrated within the SFU-supported Neptune Canada project. Research in environmental education and education for sustainable development will be key to understanding human interactions with the environment.

Ecosystems and Resources. Environmental research has broadened to encompass concerns such as species at risk, biodiversity, sustainability and endangered habitats. SFU researchers, including those in the Centre for Wildlife Ecology (CWE) and the Cooperative Resource Management Institute (CRMI), conduct basic and applied research in wildlife, fisheries and forest ecology and provide knowledge and personnel that will help meet the challenges of conservation. Aquatic and fisheries research is aimed at the understanding and management of fish populations in their marine and freshwater habitats, as well as the broader management of the coastal zone, and ecosystem science. SFU research related to terrestrial ecosystems includes ecological, institutional and economic approaches to the conservation of ecosystem services, biodiversity conservation and invasive species, and ecosystem-based forest management and industrial forestry issues. Energy and materials management is also emphasized, through developing and applying sustainable policy models that are both technologically explicit and behaviourally realistic. SFU researchers also study the modern and ancient geological environments, natural hazards, and geological resources. SFU has a strong spatial research emphasis in health and environment, including optimal location of health services and population health. This concentration is augmented with visualization approaches, such as multi-dimensional geovisualization and geospatial interface research. Modeling of complex spatial environmental systems, land use, land cover and urban growth continue to be important activities, together with modeling of dynamic spatial phenomena in forestry and landscape ecology.

Climate Change Solutions. As a founding member of the Pacific Institute for Climate Solutions (PICS), SFU researchers are well positioned to contribute to the development of innovative climate change solutions, seek new opportunities for positive adaptation to climate change solutions, and lead the way to a vibrant low-carbon economy in BC and globally. Researchers involved with SFU's Adaptation to Climate Change Team (ACT) are studying critical climate change impact topics and producing policy recommendations for adaptation: biodiversity, extreme weather, energy, water security, crop and food supply, population displacement, health risks, new technologies, and sea level rise. Researchers in SFU's CTEF-funded "Climate Change Impacts Research Consortium" are taking a risk-based approach to the study of the secondary effects of climate change on human and ecosystem health.

Alternative (Green/Clean) Energy Technology. SFU is well positioned to become a leader in green energy technology research. Interdisciplinary initiatives in this area will focus on energy production, distribution, and utilization, along with related manufacturing technology and green IT. Current research includes fuel cell materials, design and diagnostics, energy management and harvesting, new generation fuel injectors for hydrogen technology, green IT technology, green computing, smart grids and smart houses. Another key area of research involves investigating human-centered sustainable systems at the intersection of conservation, sustainable design, alternative energy production and social behaviour around our ecological footprint. The rise of ubiquitous computing, smart environments and the widespread use of mobile devices offers an opportunity to enable occupants to dynamically interact with building technologies through digital media.

Aboriginal Communities and the Environment. We have substantial research strengths in applications of resource management and resource planning to Aboriginal communities, with a particular focus on Aboriginal and place-based community co-management, forest management, fisheries and aquatic management, protected areas and heritage planning, and strategic land-use planning. Other areas include heritage tourism, coastal zone management and planning, geographic information science, and community planning and development. We will continue to develop our strengths in issues related to resource and environmental management and planning by Aboriginal people on their traditional lands. These activities will draw on our existing strengths in management and planning, and analytical tools such as geographic information systems, and on existing strengths in Aboriginal resource management practices and traditional ecological knowledge. We will also develop our engagement with Aboriginal peoples, both in a research context and an educational context.

Health and Biomedical Sciences

Research at SFU aims to describe human health in its full context, including the diverse impacts that social inequities have on health. We have strength in genomics, bioinformatics, and health informatics, biostatistics, biomedical sciences,

neuroscience, medicinal chemistry and drug development, biomedical devices, biomedical imaging, mental health and addictions, as well as in health policy and cultural and population studies. Novel research and programs have or are being developed in population and public health, global health, infectious diseases, aging and chronic illness, and brain function and development. SFU is a leader in the secure analysis of sensitive data, such as that available under Population Data BC. Our goal is to develop interdisciplinary collaborations and partnerships that bridge the biomedical, clinical, and social sciences and involve the wider community, building on SFU's tradition of innovative and effective outreach.

