

Strategic Research Objectives

The University of Waterloo's mission is to advance learning and knowledge through teaching, research and scholarship in an environment of free inquiry and expression. Waterloo's extensive interaction with the non-academic community has provided researchers with unparalleled opportunities to understand the needs of the private sector, the community and governments. The University counts among its strengths a liberal intellectual property policy where IP remains with the inventor(s), the very high quality of its incoming students and the impact of its co-op education program on further developing and enriching this quality. These factors enable the University to attract and retain excellent new faculty, ensuring an influx of new ideas, new areas of research, great enthusiasm and adaptability in changing times.

Waterloo's overall research goal is to be a global leader in the development and implementation of a knowledge-based society in the 21st Century. Specifically, the University's objectives are to:

- emphasize basic and applied research in all disciplines, and facilitate the synergy between basic research and the application of knowledge;
- stimulate high impact multi- and inter-disciplinary research on societal problems by increasing collaborations between researchers in science, mathematics and engineering and their counterparts in the humanities and social sciences, the health sciences and the environmental sciences;
- commit energy and resources to becoming noted for research in "knowledge exchange", connecting and communicating with people technologically, cognitively and comprehensively;
- attract increasing numbers of high quality graduate students and postdoctoral fellows into research that is deep, broad and challenging;
- accelerate a global presence through enhanced international collaborative research and significantly increase international graduate student enrolment;
- develop a passion for research among undergraduate students at an early stage by involvement in research activities through seminar courses, research assistantships and other research interactions;
- ensure timely and effective dissemination and application of research through presentation and publication of results and, when appropriate, commercialization, and enhance and encourage the entrepreneurial spirit in students and faculty.

Major Thrust Areas for Research and Research Training

The University has identified five thrust areas in which to promote major growth in research and research training: Information Technology; Environment and Energy; Health; Materials Manufacturing and Devices; and Innovation, Society and Culture. These five areas embrace extensive and diverse bases of research expertise. Innovative research at Waterloo will, of course, not be limited to these five areas; it has thrived and will continue to thrive in many other sectors of the University's academic community, and we will continue to encourage this breadth of creativity.

Information Technology

Information science and information technology have been prominent at Waterloo, both as subjects of research and as enabling tools in research and teaching. Waterloo will continue to pursue research into the fundamentals of information structure and analysis, the technology for new forms of connectedness, and new tools for learning and disseminating knowledge in all disciplines. Waterloo will remain a world leader in the development and utilization of new information technology and a leading supplier of information technology professionals at all levels. By focusing on research involving the deployment of information technology and resultant knowledge interchange in areas that are of major importance to present and future societal needs, Waterloo will continue to attract and retain high calibre researchers.

UW is investing heavily in establishing world leadership in Quantum Computing and has established the Institute for Quantum Computing (IQC). Research in wireless communications will be extended to optical and other networks, digital signal processing, multimedia compression and data/voice over mobile Internet protocols. Software engineering initiatives, including multimedia network Internet programming, embedded and real-time systems, legacy systems and languages for hand-held devices will be promoted through Waterloo's new interdisciplinary degree program in Software Engineering and established research Institutes and Centres such as the Institute for Computer Research (ICR) (<http://www.icr.uwaterloo.ca/>). Data and text management and data mining with emphasis on multimedia, object-oriented, structured (relational) and unstructured (Internet) data and text repositories will give rise to a variety of knowledge-based and knowledge-intensive research initiatives.

Waterloo will also expand research capacity in related areas of application in which considerable strength has already accumulated. These include: vision and imaging from the perspectives of human-computer interactions, machine intelligence and learning, virtual reality and cognitive ergonomics; modeling, remote sensing, geographical information systems; scientific computing and computational mathematics; digital media and animation; health informatics and bioinformatics; design of computing equipment; e-commerce; and Internet education and collaboration to expand our classroom walls and individualize instruction.

Environment and Energy

The University will continue to emphasize the integration of theory and practice in its quest to identify and understand the interrelationships between human and ecological concerns in the development of healthy, sustainable environments and societies. It will also continue to encourage diversity in environmental research by fostering individual scholarship, creating an atmosphere that supports interdisciplinary research, and establishing institutional partnerships to address environmental issues at local, regional, national and global levels. These strategies make Waterloo a leading educator of professionals with expertise in the environment.

