

The University of Victoria

CRC/CFI Strategic Research Plan

2012 - 2015

April 20, 2012

Introduction

The University of Victoria (UVic) is one of Canada's most research intensive comprehensive universities. Our researchers are highly successful in attracting external grants and contracts, receiving on the order of \$100 million per year in each of the last five years (\$103 million in 20-10-11). UVic invests significant resources in research activities, and we have a continued commitment to excellence in research. This Strategic Research Plan outlines how the Canada Research Chair (CRC) and Canada Foundation for Innovation (CFI) programs will continue to be used to enhance our capabilities.

Dynamic interdisciplinary connections promote collaboration and exchange among our researchers and with others around the world. Much of our research success can be attributed to the efforts we have devoted to building or supporting these linkages. Currently, UVic has 17 approved interdisciplinary Research Centres. UVic participates in 10 Networks of Centres of Excellence. In addition, we provide support for, and participate in, a number of large-scale multi-university consortia such as the Pacific Institute for Climate Solutions, WestGrid, TRIUMF, Compute Canada, the Canadian Oceans Research Universities, and Pacific Institute for the Mathematical Sciences, all of which help our researchers to maintain their positions at the cutting edge of their fields.

Research partnerships across sectors, with other institutions, and with communities are strongly encouraged and supported by the university. Links with the private sector have been strengthened through the programs of our NSERC Industrial Research Chairs. Similarly, our CRC and CFI projects, such as NEPTUNE and VENUS, have built new partnerships with other research institutions, government agencies, and private sector partners.

Over the past five years (2008-2013), we have hired 146 new faculty members. These vacancies were filled due to retirements, new program development and general distributed growth. We anticipate that this level of recruitment will continue for the next five years. The CRC and CFI programs have assisted greatly with the optimization of faculty renewal and retention, the enhancement of research facilities, and the advancement of research in selected theme areas.

Objectives

Advancing the state of knowledge and applying it to societal challenges and aspirations are the primary goals of university research. Six objectives express the means through which UVic has been working towards these goals. Taken together, the objectives apply to all of the thematic areas described in this strategic plan. We will:

1. Foster research excellence and enhance UVic's role in the global exchange of knowledge.
2. Promote emerging areas of interdisciplinary research of the highest quality.
3. Optimize faculty renewal by recruiting world-class researchers.
4. Enhance UVic's capacity to educate highly qualified personnel for BC and Canada.
5. Build the infrastructure to support leading-edge research.
6. Contribute to the economic growth and social advancement of BC and Canada through the development of the intellectual capital created at the University and via collaboration with various communities through joint research endeavours.

In addressing these objectives, the university seeks to optimize the funding available from the CRC and CFI programs by combining it with operating and infrastructure support from other sources including: the federal granting councils, other federal and provincial agencies, institutional resources, the private sector, and communities.

Research Themes and CRC/CFI Proposed Allocations

The University has identified ten thematic areas in which to develop or maintain excellence.

1. Biomolecular analysis and applications to biotechnology, health, and the environment
2. Cognition and learning
3. Creative arts and culture
4. Cultural knowledge and indigenous research
5. Environment, Oceans, and Climate - Science and Policy
6. Global politics and economics
7. Health and society
8. Information technologies
9. Mathematical and computational modelling and design
10. Matter and energy

UVic has 37 approved CRC Chairs, distributed as shown in the following table:

Thematic Area	CIHR			NSERC			SSHRC			Total
	Tier 1	Tier 2	Total	Tier 1	Tier 2	Total	Tier 1	Tier 2	Total	
1	1	2	3		5	5				8
2		1	1					1	1	2
3								1	1	1
4							1	2	3	3
5				3		3	1		1	4
6										
7		1	1				1	2	3	4
8				3	3	6	1	1	2	8
9				1	1	2				2
10				2	3	5				5
Total	1	4	5	9	12	21	4	7	11	37

Assessing Success in Meeting Objectives

The success of the CRC and CFI programs is measured by the following indicators:

- Recruitment and retention of exceptional researchers
- Development and strengthening of identified research programs
- More interdisciplinary, inter-institutional and intersectoral initiatives
- More international and national awards and recognition for faculty members, and invitations to join prestigious learned societies

- More faculty memberships on grant review panels and international editorial boards
- Enhanced quality and quantity in publication records
- Increased participation and success in granting council competitions and other external research funding programs
- Greater involvement in large-scale funding programs with private sector links, such as NCEs, CFI and NSERC IRCs
- Growth in knowledge mobilization and transfer of intellectual property outside the university
- Growth in postdoctoral and graduate programs that attract top students
- Increases in graduate and postgraduate fellowship awards

Gender Representation in CRC Nominations

The University of Victoria has a strong commitment in its faculty hiring to achieve equitable representation in the equity groups designated in the Employment Equity Act and Federal Contractors Program: aboriginal peoples, members of visible minorities, persons with disabilities, and women. The process for nominations for CRC positions makes, explicit that the University's equity policies apply. This has been reinforced by the Vice-President Academic and Vice-President Research in their interactions with the Deans, Chairs and Directors directly responsible for developing nominations.

