



## Strategic Research Plan

*The University of Guelph Strategic Research Plan describes a broad set of themes and emphases that provide the research context of the University Integrated Plan, a document culminating from a planning process beginning at the departmental level. This plan serves as a framework by which allocations of Canada Research Chairs and submissions of major institutional infrastructure requests to the Canada Foundation for Innovation are made. The University of Guelph is a research intensive institution that recognizes the distinct role it plays provincially, nationally and internationally; it will continue to build on its rich history in agricultural, veterinary and life sciences, and is committed to the development of research excellence in other areas of emerging strengths. The complete picture of research at Guelph includes outstanding scholarship in the arts, humanities, social sciences, life sciences, physical and engineering sciences, agriculture and veterinary sciences. The plan, while building on our history, embraces the richness of a diverse scholarly community that is positioned to contribute fully to key strategic priorities of the University and generally to society. This plan provides highlights of thematic activities of importance to the University, and a vision for the future rather than a complete compendium of research activity*

### 1. Introduction

The University of Guelph (Guelph) has a rich history of global leadership in agricultural and veterinary research. Over the last 50 years other areas of important scholarly activity have emerged reflecting the expanding diversity of academic pursuits and research intensity commensurate with its place as a leading comprehensive university. Guelph has a tradition of responding to societal need for advanced training in arts, humanities, social sciences, life sciences, physical and engineering sciences. The University is proud of its heritage and is able to take full advantage of the collaborative and interdisciplinary nature of research in a climate of innovation, and global competitiveness.

One of Guelph's key strengths is its ability to form connections between the major areas of academic research and scholastic endeavor, which frequently traverse colleges and disciplines. The breadth of disciplines and the tradition of collegiality have promoted the development of research programs capable of carrying ideas from conceptual and laboratory stages of research through to field application and commercialization. The Strategic Research Plan (SRP) fully respects the mission statement of Guelph which identifies research intensity, learner-centeredness, internationalism, collaboration and open learning as broad strategic objectives. Of these, research intensity, internationalism and collaboration are particularly

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enhanced by the SRP. Guelph has a large number of successful partnerships with other universities, federal and provincial government agencies, industry and researchers nationally and internationally.

This plan captures not only those research themes for which Guelph has cultivated a deserved reputation, but also those where it can make a distinctive contribution to current research and those which it sees as emerging in the near future.

## **2. Major objectives of the SRP**

Research at Guelph is undertaken within a framework of six guiding objectives:

**Research excellence** Research is taken to include all forms of scholarship that create new knowledge or new art. Guelph encourages research excellence in all fields of enquiry. Research excellence is sought in individual, interdisciplinary and collaborative research.

**Supporting creativity and diversity** There is widespread recognition that the university's vibrancy is reflective of its diversity and creativity. Guelph strives to be a recognized centre of discovery and advanced training and to be respectful of fundamental, discipline-based research. It is also recognized that Guelph's discovery-based research extends and evolves into distinct opportunities to address matters of importance to society. Indeed, societally-relevant or "applied research" is an important aspect of the research undertaken at Guelph, an increasingly recognized leader in knowledge mobilization, collaborations with external partners (e.g. industry, government and non-government organizations), and community engagement strategies.

**Innovation** Broadly defined, innovation includes advances in how knowledge is created and applied. Guelph researchers also play a key role in contributing to Canada's stock of innovative products and methodologies. As such, Guelph research is expected to figure prominently in the proposed national expansion of the commercialization of university research. The expanding engineering programs and the establishment of the College of Management and Economics represent aspects of the important academic developments that will contribute to this goal. Guelph recognizes the requirement to foster innovation through opportunities to develop new interfaces to support growing interactions and collaboration between disciplines and with research partners.

**Public Policy** Research in policy rich areas such as animal and human health, culture, work, crime, poverty, language, agriculture, food safety, and environment (including water management and climate change) draws Guelph into the cross-section of critical debate and development of public policy, and the advancement of societies and governments. To effect policy development and change through research and scholarship is an important contribution Guelph will make in a variety of ways both within Canada and internationally.

