THE UNIVERSITY OF BRITISH COLUMBIA STRATEGIC RESEARCH PLAN*SUMMARY*

(updated February 2006)

We are in the midst of revolutionary economic and social change driven by knowledge and innovation, whose impact will far exceed that of the industrial revolution. We stand at the threshold of a new global age; an age in which interdependence transcends national boundaries, information is exchanged instantly, concern for our planet and the environment is international, the global economy and innovation is interlinked, and dreams for a peaceful and prosperous planet are universal.

Across Canada, industry, governments and the public are recognizing the need to invest in the education of our citizens and in knowledge creation.

One could argue that Canadian universities are the nation's most valuable resource in a knowledge-based economy. Collectively universities engage in two billion dollars of research annually, which accounts for twenty five percent of all research conducted in Canada. Canadian universities graduate 175,000 students annually, with the knowledge, creative and analytical skills needed to advance Canada economically and socially. The University of British Columbia is a major research-intensive university in Canada, with a research budget of $364 million in 2004-5.

THE GOALS

UBC's goal is to excel internationally in research and teaching, and to be a leader in discovery and scholarship that is the wellspring of scientific, technological, social, cultural and organizational innovation in the nation and in the world. By conducting basic and applied research of international acclaim, and by educating graduates with outstanding creative and analytical skills, the university aims to enhance its impact on society. The broad goals of the university are: to create innovative ideas and methodologies across the array of disciplines; to improve the quality of life for the citizens of Canada; to chart a course for society to lead and to adapt to rapid technological and social changes; to lead in the creation of cultural, artistic and literary work that elevates the human spirit; to aid economic development and diversification through the creation of new industries and the strengthening of existing businesses; to inform responsible ethical, legal, environmental and public policy; to enhance recognition of our global interdependence by fostering international cooperation and exchange of knowledge.

To accomplish these goals, the University of British Columbia has identified critical strategies, which are embodied in its TREK 2010 vision statement embracing **people, learning, research, community, and internationalization**. These include, attracting and retaining outstanding faculty, offering students an intellectually challenging education, conducting leading-edge research, fostering social, cultural and economic development in the community, and enhancing our participation in international affairs. The successful impact of universities on society is determined by the quality of its people. The Canada Research Chairs (CRC) program provided the foundation for UBC's retention/renewal strategy for the very best researchers. These chairs were allocated in areas where UBC already had strength as well as new areas, which may in the future be as important as the discovery of the double helix structure of DNA was to genomics, or the invention of the transistor was to communication technology, or the establishment of Medicare in Canada was to the quality of life for Canadians.

Major discoveries and scholarship do not happen in a vacuum; they require a rich research climate of effective collaboration, the necessary administrative and technical support, and access to the appropriate infrastructure. The University is committed to fostering such a research milieu.

RATIONALE FOR RESEARCH CLUSTERS

To tackle the broad goals described above the university has identified eleven research clusters. Integral to the development of these clusters and the research plan described in this document has been the process of extensive consultation with faculties, teaching hospitals, departments, schools, centers, and institutes that has occurred. These research clusters are built on existing "centres of excellence" as well as areas selected for growth. Clusters were structured to cut across different faculties; across traditional disciplinary boundaries. They have typically attracted significant external research funding. UBC and its affiliated hospitals have received over $290 million in Canada Foundation for Innovation grants. UBC has committed the $50 million gift from Dr. S. Blusson in support of the CFI projects. Many of the researchers in the clusters are involved in the National Networks of Centres of Excellence programs, of which UBC is a participant in seventeen. The university has supported researchers in these clusters through endowed chairs, and laboratory space in new or renovated buildings at the Point Grey or hospital campuses.

The first two of the eleven clusters are **Biotechnology and Genomics** and **Human Health and Genomics,** which are at the heart of the biomolecular revolution, advancing our understanding of the molecular basis of life, and creating unprecedented opportunities to control disease,

enhance sustainability and enrich the environment by being able to understand and manipulate highly complex biological systems.