Environmental research at Waterloo addresses the atmosphere, cryosphere, the earth's surface and subsurface, aquatic systems, and habitats. This work is performed from the molecular to the planetary level in fundamental science, mathematics, engineering applications, and understanding societal impact. This broad-based multidisciplinary approach has placed the University in a position of international leadership in environmental research. Waterloo has well-established linkages with other universities, government agencies, national and provincial parks, and conservation agencies. It has also achieved extensive private-sector interactions in areas such as mining, petroleum, biotechnology, groundwater remediation and environmental assessment.

Specific strengths include research in water treatment and supply (toxicology; mathematical modeling of surface and groundwater; water quality assessment; stable isotopes to trace contaminant migration and biogeochemical cycles; biotechnology and bioinformatics; risk analysis and management; remediation), ecosystems (management and restoration; Great Lakes; aquatic ecosystems; toxicology; stable isotopes; remediation; risk assessment; remote sensing; informatics; habitat change), atmospheric quality (atmospheric chemistry and modeling; alternative fuels; high altitude monitoring; remote sensing; atmospheric management; contaminant dynamics), building sustainable communities (policy and planning; human systems; risk management and assessment; sustainable, healthy and just societies; reuse and recycling; globalization; health and environmental exposure; environmental infrastructure renewal; transportation and urban systems; energy-efficient technologies; tourism and eco-tourism, international development and globalization; public awareness) and sustainable energy management (renewable energy sources including wind, fuel cells, nuclear energy, solar energy and the energy inherent in biomass; policy).

Health

Waterloo health researchers have achieved excellence in the evaluation of health status, statistical analysis of health data, prevention of illness and injury, the systemic and molecular basis of disease states, drug design and discovery, cognitive neuroscience, sight enhancement and enhancement of quality of life through strong basic and applied programs. In spanning the spectrum from cell to society, particular expertise lies in the development of population-based interventions to improve lifestyle health behaviours as well as the sustainability of physical and social environments necessary to support healthy individuals and populations within the framework of Canada's new vision for health research. The generation of new knowledge in health and its application in clinical and community settings is approached from an interdisciplinary perspective, with consideration given to the entire life span, with particular emphasis on an aging population.

The Research Institute for Aging has been established to promote research relevant to aging, in both community and institutional settings within a continuum of seniors' accommodation and health care services and by the translation of research findings into coping and care-giving strategies (<http://www.ria.uwaterloo.ca/>). A School of Pharmacy will open in 2007 with new research facilities. Health informatics (<http://hi.uwaterloo.ca/hi/index.html>), a Waterloo research priority, represents a primary means of disseminating knowledge to the professional, consumer and research communities.

Waterloo researchers will develop the data management capabilities essential to the advancement of health informatics and health policy. The evolution of health informatics has resulted in the creation of an Institute for Health Informatics, a platform for creating and disseminating scientific knowledge in all areas of health sciences, wellness and medical research. The University Centre for Applied Health Research (<http://www.ahs.uwaterloo.ca/~cahr/>) will stimulate

investigations into disease/injury prevention and health promotion. The Institute for Vision Science and Technology will expand research on contact lens and low vision problems.

Investigations into genomics and proteomics, pharmaceutical chemistry and biophysics, biostatistics, and data mining for health and wellness are key areas for research growth. Furthermore, integrative biology (molecular and systemic physiology, biomechanics, ergonomics), behavioural neuroscience, human body trauma and gerontology are well developed and will continue to advance at Waterloo. Health researchers will examine other related interdisciplinary research areas which include: the effect of socio-cultural, biological and behavioural factors on health and aging; the quality of life and its relationship to work, leisure, family and community; and research into sustainable, healthy and just societies and communities.

Materials, Manufacturing and Devices

Waterloo has a strong foundation in Materials research and has dedicated key resources to the understanding and synthesis of new materials and their incorporation into products and engineered systems. Emphasis has been placed on improving quality and productivity. In common with other areas of research, computer modeling and simulation play key roles in optimizing both the design and processing of materials and are central to work on robotics and process control.