The application of the policies has been reflected in efforts made to solicit applications from qualified women, the women candidates that have been short-listed, and the chairs awarded to women. Nevertheless, the University has faced a major challenge in appointing women to CRC positions to date, particularly to Tier 1 positions, where there are two female appointments out of 14 Chairs (14.3%). We have fared better in Tier 2, with 8 female appointments out of 23 Chairs (34.8%). In part, this is related to the large proportion of NSERC (21) relative to SSHRC (11) chairs in the University's allocation and the historical under-representation of women in the natural sciences and engineering, especially at the senior level that applies to Tier 1 positions. The University will continue its efforts to achieve better gender balance in CRC Chairs as well as continue to pay attention to representation of the other designated groups.

Planning and Approval Process

The CRC and CFI Strategic Research Plan has been developed through an iterative and collaborative planning and approval process under the leadership of the President, the Vice President Academic and Provost, and the Vice President Research. In 2003, the CRC and CFI plans were combined into a single document. The Deans, in consultation with their faculty colleagues, have made significant contributions to its revision. The Plan is reviewed and revised every three years.

Chair nominations come from the Faculties. Ultimately, the decision of which CRC nominees to put forward is made by the President and the two Vice Presidents. CFI applications are developed under the direction of an Institutional Planning Committee that is chaired by the Vice President Research.

Research Area Descriptions

1. Biomolecular Analysis and Applications to Biotechnology, Health, and the Environment

The speed and power of methodologies for structural determination have increased enormously in the past decades, and the technology of directed genetic modification has opened the way to define structural change in proteins. Research in biomolecular structure and function is now poised to answer its greatest challenge: to develop a language that translates molecular structure into biological function. We are following two directions in biomolecular research: first, the further development of our ability to predict function from structure; and second, application of existing and emerging methodologies to develop useful and interesting new or modified biological molecules. Biomolecular approaches are essential to genetic counseling, the development of therapeutic agents and diagnostic tests, and the identification of environmental factors contributing to disease risk. Establishment of the Genome BC/UVic proteomics platform facility at the University in 2002 added a powerful tool to support health and environmental research. Proteomics technology has also made this area of science economically appealing to companies involved in drug discovery, target identification and validation. Other applications include agriculture;

bio-defence; clinical diagnostics; disease prevention; gene therapy and oncology.

The University of Victoria has both established and emerging research strengths in microbial pathogenesis, structure-function relationships of biological macromolecules, neuroscience, vaccine development, molecular and cellular plant biology, cancer biology, immunology, and genetics of environmental mutagenesis and disease. Using biotechnology to provide solutions to health, environmental problems, agriculture and aquaculture is also an area of strength for the University. Applications under development include rational design of vaccines for aquatic species, genetic engineering of plants for enhanced sequestration of carbon and production of medicinally important chemicals, and in vitro fertilization of spruce and Douglas fir.

Using the resources of the CRC and CFI programs, we are able to pursue both major directions of this research. Proposals complement our current strengths by allowing recruitment of both senior and junior colleagues who can add specific new techniques and approaches, and who will provide leadership to some natural groupings of researchers already in place. The key to success is the acquisition of researchers who focus on the theoretical and experimental bases of biological structure. Some of the functional aspects are well covered currently, but further developments will require a deep expertise in newly emerging understandings of structure, both macromolecular and genetic. UVic has a good distribution of scientists studying problems in human, plant and animal biology. These areas share an essential need for new kinds of expertise to guide us in the next steps: to derive powerful new drugs, biological modifiers, and genetic approaches to practical problems.

Individuals recruited become part of networks of research already in place and of others under development. Thus, the Centre for Forest Biology, which is engaged in various aspects of understanding problems in forestry, are strengthened by adding core expertise in molecular approaches. The Chemical and Structural Biology Group and the Center for Biomedical Research, comprising members from the Departments of Chemistry, Biology, and Biochemistry, Microbiology and the Division of Medical Sciences, similarly benefit from these programs. There is overlap with other theme areas, particularly *Information Technology* and *Mathematical and Computational Modelling*, both of which will provide assistance with the interpretation of genetic structural patterns and in the development of rapid genetic information processing.

2. Cognition and Learning

There are few more promising or important targets for scientific research than understanding how human minds acquire and use knowledge. During the past half century, major research gains have been made across the disciplines of biology, psychology, education, and cognitive science that contribute to our understanding of the basic principles governing the acquisition of new knowledge and skills. Neuroscience is an emerging research focus that links the disciplines of biology and psychology. A clear distinction is now known to exist between learned problem-solving skills in novice learners and the specialized expertise of individuals who have proficiency in particular subjects. How people use knowledge and memory to guide performance, how cognition and learning change over the lifespan, and the role technology plays in learning, are some of the important challenges being examined in this research area. Answers to questions such as whether the process of cognitive loss in aging populations can be slowed down through intervention have major implications for our society. The development of effective models for computer-assisted learning has application at all levels of our educational system.