Thus the first decade of the twenty-first century will be marked in large part by the solution of the human genome and the genomes of dozens of important plants, animals and microbes. Knowledge of the human genome will provide the foundation for much of the basic, applied and health related research in the new century, and will catalyze explosive growth in therapies for preventing and curing disease. The second cluster in this area, **Biotechnology and Genomics** is linked to growth in products derived from biotechnology, including new drugs, new crop varietals, improved processing enzymes, cultures, human tissues and organs, new polymers, and improved methods for treating environmental contamination. Although one might be tempted to assume that the field of genomics will be in the domain of biological sciences alone, the benefit of interdisciplinary approaches to tackling new challenges in functional genomics cannot be overemphasized. Bioinformatics is critical to the organization and application of genetic information. This field is progressing as a result of advances in information technology, software engineering, and computer science. Developments in DNA sequencing and sensor technology are benefiting from inventions in physics, chemistry, and engineering.

The **Human Health and Genomics** cluster encompasses core research themes including Infection/Immunity, Cancer, Cardiovascular and Respiratory, Wound Healing, Pathogenomics, Pharmacogenomics, Genomic Imprinting, Antimicrobial drug discovery, Transplant research, Stem Cell Genomics, Asthma, Gene-based medicine, Genetics and Behaviour, and Blood proteins. Strong research groups are housed in the new Life Sciences Institute on the main campus and at hospital-based research institutes (CFRI, VCHRI, Providence, BCCA, BC CDC) in the lower mainland. Research efforts span the 'gene to society' multidisciplinary and systems approach and focus on human biology in health and disease across the lifespan. There is a strong focus on providing children with the best possible start in life, including determining fetal origins of disease and early indicators of disease risk, developing vaccines that protect them from infection, and characterizing mechanisms for nutritional and environmental effects on health. In line with the 'aging' population, there is also world-class research to address prevention of complex and chronic diseases of adulthood.

UBC has extensive strength in this field, and the 1993 Nobel Prize to Dr. Michael Smith in the area of genomics is an accomplishment in which the university takes great pride. The research in these two clusters is supported by major infrastructure projects and funds from CFI, BCKDF and Genome Canada. Previous investment by CFI and BCKDF includes the laboratory for Molecular Biophysics (1998), Biotechnology Laboratory (1999) and Centre for Integrated Genomics (2000), the iCAPTURE Centre (2000), the Centre for Research in Childhood Diabetes (2000), the Center for Blood research (2001), and more recently, the Centre for Hip Health (2003), and the Centre for Disease Modeling (2003). The Centre for Disease Modeling provides a world-class biohazard containment facility for study of viruses such as SARS, HIV, influenza, Hepatitis C, and West Nile Virus that present substantial threats to human health. Major aims are to develop vaccines that would prevent infection by these viruses and to develop anti-viral drugs that prevent the virus from spreading in the body and causing disease. Recent initiatives that build on existing strengths and enhance this prior investment include the Centre for Drug Research & Development and the Centre for Understanding & Preventing Infection in Children, each of which is supported by major endowments.

Unravelling the mystery of the human brain will be one of the greatest scientific challenges of this century. Brain research is embryonic in maturity compared to investigations on other aspects of human function. Although remarkable discoveries on the anatomy and function of the brain were made throughout the last century, far less is known about how to effectively intervene when these functions become disordered or diseased. The obligation to find cures for diseases of the brain is particularly pressing since they detract terribly from the quality of life for those afflicted and for their families, as well as incurring an enormous financial burden. Canada is estimated to spend over $30 billion per annum on this problem. The **Neuroscience and Cognitive Systems** cluster is a target area for research investment.

The UBC Institute of Mental Health is a central component of this cluster, and is supported by a newly established endowment of $20 million from private and governmental sources. The three Chairs in this Institute will complement the Provincial Leadership Chairs in Depression and in Addictions ($5 million each). The cluster also received seven major CFI awards. The Brain Research Centre ($8.5 million), MRI Medical and Biological Functional Imaging Centre ($ 8.5 million), High Resolution Functional Imaging in Neurodegenerative Diseases ($4.5 million) and ICICS ($22 million). CFI funding was also received for ICORD – an interdisciplinary research center for promotion of functional recovery after spinal cord injury ($12.8 million), a Centre for Macular Research ($1.26 million) to exploit powerful new and emerging technologies to increase our understanding of the visual system, and for a micro-PET for a Functional Imaging Centre ($515K).