Waterloo has a broad spectrum of expertise in materials science, engineering, processing and systems design. Waterloo currently has a critical mass of researchers in electronic materials, polymeric materials and construction materials. Moreover, the University has established state-of-the-art materials processing and characterization facilities including a high temperature materials synthesis centre, a microelectronics processing laboratory, a polymer production/processing/characterization facility and a fire research and training centre to study fire suppression, materials behaviour, safety and personnel performance and behaviour. Mechatronics is a focus of expansion. Three particular areas are targeted: MEMS and NEMS (micro and nano electromechanical systems), advanced robotics, and vehicle mechatronics (advanced vehicle systems and subsystems).

Other areas of expansion include the following broad initiatives:

Energy-efficient technologies: magnetic materials, superconductors, thermoelectric materials and energy storage materials.

Nanotechnologies: This thrust will centre on an inter-disciplinary thin film laboratory that is unique to Canada in its breadth and scale of equipment and related infrastructure. The focus is on electronic systems ranging from large-area “giga” systems (one billion pixels) to “nano” technology (with dimensions of one billionth of a metre). With the establishment of shared research space with IQC, Waterloo will establish a core facility that will serve as a national resource for the rapid development of quantum information processing and will be uniquely configured for the fabrication of quantum and nano devices.

Infrastructure Renewal: This research focuses on the preservation and replacement of Canada’s \$3 trillion worth of infrastructure. It will be built around five themes: roads, pavements and bridges; building-sciences and materials; trenchless and tunneling technology; repair and rehabilitation of structures; construction engineering and management.

Materials Synthesis, Processing, Characterization and Modification: Our goal is to develop further Waterloo’s expertise in designing materials from the atom up. It is anticipated that the novel materials produced by such methods will have unique properties and applications such as specialty and commodity polymers.

Automotive: The Waterloo Centre for Automotive Research (<http://watcar.uwaterloo.ca/>) will promote and support innovative, multidisciplinary research across a broad spectrum of research areas including alternative fuels, design, environmental issues, human factors and ergonomics, manufacturing, mechatronics and vehicle safety.

A High Magnetic Field Laboratory as a National Facility: Waterloo is uniquely positioned to establish a national laboratory that will harness existing expertise, establish long-term partnerships with leading corporate developers and provide access to broad ranging and highly specialized instrumentation based on high (as high as 20 Tesla) magnetic fields.

Innovation, Society and Culture

Progress requires an understanding of the human condition and an insight into how people create and react to change and innovation. Waterloo intends to be a world leader in the analysis of the process of technological innovation from conception to development, including implementation, diffusion, adaptation and social ramifications. We will focus on combining basic and applied research to study cultural forces and social pressures that provide the context for, and the content of, technological change.

A number of highly accomplished and truly distinctive research centres have been established. These include: the Centre for Cultural Management, whose mandate includes online cultural management education; the Canadian Cultural Research Network, which is intended to promote the sharing of research and information in the cultural sector in Canada; the Centre on Foreign Policy and Federalism, which examines the history and current political implications of Canadian international relations; the Centre for Advanced Studies in Finance, which provides a focus for research and education in finance; the Centre for Accounting Ethics, which undertakes research on ethical issues in accounting; the Centre for Election Studies, which serves as a resource for the study of Canadian elections; the Computational Neuroscience Research Group, which is dedicated to developing and applying a unified mathematical framework for modeling large scale neurobiological systems; and the Survey Research Centre, which conducts survey research for academic programs and community groups, the Canadian Centre of Arts and Technology, which undertakes research into the dynamic human interface between arts and digital technologies, the Early Childhood Education Centre and Centre for Child Studies which undertake research into child development to encompass infant language acquisition.

Waterloo will develop and enrich its reputation as the “most innovative” university in Canada with a clear focus on its qualitative and quantitative research in the social sciences and humanities. Some of the critical factors explaining the invention and diffusion of technology include accounting for profits and incentives set by the political-legal framework, complementary public capital, and culturally determined attitudes toward risk-taking or risk-aversion. Research in the social sciences and humanities has established that, by chance or design, these values are inculcated by means of the family, religion, literature, peer groups, media - and further, that these forces are distinctly different among the many cultures and subcultures which comprise Canadian society.

UW will also expand applied research in fine arts, cultural management, information systems, finance, anthropology, sociology, economics, psychology and religious studies to examine the factors influencing entrepreneurship, and more generally, creativity.