Genomics, Bioinformatics, Health Informatics, and Biomedical Technologies. Genomic sciences are redefining the research landscape of the fundamental life and biomedical sciences and their applications, and the concept of personalized medicine is being realized based on the application of genomics to the diagnosis and treatment of patients. SFU has expertise in genomics, bioinformatics, and data mining, and is playing a leading role in the formation of a regional Genome Sciences Institute. SFU also has strengths in biomedical technologies and medical imaging, radiopharmaceuticals, computational anatomy, bio-sensors, biomedical optics, signal processing, biomechanics, assistive technologies, haptics, micro/nanotechnologies for medical applications, micro-fluidics, biochips, bioinformatics, computational biology, health informatics, and chronic disease management. Research involves computer scientists, engineers, interactive arts researchers, biomedical scientists, kinesiologists and psychologists working with clinicians to develop new tools and products. The combined effort will address issues of human health, ranging from molecular, cellular, and systems biology to population health and modeling.

GE3LS Analysis. The consequences of scientific and technological innovation are significant, especially when it comes to genomics and its Ethical, Economic, Environmental, Legal, and Social aspects (GE3LS). Research will inform legislation to control innovative growing practices in agriculture, and economic and environmental practices in fisheries and forestry. Genomics research has economic and social implications in such many applications including bee colony collapse, bioremediation for industrial waste, and diagnostic tools for disease and mental disorders. As whole genomes of organisms become known there will arise issues of intellectual property and ownership and usage of such information. How society deals with such a brave new world will be the focus of research in this subtheme.

Chronic and Infectious Diseases. Strength exists in genomics, bioinformatics, biomolecular interactions, psychological and psychiatric disorders, and we are developing strength in proteomics and metabolomics. Two CTEF-funded teams are capitalizing on SFU's unique strengths to discover and test potential new therapeutic targets, and to take novel molecules and nanomaterials from the chemistry lab into the clinical setting and develop strategies for medical imaging, diagnostics, surgery, and drug delivery. The drug development pipeline from genomics input to pharmaceutical output is well represented at SFU—an important node of the Centre for Drug Research and Development. Additional strengths exist in virtual reality therapy and training, visualizations and accessible tools for managing pain over time, and the extension of these tools to the community. Strategic research that bridges nutrition, biomedical and behavioural science would complement existing strengths. Collaborations in this area require support of a wide range of technologies including biomarkers, transgenic animals, nanotechnology, novel imaging and visualization modalities, province-wide comprehensive data and geographic information systems, and complex social modeling.

Human Development and Aging. Strength in human development and aging exists in basic biomedical, population, and social sciences, including the areas of children's social, emotional, and mental health, brain development, brain function and problem-solving, mammalian developmental biology, birth defects, molecular-genetics, epigenetics of cellular differentiation, children's health policy, adolescent mental health, health behaviour and risk, youth crime and violence, gender and aggression, and longitudinal studies on aging. The broad field of neuroscience offers an exciting area for strategic investment, especially in areas focusing on aging and degenerative diseases of the nervous system and its connection to behavior and health. SFU strength exists in clinical psychology, neurobiology of addiction and of age-related degenerative disease, and psychological mechanisms underlying youth aggression. SFU will apply its combined strength in imaging, neuroscience, genetics, epigenetics, and cellular physiology to the study of development and aging.

Population and Public Health and Health Services. Expansion of population sciences and public health practice across areas of shared research focus, such as in infectious diseases and global health, mental health, environmental, occupational health

and earth systems, and Aboriginal health and the impact of social disparities on health could increase synergies in emerging areas of cross-disciplinary strength at SFU. Bridging SFU's substantial strengths in biomedical sciences and health services to population and public health would result in a competitive advantage. Such an approach would build on newly established research strengths focused on population level interventions and health policy sciences. Continued growth to support this subtheme would include bridging areas in social inequities of health, global and Aboriginal health, ethics, health economics and health policy including new health services models, intervention trials and uptake of best practices in primary health care. Growth of research strength in environmental and occupational health would include a focus on molecular toxicology, genomics, proteomics, and metabolomics that study the cellular and molecular responses to drugs and to xenobiotics associated with environmental exposures, and would include the development and use of biomarkers, medical imaging, and basic neuroscience.