Examples of centers of excellence at UBC include an emphasis on early intervention in psychosis, involving a translational or "bench-to-bedside" research approach where faculty from neuroscience, genomics, radiology, psychology and clinical investigators in Psychiatry work as a team on this most disabling disorder of youth and early adulthood. Other interdisciplinary studies focus on the aging brain, where huge societal needs are envisaged as the baby boomers enter prime ages for diseases such as Alzheimer's, Parkinson's and stroke. The area of neurotrauma and spinal cord injuries has received considerable support from the Rick Hansen Institute. Biomedical engineering is paving the way for innovative solutions to these debilitating disabilities and is being recognized as critically important for understanding spinal cord mechanics and treating neurotrauma. The "learning brain", an inter-faculty effort to enhance human learning and memory and to remedy learning disabilities in brain-injured children will also be explored in this cluster.

An important extension of all the basic research on human health is the need to translate these discoveries into practical outcomes in health delivery, and services to benefit all. The **Population Health, Services and Human Development Cluster** has been established with this outcome in mind and compliments two of the four quadrants of the newly formed Canadian Institutes of Health Research (CIHR). These include CIHR's focus on society, culture and population health and well being in individuals and in populations, and also addresses questions as to how administrative, legal, social and educational systems relate to health and development. In addition CIHR's focus on health-related services and systems is also central to the research foci of this cluster; this includes research on the delivery of services that may have an impact directly or indirectly, on both physical and mental well-being, and the development of approaches to improve the health of populations through activities that lie within, but also may lie outside of the health care system – such as the social and educational system.

A key strength of this cluster is the BC Linked Health Data Base (BCLHDB) maintained by UBC's Centre for Health Services and Policy Research. The former is acknowledged as the world's largest longitudinal, population-based database on health services utilization and the determinants of health. The Education Information Data Centre at UBC was recently awarded CFI funding to link educational data from related fields, such as child development, health and economics. Other strengths include the HIV/Aids effort and the Canadian HIV Trials Network headquartered at UBC.

The 1948 invention of the transistor and the subsequent discovery of the laser, both of which are quantum mechanical devices, are the basis of the computer and the internet, which are transforming the way we communicate, access, process and interpret information and entertain ourselves. Fuelling this revolution is an extraordinary increase in computer power, which according to Moore's Law doubles every eighteen months. Developments in the fabrication of microchips, which are the basis for this unprecedented growth in computer power and the accompanying breathtaking technologies, is being aided by a steep reduction in costs of microchips.

Critical to this vision is the miniaturization of microchips with increasing power and capability. The research cluster, **Microelectronics and Information Technology** builds on existing excellence in this area at UBC and positions research in this cluster to capture exciting opportunities in areas such as e-commerce, intelligent systems-robots and machines that think, computational biology, entertainment and electronic interaction, to name a few. The recent award from CFI for the creation of the Institute of Computing, Information and Cognitive Systems (ICICS) with total funding of $22 million will be a powerful stimulant to research in this cluster as well as the cluster on Neuroscience and Cognitive Systems.

The increasing miniaturization of microelectronic circuits based on silicon is giving way to new devices based on quantum structures governed by the laws of quantum mechanics. The fundamental concepts of quantum mechanics challenged and frustrated some of the deepest thinkers of the twentieth century, and are still the focus of academic debate. Despite its confounding roots, quantum mechanics itself has grown to be a powerful tool for describing how the fundamental building blocks of our universe interact, and ultimately form the macroscopic objects that we directly experience. As scientists and engineers unlock the power of quantum mechanics and translate it into technological developments, another scientific revolution will begin. For instance, the long-term future of computer power will be determined by developments in quantum structures and promise the advent of quantum computing. Developments in nanotechnology are advancing quantum computing from a dream to reality. A cluster entitled **Quantum Structures and Information** has been identified as important to UBC's research mission to ensure that Canada stays competitive in this emerging field. The **Nanoscience Cluster** promises the understanding of structures on the nano-scale and the development of other devices, of the order of molecules, for numerous applications.