**Training of highly qualified personnel** Research at Guelph is critical to the development of highly qualified personnel and it is the primary way in which we train graduate students. The several research clusters and centres at Guelph, many with significant federal funding through the Tri-Councils<sup>1</sup>, programs that support strategic and infrastructure programs<sup>2</sup> and provincial investment through the Ontario Ministry of Research and Innovation (MRI) programs<sup>3</sup>, are attracting excellent post-doctoral fellows and graduate students. As a particular objective, Guelph ensures that through its teaching requirements, Canada Research Chairholders and all of our leading researchers play an important role in both undergraduate and graduate programs. It is essential that research be integrated into the academic mission of Guelph.

**Collaboration** Although Guelph has a conventional structure in terms of academic units, there is a growing number of multidisciplinary teams of researchers. Guelph enjoys an effective system of interdepartmental communications, and had recently created a Research Services Council comprised of associate deans for research and key Office of Research staff, to provide more coordination of efforts and to find common ground among research interests and needs across campus. Further planning and development by Guelph is leading to the establishment of research institutes around specific areas where a combination of research resources, critical activity and opportunity, and collaborations exist.

### 3. Research themes

Guelph is a leader in responsible community engagement, in cultivating artistic creativity and in understanding the social cultural, economic and ecological context and constraints in which technological progress unfolds. Guelph makes unique and leading contributions to research in several distinct thematic areas of importance in Ontario, Canada and internationally. We recognize that research is integrative and research programs often span more than one theme or sub-theme.

#### 3.1 Environment, ecology and biodiversity

Guelph has a broad research theme embracing the areas of environment, ecology and biodiversity that spans the entire campus. The sub-themes in which Guelph places particular emphasis are:

- **Aquatic environments.** Guelph has over fifty faculty members with research interest in aquatic sciences ranging from marine biology and aquaculture through to issues related to ecotoxicology and water quality management. Guelph has state-of-the-art facilities for research involving a diversity of aquatic organisms from fish and amphibians through to invertebrates and plants. Ongoing research in the areas of aquaculture biotechnology, fish health management and fish stock assessment and management are enhancing our

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<sup>1</sup> Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council, and Social Sciences and Humanities Research Council.

<sup>2</sup> Canada Foundation for Innovation (CFI), Genome Canada, and the Canada Research Chairs (CRC) program.

<sup>3</sup> Early Researcher Award, Ontario Research Fund-Research Excellence and Infrastructure Programs, and Ontario Centres of Excellence.

competitiveness in the aquaculture sector and providing the technologies needed to ensure that current fishery resources are managed in a sustainable manner.

- **Biodiversity and evolutionary ecology.** Guelph researchers are engaged in fundamental and applied studies of the interactions of plants, animals and microbes. In addition to conventional collection and morphological analysis of the various forms of life, Guelph has emerged as leader in the development and application of new approaches based on the use of molecular analyses to characterize the diversity of life forms.
- **Water quality and management.** With concerns about water quality and availability in Ontario and in many parts of the world, there is a pressing need to better understand conditions which affect water quality and to provide a sound basis for the formulation of policy. Guelph research in water quality and management is well-established. Work involves surface and ground water hydrology, characterization of contaminant sources, ground and waste water remuneration, wastewater treatment, waterborne disease surveillance, population medicine, toxicology, stochastic modeling, environmental epidemiology and geographical information systems.
- **Global environmental change.** Scientists at Guelph and elsewhere are increasingly confronted with environmental issues that are often global in scope, that evolve over long time periods, and that reflect dynamics in and interactions among biophysical and socio-economic systems. Issues such as global climate change, deforestation, desertification, ocean and fisheries dynamics, require innovative interdisciplinary scholarship. At Guelph, geographers, economists, zoologists, plant scientists, soil scientists, sociologists and political scientists, and others are engaged in wide-ranging research in the causes and consequences global climate change.
- **Controlled environments.** Guelph researchers are exploiting various forms of controlled environments to gain fundamental information on the roles of environmental factors in life science research. Research facilities at Guelph enable studies of controlled environments, such as greenhouses, deep space missions and in closed buildings. Researchers are also able to selectively vary plant and animal communities and to investigate fundamental questions related to natural selection, evolutionary ecology and the impact of climate change on living systems.
- **Human-environment interactions.** Researchers at Guelph are engaged in assessing the social, cultural and environmental consequences of human actions as well as in conceptualizing the necessary responses (including policy, technology and design) to enhance the benefits, and avoid or mitigate the negative impacts.