Health Systems. Foci include comparative studies of international primary health care systems, explorations of the cost effectiveness of chronic disease prevention and management approaches, estimates of health resource needs and mix of specialists, organizational studies of inter-professional training and practice structures, performance outcomes of innovations in primary care practice and incentive structures, organizational studies of leadership and processes in health system change management, forecasts of health care needs and health system responses, assessments of the impact of primary care interventions on indicators of population health, community assessments of the social determinants associated with chronic disease distribution, and the issues of health equity, social justice, and ethics in health care. The resulting research outcomes will provide objective information to aid decision-making by Canadian governments, as well as an opportunity for global outreach.

Pedagogy

Pedagogy stresses the mutually constitutive and intersecting activities of scholarship, teaching, and engagement. Research in this theme is conceptualized as a framework of four essential components: understanding, research use, knowledge mobilization, and reciprocity. Future research vitality lies in actively inter-relating these four framework components, and these components individually and together represent significant foci for emerging scholarship.

Foundations for Success. Research in this sub-theme seeks to better understand the impacts of foundational educational programs in academic literacy, mathematics, and technical literacy on success in academe and the workplace. SFU researchers are exploring the professional development of teachers; designing and teaching writing-intensive, quantitative and breadth courses, and Masters and Ph.D. programs in mathematics education; examining the role of technology in teaching, collaborative group teaching and problem solving; virtual worlds for course delivery; understanding mathematical cognition and learning; and examining how the rapid evolution and revolutions in technologies affect education and people's readiness for new jobs.

Education and Human Development. Education is central to focusing and fostering human growth and development. These terms are used in a broad sense, to encompass: acquiring knowledge, developing skills, becoming prepared to apply and transfer achievements, exploring and articulating attitudes, generating and controlling motivation, and nurturing a positive sense of self in a context of connection to others. SFU pursues this research across the lifespan from early childhood through later adulthood in a variety of settings within and beyond schools. Research in this subtheme will enable us to better understand how development happens, to identify factors affecting it, and to determine how to best intervene for the benefit of individuals and their social groups.

Education for Diverse Populations. SFU has significant expertise in second language acquisition and pedagogy, civics (in a broad sense grounded in ethical and moral considerations), issues in international education, and working in close and productive partnership in multi-cultural or cross-cultural contexts, such as the Metropolis British Columbia Centre of Excellence for Research on Immigration and Diversity, the Imaginative Education Research Group and its "Building Culturally Inclusive Schools" project, the CTEF-funded research team "Education Systems and Outcomes in Diverse Communities," and the Centre for Research on Early Child Health and Education. SFU research has also led to advances in our understanding of multicultural practices, philosophies of language, and the roles that language and culture play in pedagogical practice; and in the development and testing of innovations in the uses of media, technology, and pedagogical methods to support education for diverse populations. SFU researchers are also focusing on ways to increase the participation and success rates of Aboriginal peoples at all levels of education, building on an almost 40-year tradition of

engagement with Aboriginal communities in teacher education, Masters' programs and other credit- and non-credit ventures. Critical components of this research agenda include the further development and refinement of respectful and culturally appropriate research methodologies, the development, implementation and assessment of new pedagogical strategies, and the incorporation and mobilization of Aboriginal knowledge and philosophies into the mainstream educational system.

New Models for the Delivery of Medical Education. Alternative models of medical education are necessary to better manage Canada's health care system. SFU will explore a system of integrated care, built around integrated clinical disciplines that reflect patient care needs such as mental health, developmental health, acute care, chronic disease management, rehabilitation, and palliation. A program based on preventive medicine, generalist training, primary care, community health, and innovative practice models such as integrated diagnostic services for primary care physicians could be developed. Activities would also build on the current pedagogical strengths of SFU in e-health and health promotion, nutrition and metabolism, virology, immunology, physiology, genetics, epigenetics, epidemiology, biostatistics, demography, mathematical modeling, virtual reality, social and policy science, and ethics, as well as molecular biology and biochemistry, chemical biology, biological physics, cognitive (neuro) sciences, biomedical engineering, and imaging sciences.

Technology and Education. SFU is poised to take a leadership role in the research domain to understand the pedagogical basis of online and blended learning. A necessary component of this research focuses on transformative tools that help learners study and learn more effectively; however, research also extends to the people and settings under which technology is used. The goal in this area of research is to enhance the human interactions that are the foundation of education. Important topics include mechanisms of learning, models of teaching, designs for curricula, policy assessment and development, leadership, and professional conduct in technologically enhanced teaching and learning. Major research initiatives are underway in education, communication, and computing science, with psychology, statistics, and engineering science planning further involvement. Current projects build on a distinguished record of accomplishment in educational technology.