The exponential growth of nanoscience is largely due to the development of new instruments used to probe materials at the atomic scale. UBC has one of

the strongest Canadian efforts in this area, with a core group of researchers from the Faculties of Science and Applied Science. An $8.1 million award from CFI and partners to UBC and Simon Fraser University for nanostructures-related equipment will boost efforts in this area in B.C. There is also a nucleus of outstanding research in the field of quantum computing and in high-temperature superconductivity.

Synchrotron research plays a central role in the areas of nanoscience, quantum materials, and quantum structures and devices. AMPEL has played an active role in establishing state-of-the-art x-ray absorption, x-ray magnetic dichroism, and resonant x-ray scattering facilities at the Canadian Light Source. They are now engaged in a further effort to fund and build an innovative beamline dedicated to spin and angle-resolved photoelectron spectroscopy. This proposed facility is essential to support studies to elucidate and control the electronic properties of complex, artificially engineered materials, which are a predominant theme across most of the research thrusts in the Nanoscience and Nanotechnology and Quantum Structures and Information clusters at UBC. The high level of involvement of AMPEL group leaders in these world-class programs will assure access to these critical facilities to UBC researchers at the forefront in key areas of fundamental science and technology.

The university is a place where the very foundations of our understanding of the universe must be pursued. The most fundamental aspects of mathematics, physics and astronomy are the basis for a cluster entitled **Origins and Mathematical Structure.** The research foci of this cluster address some of the most basic questions of human interest, and the most exciting challenges that astronomers, mathematicians and physicists grapple with: “What is the universe made of?”; “How did it begin and how will it end?”; “How did our own solar system form?”; “Is there life elsewhere?”

There is enduring public interest in cosmology and astronomy and these are topics that excite students and enhance their appreciation of science and the search for new knowledge. Other benefits include the elevation of Canada in the international community as a country of scientific excellence and technological savvy.

Universities are bastions of fundamental research, and if UBC is to assume a place among the leading research institutions of the world it must be recognized as contributing significantly to this field. UBC has considerable strength in the area of origins and mathematical structures. It is an important participant in several experiments to measure the cosmic microwave background that is helping us to understand the large-scale structure in the universe. The departmental strengths in stellar astrophysics will blend well with the proposed initiative in planetary astrophysics. UBC also has outstanding researchers in core mathematics areas. Probability is the area of greatest strength , boasting one of the top three groups in the world.

To support the research themes of three different clusters, the **Pacific Institute for Theoretical Physics (PITP)** was established in 2003. PITP is an international research institute, based at the UBC, but sponsoring research networks and research collaborations with PITP members from many countries. It plays a key role in supporting the **Origins and Mathematical Structure** cluster, the **Nanoscience** cluster, and the **Quantum Structures and Information** cluster.

The impact of globalization, technology and liberalization on society, culture, language and our values, are more than of mere academic interest. The events unfolding around us will alter the quality of our lives and we must be engaged in scholarship that informs our ability to manage change for our benefit.

Society in Global Context and **Culture and its Representation** clusters at UBC are directed at fostering research and scholarship that addresses social and cultural issues within Canada and in the world. Research within the clusters will improve our understanding of the evolving nature and representation of culture and society from a wide range of disciplinary perspectives, and will facilitate examination of social and economic policy and practice in both national and international contexts. It focuses on three areas, Asia-Pacific, the Americas and Europe. UBC has considerable strength in Asian studies focusing on Asia Pacific Civilizations, and East Asian Buddhism. In recognition of our European links, Christianity and culture has been identified as an area for research growth. Strengths in historical consciousness and empirical analysis will enrich UBC’s contribution to Canadian society, while a chair in U.S. politics will be a vital stimulant to the U.S. studies program.

The implications of globalization are nowhere more apparent than in the areas of environmental stewardship and the development of sustainable societies. Indeed there is a growing consensus among world leaders that sustainability is one of the greatest challenges facing human societies in the twenty-first century. Rapid economic and population growth, the voracious exploitation of resources, the massive consumption of fossil fuels, and the escalating material demands of consumer societies have brought the globe to the brink of crisis. Current patterns of consumption and growth cannot be sustained. The earth has been dramatically affected by environmental changes induced by human activities. The implications are complex. Urgent attention must be given a number of critical research questions, and work on these will necessarily draw

upon knowledge, approaches, methodologies and perspectives of several traditional university disciplines. Thus a **Sustainability/Environment** cluster has been created to build on UBC's capacity and to enhance it's potential to address issues of pressing national and global concern.