Our strength in cognitive science and associated educational research involves researchers in our Department of Psychology and Faculty of Education. Researchers in neuropsychology and cognition are examining the biological processes of cognition and the ways these are affected by aging and neurotrauma. The Brain and Cognition Laboratory established in 2003 acts as a cluster for researchers investigating behavioural plasticity, autism, schizophrenia and attention-deficit hyperactivity disorder. Another research focus, computer-assisted learning, ranges from understanding the process of learning theoretically, to developing interactive methodologies for improving the delivery of content through technology. Research on information technology as a tool in teaching and learning is an emerging field that builds on these strengths. Innovative educational approaches that involve both technological applications and fundamental pedagogical methodologies are helping to increase the effectiveness and efficiency of teaching and learning. There is related work in Education in the research program of the Lansdowne Chair in Applied Cognitive Science and in research on improving teaching performance.

Several on-going Fine Arts projects involving experiential learning interrogate how students and communities shape attitudes, values and beliefs. One such example is the continued study of Applied Theatre led by Dr. Warwick Dobson. Students research such community situations as attitudes to senior citizens, and based on that

research, use the resulting facts to create theatre productions, which are then performed in schools and community agencies to challenge and explore societal dynamics. Other projects led by Mary Kerr involve oral history and community research.

Many Visual Arts and History in Art areas of graduate research explore cultural practices; ways public spaces are inhabited and societal issues through artistic projects for which on-site research is conducted. For instance, a project in the Visual Arts Department led by Paul Walde focuses on Extended Media Practices and Sound. That work explores relationships between nature and culture through an investigation of the disciplinary areas between music and art including performance-based work. Such projects explore cognition in different fields and challenge the public via a performance.

The CRC and CFI programs encourage interactions between individuals working in the theoretical dimensions of cognition and learning and those who apply the knowledge in classrooms and other learning environments. Complementary strengths are being created in such areas as: memory, attention and decision-making processes; computational modelling of cognitive processes; visual perception and cognition; the interface between neuropsychology and cognition; addiction; and the theory of mind. The CRCs provide a means to connect with researchers in lifespan development, particularly those studying aging and youth and society. Links to the theme areas of *Environmental Science and Policy* and *Cultural Knowledge and Indigenous Research* are also being strengthened in matters concerning the relationships between local/lay and scientific knowledge construction. Our collaborations with several large-scale NIH and NIA investigations in cognition, and an innovative program of educational research in the Centre for Learning and Teaching likewise gain from the CRC program.

3. Creative Arts and Culture

The University of Victoria believes that the creative arts play a vital role in promoting civic engagement and global citizenship in sustainable societies at the local, regional, national and international levels. The arts are a sphere of engagement and the means by which we represent our cultures to others and to the future. Most importantly, it is through the creative arts that we define ourselves in the present. The behind-the-scenes research faculty members in Fine Arts conduct in order to create a painting, a video, a play, a book of creative non-fiction, novel or poetry becomes a seamless part of both their teaching and creative expression.

Work in the creative arts is becoming increasingly inter-disciplinary and inter-institutional. For instance, one project in History in Art led by Dr. Carolyn Butler-Palmer involves the University of Victoria and Atomi University in recovering and cataloging the work of Japanese-Canadian artist Elizabeth Dewar (1889 to 1951). The project is multi-disciplinary in that it also involves students and faculty members from Pacific and Asian Studies and ethno-botany.

Members of Fine Arts contribute to the Faculty's efforts to promote and expand the mobilization of research knowledge for societal benefit by engaging the University of Victoria and community in examining the role of art in social transformation. This is achieved through the organization of community-based conferences, exhibitions, performances, public talks, symposia, art reviews, as well as radio and television broadcasts. The development of new theoretical constructs is forming part of this reappraisal.

Research conducted by musicians, artists and writers eventually leads to a creative work, the process and practice of which then becomes part of the faculty member's intellectual development and is reflected in his or her teaching practices. By the very nature of their creative process, members of the Faculty of Fine arts are activists and interrogators within their culture. For example, a project in the School of Music led by Dr. Daniel Biro is using technology to pursue a cross-cultural understanding of Jewish, Christian and Islamic chant traditions.

The CRC and CFI programs play a role in this process of re-evaluation, focusing on the activist dimensions of modern and contemporary art as well as radical political thought and culture. The location of a CRC within a diverse community of scholars in the Faculty of Fine Arts enriches debates and dialogues across related disciplines, which not only include areas such as Music, Writing, Theatre and the Visual Arts, but also Sociology, Political Science, Philosophy, History, Indigenous Studies, and Critical Theory. The interdisciplinary focus on anarchist studies is yielding theoretical and practical results for the critical analysis of art, politics and social change, as well as the establishment of a world-class Archive focusing on the anarchist movement in Canada.