Deployment of Canada Research Chairs

Allocation of Tier I/II Canada Research Chairs to the five major thrust areas is preliminary. The number of Chairs available is to be revised annually, and efforts to fill the Chairs will need to be integrated with the University’s overall faculty recruitment and retention activities. Also, the major thrust areas overlap, and some Chair appointments will contribute to more than one area.

The University expects that 70% of the Chairs will be awarded to internal candidates, that 10% will be awarded to candidates currently holding regular faculty positions at other Canadian universities and that 20% will be awarded to senior researchers from outside Canada. As the program evolves, the University will endeavour to increase efforts to attract researchers from other countries.

The University of Waterloo is conscious of the importance of ensuring that the gender balance within its professoriate is in line with the proportion of men and women in hiring pools for the various disciplines.

Committed to diversity, UW commissioned a report in 2002, “Welcoming Women Faculty” <http://www.adm.uwaterloo.ca/infosec/OfficialDocuments/ffr.finalreport.10june02.pdf>. It resulted in a number of new initiatives to improve gender balance in the professoriate. They include:

- Appointment of a “coordinator of faculty recruitment and retention” to help departments share information about best interviewing and hiring practices, and to help potential faculty members find schools for their children and jobs for their spouses.
- A program of bridge funding, in order that promising young faculty can be hired when they are available, even if a position is not yet open.
- Improvements to the parental leave policy.

Tentative Allocation of Tier I/II Chairs

MAJOR THRUST AREAS	NSERC	SSHRC	CIHR	TOTAL
Information Technology	9/10	0/0	0/0	9/10
Environment and Energy	5/1	0/0	0/0	5/1
Health	2/5	0/1	1/3	3/9
Materials, Manufacturing and Devices	6/6	0/0	0/0	6/6
Innovation, Society and Culture	0/0	1/5	0/0	1/4
Total	22/22	1/6	1/3	24/31

Institutional Support for Research and Research Training

Waterloo is committed to the coordinated and aggressive pursuit of funding for research, including support for graduate student research. Through its External Relations Office and the Office of Research, Waterloo will continue to seek industrial funding and will actively pursue government and granting council opportunities, paying particular attention to basic research and areas in humanities and social sciences that typically do not attract private sector support. Fund raising strategies and priorities are being developed. High priorities include matching funds for federal and provincial initiatives and funds for endowed chairs and professorships. Special attention will be paid to the research needs of junior faculty members to help them get established. This includes provision of mentoring, special financial support and reduced teaching and service workloads.

Benchmarking Research Achievements

The University of Waterloo will employ various measures to evaluate success in meeting the objectives of its Strategic Research Plan.

Scholarly Output: The number and quality of journal articles, books, papers in conference proceedings and other publications generated by increased research activity in the major research thrust areas will be a key measure of scholarly achievement. The number and prestige of awards to researchers, patents, and royalties paid and research contract growth also contributes to the assessment. Scholarly achievement is also demonstrated by prestigious invited talks at conferences.

Growth in Research Capacity: Significant increases in university faculty and research staff and in research infrastructure will be key indicators that the objectives of Waterloo's Strategic Research Plan are being met.

Training of Highly Qualified Personnel: The incremental numbers of post-graduate degrees granted, post-doctoral fellows supervised and visiting scholars attracted will be determined, as will acceptance and retention of graduates in positions in Canadian companies, institutions and agencies. Special attention will be paid to the repatriation of Canadian scholars.

Knowledge and Technology Transfer: Evidence will be sought to demonstrate the extent and rate of knowledge uptake to create new products, processes and policies, to extend capacities and to foster commercialization within the Canadian receptor community.

Original Contributions: The entry of intellectual property into teaching at all levels of study and the degree to which it has pushed back the limits to understanding will be important elements in assessing how well the objectives of the Strategic Research Plan are being met.

Planning and Approval Process

The University's institutional plan, "Building on Accomplishment, A Plan for the University of Waterloo's Fifth Decade", was the outcome of a three-year, University-wide consultative process. Planning for the 6th Decade Report is underway. This Plan serves as the framework for subsequent planning endeavours. Following this, a Senate-approved Strategic Research Plan (SRP) and Plan Summary was submitted to the Canada Foundation for Innovation in early 1998. A Strategic Research Plan Committee is in place to update the SRP periodically.