Seven UBC Faculties (Agricultural Science, Applied Science, Arts, Forestry, Graduate Studies, Law and Science) participate in this cluster. Examples of existing activities that have a high profile include the Georgia's Basin Futures Project, which is an inter-faculty collaboration, involving the Sustainable Development Research Institute. It is supported by a $2.5 million MCRI grant from SSHRC. The Metropolis project, involving UBC and SFU, is tied to national and international networks in twenty countries. The Fisheries Ecosystems Research Laboratory ($10.6 million) and the Earthquake Engineering Research Facility ($2.5 million) were funded by CFI. In addition UBC is developing a $36 million Center for Integrated Research in Sustainability (CIRS) and construction of the $11 million Clean Energy Research Centre (CERC) is nearing completion; each was supported through CFI, BCKDF, and private sponsors. All of these facilities form a vital infrastructure for researchers in the **Sustainability/Environment** cluster.

The University of British Columbia is committed to sustaining and enhancing excellence in learning and teaching. In order to achieve this, it is important to develop a thorough understanding of what makes for effective learning. At the core of the university experience for students at all levels is the information exchange and learning that takes place during an undergraduate or graduate students' tenure on campus. Learning occurs both inside and outside the classroom or laboratory and research into the mechanisms associated with university learning is the subject of ongoing scholarship. The initiative is based on the premise that educational development can be impacted by an understanding of the underlying principles of student learning. This initiative seeks to extend theoretical understanding of student learning, the impact of the recent proliferation of communications technology, and the role of formal and informal learning environments. UBC's commitment to innovative teaching and learning approaches is evident through units such as the Institute for the Scholarship of Teaching and Learning, the Irving K. Barber Learning Centre, and the Office of Learning Technology.

UBC – OKANAGAN

A significant development over the past two years has been the emergence of a new UBC campus in Kelowna: UBC-Okanagan. Created by the provincial government to meet the increasing need for university spaces in British Columbia, this new campus is part of the UBC system, yet retains its own identity. It shares many of the goals and aspirations of the Vancouver campus of UBC, and provides unique opportunities for innovative approaches in learning and research. Together, the two campuses form a powerful system, developing new strengths and possibilities in graduate and undergraduate education and opening up new areas for scholarly collaboration.

UBC-Okanagan's academic plan calls for an intimate learning community that is also an integrated research community, a community that is locally responsive, globally conscious, adaptable and sustainable. The research strategy fosters interdisciplinary participation across units, faculties and centres and emphasizes research that will demonstrate positive impacts for the Okanagan region, British Columbia, Canada and the world. It will attract new faculty who will build on the existing strengths of the institution and facilitate graduate training. To accomplish these goals, UBC Okanagan has identified eight research themes that cover a broad spectrum of basic and applied research, serving the needs of the local community and the world. One of these themes is Sustainability, which resonates with UBC's Sustainability/Environment cluster. Rapid population growth in the Okanagan region is stressing natural systems, degrading air and water resources, and reducing critical habitat for nationally and provincially threatened species-at-risk. Thus, the region provides a living laboratory for addressing global problems in sustainability. UBC Okanagan has developed strengths in the fields of conservation biology, watershed management, environmental change research, rhizosphere biology and plant natural products.

The UBC strategic research plan transcends disciplinary and faculty boundaries and facilitates synergies among researchers who have not previously interacted. The inclusion of ethicists and philosophers in a genomics and health cluster is one such example. In so doing they will bring to bear expertise needed to conduct research in fields where the most challenging problems are, at the intersections of traditional disciplines. The university has several major objectives in pursuing this strategy. The first is to excel internationally in research and teaching, and to be a leader in discoveries and scholarship that serve as the wellspring of scientific, technological, social, cultural and organizational innovation in the nation and in the world. To accomplish this goal the university must attract and retain outstanding researchers, a cornerstone of the Canada Research Chairs program.