CRC/CFI programs in Creative Arts and Culture are strengthening the University of Victoria's status as a research institution and providing innovative, interdisciplinary leadership in an important cultural sphere of society.

4. Cultural Knowledge and Indigenous Research

As Aboriginal populations, environments, and cultural traditions continue to be eroded by the forces of the global economy, the protection of these rich, diverse resources has become critical. Uncovering and preserving unique cultural knowledge and experiences such as language, literature, art, traditional knowledge of ecology and environmental management, and governance requires innovative research that relies on the ability to draw from numerous perspectives. The University of Victoria is exploring the forces that influence the formation of cultural knowledge on a global scale, and also has special interest in the indigenous cultures of British Columbia and Canada. How the literary traditions of Canada's indigenous peoples relate to those of other Aboriginal peoples, and how the wisdom and traditional knowledge of cultural groups can be integrated into Canadian society are current research topics. Approaching from a perspective within the community, as well as from the outside, we are working on finding ways of helping preserve traditional beliefs and values while enhancing the quality of life of indigenous peoples and supporting the capacity for development of indigenous communities.

UVic has a long tradition of interdisciplinary research in First Nations languages and literatures and their preservation. We have been instrumental not only in documenting the linguistic structures and the oral literatures found in BC and the Pacific Northwest, and elsewhere in the world, but in helping maintain the vitality of these cultural treasures. Research and teaching in languages has been fostered by the Humanities Computing and Media Centre, which has an international reputation for excellence. Our scholars in this field have received prestigious awards, including the Governor-General's award for writing, Killam awards and Guggenheim Fellowships, and seven are members of the Royal Society. Research in this theme is multi-disciplinary, involving faculty and graduate students in Education, Fine Arts, Human and Social Development, Humanities, Law, and Social Sciences. Interdisciplinary research is promoted by the Humanities Research Collectives, the Centre for Pacific and Asian Initiatives, the Centre for Studies in Religion and Society, and the planned Visualization Innovation Centre. A prominent research theme is social justice encompassing legal, sociological, environmental, governance, policy and other political theory perspectives. There are complementary links with other fields of strength, especially *Environmental Science and Policy*; *Global*

Cultures and Politics; and *Health and Society*. In addition, professional capacity-building through participatory research is a distinctive strength of our programs in the Faculties of Law and Human and Social Development. Our focus on Aboriginal issues in BC yields theoretical, methodological, and policy outcomes of national and international significance and application in the field of indigenous research.

Many Indigenous peoples explore and describe their relationships with one another, with other peoples and with the natural world through artistic lenses. Several members of the Faculty of Fine Arts study indigenous art in an effort to better understand the complex cultural relationships in the field. For example, the Audain Chair brings practising artists such as Michael Nicoll Yahouglaanaas to campus to both teach and mentor students. And Kerry Mason has for many years made indigenous art key to her teaching of Pacific Northwest art.

Participation in the CRC and CFI programs enables UVic to further strengthen the credibility of our program from all cultural perspectives. Although the research currently addresses viewpoints from within the Aboriginal and other unique cultural communities as well as external perspectives, we have a significant shortage of indigenous scholars. We need to have more faculty who are from indigenous cultures, to bring depth and legitimacy to research in this theme. In addition, there is a need to place the cultural dimensions of indigenous languages and literatures of Canada within an international context. Chairs build upon strengths already evident at UVic, and integrate our strengths in the global dimension of social justice, law, governance and cultural, literary and linguistic understanding. We have a special role to play in preserving local heritage, a role that is enhanced by our extensive research activity in the area of global cultural knowledge. Chairs and infrastructure in these areas both heighten the profile of indigenous scholars in research and serve as a focal point for research and significant linkage to the Aboriginal communities themselves.

5. Environment, Oceans, and Climate - Science and Policy

Global change related to ecology, the environment, and its effect on human affairs, is a theme that calls for the creativity and effort of scholars across the disciplines. Advances in our understanding of how atmospheric, earth, and ocean systems interacted with and influenced the paleo-environment enables us to predict physical outcomes. The ability to track modern changes in the ocean depths using continuous data streams from our coastal and deep ocean observatories (VENUS/NEPTUNE) is yielding new discoveries about the impact of human activities on the

ocean environment. The study of the past is integral to and complements this work in that it yields insight into natural boundary conditions while providing data critically needed for model calibration. How we use this scientific knowledge—past, present and future—and integrate it with social and cultural issues concerned with ecological, environmental and community sustainability remains a great challenge. Conducting basic research on ecology and the environment, and translating it into a form that can be understood and used by policy makers, requires an integration of the strengths of many disciplines.