Education for Sustainable Development. Along with a sense of justice, responsibility, exploration and dialogue, education for sustainable development aims to move us to adopt behaviours and practices that enable all to live a full life without being deprived of basics. Sustainability education is a process of creating a space for inquiry, dialogue, reflection, and action about the concept and goals of sustainable development. The research agenda includes the development, monitoring, and evaluation of environmental learning initiatives and the ongoing identification of sustainability indicators and evaluation tools. Such work includes developing and validating instruments for measuring learning environments in community or ESD oriented programs, creating rich descriptions of how these learning environments are characterized quantitatively and qualitatively, and how they differ from other educational settings, and developing, implementing and testing a variety of program interventions in these learning environments while accounting for variations in learning, teacher engagement and other effects.

CANADA RESEARCH CHAIRS

The Canada Research Chairs (CRCs) and other prestigious Chairs at SFU serve to seed and catalyze new initiatives as well as to strengthen existing programs. We recognize the future value of further investment in selected areas that complement the resources of the Chairs. To this end, SFU has been highly proactive in providing or seeking matching funds for some of these initiatives.

Currently, SFU has been allocated 45 CRC Chairs: 18 Tier I Chairs valued at \$200K each and 27 Tier II Chairs valued at \$100K each. CRCs at SFU were phased in and have grown from 33 in 2005/06 to over 40 in 2009/10. We have now reached our full complement, subject to biennial readjustments.

CRCs should primarily serve the strategic research priorities of the University as specified in the *SFU Strategic Research Plan 2010-15* and be used to attract and retain outstanding researchers. The Vice-Presidents Academic and Research make decisions about CRC allocations jointly, after consultation with the Faculty Deans. We strive to increase the representation

of females in Chair appointments.

The following table shows the CRC appointments by funding agency, indicating where they fit within the seven thematic areas under our Plan. It does not include Chair positions that are vacant and which await nomination.

Research Themes	NSERC		SSHRC		CIHR		Total	
	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
Origins	0.5	2	0	0.5	0	0	0.5	2.5
Communications, Computation & Technology	5	5	1	0.5	0	1	6	6.5
Culture, Society and Human Behaviour	0	0	0	3	0	0	0	3
Economic Organization, Public Policy, and the Global Community	0	0	2	2	0	0	2	2
Environment, Resources and Conservation	2	3.5	0	0	0	0.5	2	4
Health and Biomedical Sciences	1.5	3.5	0	1	1	1.5	2.5	6
Pedagogy	0	1	2	0	0	0	2	1
Total by Tier	9	15	5	7	1	3	15	25
Total by Chair Type	24		12		4		40	

IMPACT OF THE STRATEGIC RESEARCH PLAN

We will undertake a periodic evaluation of research outputs using metrics appropriate to the diverse individual and interdisciplinary activities, as determined in consultation with the Faculty Deans. These data could include publications, conference proceedings, books, monographs, patents, government and public panel contributions, workshops, policy papers, performances, exhibitions, other forms of research, and awards and distinctions. This task is most readily accomplished by soliciting data from faculty through the Deans' offices once a year at the time of review of faculty for progress through the ranks. A common framework for reporting will establish a baseline from which we can gauge advancement in a particular discipline. Measures of output will also be obtained through the use of bibliometric analysis tools such as Thomson-Reuters' *InCites* using data from *Web of Science*, or Elsevier's *SciVal* that produces graphical representations of an institution's research performance using data from *Scopus*. Annual data from ReSearch Infosource and CAUBO will be used to evaluate SFU's research performance relative to other Canadian universities, including measures of research income, publication intensity, and publication impact. Data to evaluate the growth of SFU's internationalization efforts as they pertain to research will also be solicited, for example, the number of international research grants, the number of publications co-authored with international scholars, the number of international graduate students and visiting international faculty engaged in research at SFU, and the number of international awards received by SFU faculty and students. Together, these data will be used to monitor our progress towards achieving the objectives of this Plan, and to evaluate our overall research performance and research capacity.