In earth, ocean and atmospheric sciences, our focus is on fundamental interactions in the geosphere, biosphere, oceans and atmosphere. UVic has leaders in research on climate modelling, the biological and physical properties of the ocean, and the earth's crustal processes and properties. In the biological sciences we have strengths in quantitative ecology, forest ecosystems and restoration, and watershed and water resource management. In engineering, a major strength is the development of sustainable energy systems, especially with respect to cryofuels fuel cell systems design, renewable ocean energy and hybrid electric vehicles. In the social sciences and humanities, studies focus on environmental economics and stewardship, law and ethics, ecological restoration of natural systems, physical and resource geography, geomatics, and ethnobotany.

The Department of Mechanical Engineering has many strengths in marine engineering, with special expertise in hybrid power trains, autonomous underwater vehicles, production planning, and ocean engineering including ocean energy and the effect of oceans on built structures. There is also research on autonomous aerial vehicles which have many diverse applications including environmental monitoring.

The CRC and CFI programs are used to enhance the links connecting these disciplines. Existing ties are strengthened among our six interdisciplinary centres that pertain to environmental science and policy: the Pacific Institute for Climate Solutions Institute for Integrated Energy Systems, the Centre for Forest Biology, the Centre for Biomedical Research, the Centre for Global Studies, and the Centre for Studies in Religion and Society, which supports research on environmental ethics. Related research in the National Water and Climate Impacts Research Institute, Canadian Global Change Program, the Pacific Climate Impact Consortium, the Canadian Centre for Climate Modelling and Analysis, the Tri-Council Eco-research Chair program in Environmental Law and Policy, and the NSERC Industrial Research Chair program in the Environmental Management of Drinking Water are also strengthened through these programs. Several faculty in Environmental Sciences do research related to water issues and waste water and drinking water are themes of the emerging civil engineering activity in the Faculty of Engineering. The broad aim of our research in this theme is to develop a research culture in which natural scientists studying basic properties of environmental systems will collaborate with experts in social and policy studies to develop synergistic and informed teams of researchers advancing new collaborative models for integrating pure and applied environmental science with social and policy studies.

The focus of recruitment in related natural and social sciences and engineering is on climate modelling, physical oceanography, forest ecosystems, non-carbon energy systems, and social and economic policy and governance. We have strengths and aspirations in each of these areas and they are relevant to our location and local environment. Broadening our base of expertise, for example, linking sustainable energy systems, environmental health and the development of new, more environmentally friendly materials for use in industry, will further strengthen areas in which we already have strong ties through our research centres. A well-integrated, broad expertise base has immediate applications, for example in developing policies related to the effects of green house gases on climate change. Such policy decisions rely on information obtained from experts in climate modelling, geochemistry, oceanography, economics, anthropology and ethics. For sound decision-making on this and other environmental issues, however, we need to have policies that are based on an understanding of the combined knowledge and the interdependence of the relevant disciplines. Also, as host institution for the Canadian Global Change Program and the National Water and Climate Impacts Research Institute, we are well positioned to make vital links between basic science and policy studies on key issues of global environmental change.

6. Global Politics and Economics

The global change process is being driven by continuing population increase and economic development with its attendant energy demands and impacts on the environment. In addition to associated issues such as global warming, biodiversity and water shortage, globalization is having an impact on society and culture around the world. A key challenge is to learn how to manage increasing interdependence among the world's global institutions. For the future, successful governance will require a complex interplay of geography, politics, economics and society at

scales from the local to global.

At UVic, research includes exploring the forces that are precipitating globalization, and identifying its political, social, cultural, economic and environmental implications. Research areas include governance, international law and trade, politics, public management, community-based research, feminist perspectives, cultural, social and political thought, and social policy analysis. The research, which is being carried out in diverse disciplines in the Humanities, Social Sciences, Human and Social Development, Business, and Law, is central to the work of two of our interdisciplinary centres: the Centre for Global Studies and the Centre for Asia Pacific Initiatives. The Departments of Economics and Political Science and the School of Public Administration have recognized strengths in theoretical and empirical studies of global issues and institutions.

There are existing links between this and other theme areas, principally *Environmental Science and Policy*, and *Cultural Knowledge and Indigenous Research*. UVic has a well-established Centre for Global Studies, one of only two in Canada. We have established strengths in one of the most important global issues, climate change, and the CRC program is being used to enhance this capacity. The Canadian Centre for Climate Modelling and Analysis (of Environment Canada), and the Water & Climate Impacts Research Centre (W-CIRC) are based at UVic.

Proposals are designed to bring together the various researchers working on global issues. This extends the potential of successful programs in contemporary social and political thought, global studies, law and dispute resolution, and others related to global economics. The chairs and infrastructure also play a key role in building relations across Faculties and in supporting initiatives in the relevant research centres. The Centre for Global Studies, for example, complements its policy-oriented work with research of a more academic nature. Where research interests overlap with those in other theme areas, the networks are extended even further. For example, the Centre for Global Studies benefits from its connections with the Integrated Energy Systems Victoria (IESVIC) Research Centre, which develops sustainable energy systems and has interests overlapping in several theme areas, including Matter and Energy.

7. Health and Society

In recent years, there has been a significant change in our understanding of the factors that determine human health. Greater attention is being paid to a range of social, economic, environmental, and health service factors that interact in complex ways to positively or negatively influence health. These developments have been added to the foundation provided by basic biomedical and biomedical engineering research. A key concept in this reconceptualization of health is that we can profitably link studies in the natural, applied and social sciences, to shed light on the ways in which health is determined by biological factors, by social factors or the interaction between the two and the pivotal role of policy and practice in designing health care services that promote health and well-being. The creation of the CIHR reflects this shift. UVic is following this direction by developing new models of interaction among researchers from different disciplinary backgrounds who are networked with academics in other parts of the country and internationally, as well as with policy makers, health authorities and consumer organizations. By promoting such wide-reaching linkages, we believe that we will produce scholarship that is not only evidence-based but also transferable to stakeholders developing policies and intervention programs to improve the health of Canadians.

An example of such a linkage is the partnership between the University of Victoria and the BC Cancer Research Centre. The two institutions are developing a comprehensive program in cancer research that spans a range of disciplines, from studies in molecular cell biology to the effects of aging on cancer. Researchers in the natural sciences studying the genetic and molecular basis of cancer (biologists, biochemists, microbiologists, participants in the Genome Canada Program) interact with scholars investigating the link between aging and cancer. The latter group includes researchers at the Centre on Aging, and in the Faculties of Human and Social Development and Social Sciences. Other teams working from these two units are concentrating on professional communication patterns and the organization of health services that support people at the end-of-life who are receiving palliative care.

The University of Victoria's main strengths in this interdisciplinary field are reflected in the work of the over 120 tenure-track and tenured UVic faculty members and approximately 240 graduate students whose core research activities fall within one or more of CIHR's multi-disciplinary health research pillars: basic biomedical research; clinical research; research in health services and health systems; and research related to society, culture and the health of populations. The primary faculties involved in health research are Education, Human and Social

Development, Social Sciences, and Science. Inter-disciplinary centres and groups involved include: Aboriginal Health Research Group, Centre for Addictions Research, Centre on Aging, Centre for Biomedical Research, Centre for Early Childhood Research and Policy, Centre for Human Movement Analysis, Knowledge Mobilization Unit in the Office of Research Services, Population Research Group, Centre for Religion and Society, and Centre for Youth and Society.

UVic has created the Centre for Aboriginal Health Research after having been the administrative home of the CIHR Institute of Aboriginal Peoples' Health. With these initiatives, UVic is playing a leadership role in a national health research training program to educate PhD and post-doctoral graduate students about health informatics—the use of information technology in health care delivery systems.

The Centre on Aging conducts research that covers the spectrum from clinical care of the elderly to the effects of policies and programs on their lives. Members of the Psychology Department lead an international study of cognitive function and aging involving several areas of neuro-psychology, including pediatric research, epilepsy and traumatic brain injury. Researchers drawn principally from Psychology, Sociology, Nursing and Social Work and the Centre for Youth and Society are doing joint research on child and youth care. This is one component of a broader field of expertise in aspects of community-based health promotion involving researchers in the Faculties of Social Science and Human and Social Development. Researchers in the School of Health Information Science are studying the use and communication of information throughout the healthcare system as well as studying the impact of information and communication technologies on cognitive and social aspects of healthcare.

The University's strong commitment to this theme has recently been demonstrated by the creation of the School of Public Health and Social Policy within the Faculty of Human and Social Development. This new school has already begun to offer graduate programs and will attract new faculty and students who will contribute to our strengths in the thematic area of health and society.

Health research has strong needs in addressing privacy concerns and is moving more and more towards the use of high performance computing and cloud platforms. The recently created the Centre for Advanced Security, Privacy and Information Systems Research (ASPIRe) will address these needs as part of its work in the broad area of security and privacy of general information systems.

Access to the research chairs and infrastructure through the CRC and CFI programs provides the leadership required to enhance and further develop the many already well-established partnerships described above. Additional expertise in such key areas as Aboriginal health, the social, environmental and cultural determinants of health, literacy and health, use of health information, knowledge translation in healthcare, quality of life issues, community health research and basic biomedical science and engineering will enable the University to take advantage of the opportunities presented by CIHR to incorporate the contributions of social scientists, humanists and others with those of biomedical researchers.

8. Information Technologies

Changes in information technologies have profoundly reshaped the ways that people in all walks of life communicate and access information. A key area for research concerns the implications of connecting vast numbers of powerful computers in a world-wide network. Will the whole be greater than the sum of the parts? Will the network even display behaviour that could be mistaken for intelligence? The world-wide web provides a new environment for software. It has dramatically increased an already pressing need to analyze and re-engineer billions of lines of legacy code. How can advances in information synthesis and data retrieval be used to develop decision support systems in health and natural resources management? How can immersive visualization and virtual worlds make us re-think how we ask and answer scientific questions?

The application of information technology to the acquisition, processing, visualization, distribution and transmission of information is a cornerstone of research and development not only in all areas of science and engineering, but right across campus including the Humanities, Social Sciences and Fine Arts. UVic has expertise in the fundamental IT areas of software engineering, computer engineering, communications, digital signal processing, and technology management. We are applying it in areas such as e-commerce; new media, health informatics; preservation of indigenous languages and culture, and geomatics including remote sensing of earth and the oceans.

In software engineering, the Departments of Computer Science and Electrical and Computer Engineering are well

recognized for their studies on software evolution and reengineering, software system design and testing, and human-computer interaction. In computer engineering, research revolves around a state-of-the-art high performance computing facility, obtained with funds from the Canadian Foundation for Innovation. In communications, research focuses on reliable and fast transmission of information, and specifically the any-place-any-time connectivity needed by the mobile user. Research on digital signal processing is having significant impact on communications, speech and audio processing, and image and video processing.

New media, another interdisciplinary area of emerging importance, involves Fine Arts, Humanities, Social Sciences including the CRC supported Pacific Centre for Technology and Culture, and technical disciplines such as Computer Science and Computer Engineering. Digital humanities is an established area through our CRC in Humanities Computing. Our research in health informatics (through the School of Health Information Science, the Department of Computer Science and related research groups) has important applications in telemedicine in remote communities, e-health, human-computer interaction in health care, information technology in health education, and knowledge development and dissemination in health care. One of our particular strengths is in information synthesis and retrieval of health program research. The Department of Geography is using geomatics - a field that includes remote sensing and geographical information systems - to model biomass in the Amazon floodplain, monitor coastal marine environments and the intertidal zone, model and predict disease spread, and develop multicriteria decision support systems for coastal management. The management of technology and e-commerce are critical areas of interdisciplinary research which involve Computer Science and Business. Researchers in this area participate in several National Centres of Excellence: CITR, GEOIDE, HEALNet, IRIS and MITACS. They also work with industry through NSERC-IRCs and other partnerships. Our CFI-funded high performance computing centre has provided significant partnership opportunities across a number of research-intensive areas, including global climate change, computer and mathematical modelling, astrophysics, and health information.

The new research centre ASPIRe (mentioned above in 7) is focused on the areas of security and privacy which are central and critical issues for all areas of information technology research as well as to research areas heavily dependent on information technology.

The establishment of chairs and new infrastructure to further strengthen the existing activity in Information Technology is fundamental to UVic's objective of sustaining its leadership in this key area. We are particularly interested in increasing our existing strength in software engineering with an emphasis on software evolution and reengineering. Research Chairs in IT promote links to other research themes, such as *Environmental Science and Policy, Health and Society, and Mathematical and Computational Modelling*.

9. Mathematical and Computational Modelling and Design

Computational modelling brings the power of prediction and control to otherwise descriptive sciences. How can the use of computationally intensive methods, expert systems, and data engineering and mining effectively support interpretation of the data available from the human genome project, the simulation of dynamical non-linear processes, satellite mapping, robotic control and design, and the modelling of economies and environments to inform policy development? Through advances in computing, modelling is leading a revolution in the environmental, biological, and medical sciences to rival its longstanding role in the physical sciences. It is now feasible to create, for example, models for living cells, climate systems, and economic patterns. Research involving modelling demands close collaboration between mathematicians, computer scientists and subject matter specialists. Modelling also frequently involves mathematical treatment that can only be resolved using high performance computing facilities. Consolidation in this area will be driven by the desire of scholars from diverse backgrounds to share their problems and capabilities.

UVic has particular strengths in mathematical and computational modelling and design. The Department of Mathematics and Statistics is a well recognized leader in operator algebras and dynamical systems, and in close collaboration with Computer Science, works on discrete mathematics and graph theory. Mathematical modelling is a strength in the Department of Economics in the areas of econometrics and economic theory.

Virtually all other departments in the sciences and engineering, and several others in the social sciences, have expertise in areas of computational modelling and applied mathematics. These initiatives have strong links with the MITACS NCE.

Our work in this area links with research in *Biomolecular Analysis and Applications to Biotechnology* and

Information Technology. Data engineering has applications in many areas including astronomy, forestry, meteorology, and ocean science. Advances in data engineering are critical to the effective use of computation in virtually every discipline. Computational and systems engineering and design pervades all areas of engineering, and supports research in other areas. Our expertise includes computational fluid dynamics, robotics, and image processing.

UVic has a well-established network within which researchers from various departments communicate and collaborate extensively on problems in mathematical and computational modelling. Research chairs and infrastructure enhancing UVic's strength in this theme benefits many research areas, and adds strength from which new interdisciplinary research will develop. Enhancing research strength through the CRC and CFI programs in this theme area is critical to the continued growth of much of our research, and to the development of new research areas.

10. Matter and Energy

Some of the most profound questions in science concern the nature of matter: What is matter made of? What holds it together? What determines its reactivity? How do properties change under different conditions? Can we control those properties to create new forms of matter and new materials? These questions pertain to systems ranging in scale from the smallest subnuclear dimensions to the macroscopic world of chemistry, to the almost-unimaginably large structures in the universe?

Members of the astrophysics group in the Department of Physics and Astronomy focus on the properties of extra-terrestrial matter, and are world-renowned for their computational, theoretical and observational work on the formation and evolution of galaxies, stellar structure and evolution, gravitational lensing, binary/multiple stars, and studies of asteroids and comets. The Victoria Subatomic Physics and Accelerator Research Centre (VISPA) is investigating the fundamental constituents of matter, and the forces acting on them. The group is taking a leading role in research at premier international accelerator facilities in Canada, Europe, Japan, and the United States, including the ATLAS, BaBar and T2K Collaborations, three of the premier particle physics experiments in the world. Members of the group have designed and implemented a large computer farm and computer grid project in a collaborative project between departments. The VISPA group relies heavily on the infrastructure provided by TRIUMF and access to the main TRIUMF site. The University of Victoria is the lead University for the Advanced Rare Isotope Laboratory (ARIEL) and the new electron accelerator, currently under construction at TRIUMF. Current experiments probe the nature of the electroweak force, the symmetry between matter and anti-matter, and the origin of mass. Bringing these groups together is the development that astronomy and nuclear physics, once widely-separated fields, have begun a convergence in which questions about the fundamental theories of matter, originating in particle accelerators, are tested by astrophysical observations.

The development of materials with enhanced performance and lower-cost fabrication for new technology is another focus of this research theme at the University of Victoria. The Centre for Advanced Materials and Related Technology, and several departments in Science and Engineering, are studying materials for uses that include integrated energy research, medical and biomedical technology, and advanced crystal growth and devices. Nanotechnology is a unifying research theme that is bringing researchers from across the university together to examine matter, energy, and materials. Spintronic materials and devices is an emerging area within this theme. The interaction of matter with radiation (photochemistry and photophysics), and the design of molecules and supramolecular systems for specific functions, brings to this topic existing strengths in the Department of Chemistry. Members of Mechanical Engineering have joined UVic scientists at the Herzberg Institute of Astrophysics to explore the establishment of a multi-disciplinary research and graduate program in astronomical instrumentation development and associated areas such as robotics.

Energy systems research at UVic is carried out primarily at the Institute for Integrated Energy Systems (IESVic) and spans five broad topic areas: renewable energy; advanced energy conversion; carbon management; transportation and; techno-economic analysis of energy systems. Examples of research programs falling within these five areas include, respectively: integrated modeling of ocean wave propagation and wave energy conversion device performance; integrated computational and experimental analysis of polymer-electrolyte membrane fuel cells; sensors for measurement, monitoring and verification of the integrity of geologic CO₂ sequestration sites; simulation and development of drive trains for electric vehicles and; investigation of smart-grid enabled demand side management measures. Faculty and students active in energy systems research are drawn from Engineering,

the Physical Sciences, Economics and Environmental Studies and strong linkages exist with academia, industry and government across Canada and internationally, including major collaborative research initiatives with researchers in China and Germany.

According to the international newsletter *Science Watch*, UVic is the fifth most influential university in the world in the field of energy and fuels, as measured by the citation impact of the top 100 scientific articles per institution published between 1998 and 2008. In North America, only Princeton, Cornell and the US National Energy Lab performed better. Growing concerns related to climate change create a unique opportunity to leverage this international track record and to expand UVic's research capacity in this area.

CRC and CFI programs in these subject areas are being developed to strengthen our interdisciplinary efforts. The Chairs strengthen the interactions between, for example, cosmology and the design and development group in astronomical instrumentation, or the synthesis of chemical materials that provides new subject matter for study and use by materials scientists and engineers. We also look to strengthen interactions between our energy systems and advanced materials groups through chair and infrastructure support.

Postscript

This CRC/CFI Strategic Research Plan outlines the thematic areas in which we are deploying our CRCs and focusing our requests for CFI infrastructure. It is not address all research strengths at the University of Victoria. As we recruit faculty members and take advantage of other appointment opportunities, the strategic focus of the thematic areas identified in this plan evolve and new themes may well emerge. This plan will therefore be reviewed and updated from time to time to reflect the changes.