### 3.2 Agriculture, food and bioproducts

Guelph has a long history of research in agriculture, especially in the production and use of foods. A Science Watch study ranked the University of Guelph 7<sup>th</sup> worldwide for its impact on agricultural sciences over the past decade. A 2007 Deloitte impact study concluded that the

Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA)/University partnership had direct and spin-off impacts on the Ontario economy of over \$1 billion per year. In addition, the focus on agriculture at Guelph of Guelph has led to the clustering of numerous agri-food organizations, agri-food research and agri-technology companies around and in the University Research Park. Foremost among the newer areas of research interest are applications of molecular genetics, genomics, bioinformatics, modeling and systems research to create novel crops and livestock, to ensure that agricultural practices are economically and environmentally sustainable, and to ensure the safety of our food systems. Traditional and more recently recognized aspects of agriculture in Ontario continue to represent areas of special responsibility for Guelph:

- **Agricultural products and the bioeconomy.** Agricultural research at Guelph has a strong record of accomplishment that has led to transformational change in: the agricultural landscape in Ontario, the choices of crop varieties that producers have to grow, the genetics of the farm animal herds, the economics of farm operations, the environmental impacts of farming practices and the choices of food that are on the shelves in our markets. Some examples of innovation include: no till farming practices, omega- three eggs, new varieties of vegetable crops, field crops and fruits that result in a significant annual royalty stream to Guelph, identification of genes contributing to tenderness in beef. Roles for agricultural commodities with non-traditional ornamental, industrial and medicinal uses are expanding, as is the interest in crops better adapted to the stresses found in Canadian climates and for use in the developing bioeconomy. Current plant-focused and engineering interdisciplinary efforts at the University include the production of crops for industrial applications in bioproducts, including engineered biomaterials for the automotive sector, and biofuels, novel products such as medical diagnostics and veterinary vaccines, packaging and bandaging materials, the creation of plant varieties with enhanced levels of desirable pharmaceuticals, and the development of crops with desired traits for biorefining, and tolerance to biotic and abiotic stresses. There is a similar interest in the development of livestock bred or engineered for improved nutritional benefit, conversion of feed and environmental consequences.
- **Agricultural systems.** Guelph continues to place a high priority on investing in research leading to the development of economically, environmentally and ethically sound agricultural systems and strong rural communities. Risk assessment, consumer response, and bioethics are receiving increased cross-disciplinary attention and currently involve faculty from multiple colleges of Guelph. Research addressing all aspects of animal, plant and land use and animal behaviour will continue to be an important research area for Guelph.
- **Food safety.** Guelph research provides basic information needed to successfully assess the risks of future changes in food production and processing practices and provides a framework for successfully communicating these risks to consumers, governments and industry. In parallel research, colleagues in the social sciences and humanities analyze food-associated risks, actual and perceived, and consumer reactions to a variety of food

safety issues, including the use of genetically modified organisms in food production.

- **Food and soft materials.** Researchers use a multi-disciplinary approach and advanced analytic equipment to study both fundamental and applied aspects of macromolecular structure and function in a wide variety of soft materials, such as food materials, polymers, biological membranes, proteins and other materials. Collectively these materials are of critical importance to many sectors of Canadian industry (e.g., for adhesives, food technology, nutraceuticals, packaging, pharmaceuticals, drug delivery systems).

### 3.3 Physical and biological structures: function, dynamics and interactions

At Guelph researchers from across campus are using, and developing, the techniques of modern science to understand, both experimentally and theoretically, the nature of structure and their interfaces at all scales. Researchers engage in understanding both static molecular systems and the associated dynamics and interactions across all size and energy scales. Understanding interfaces, especially those between the physical and biological sciences, is a distinct interdisciplinary research priority at Guelph. Sub-themes include:

- **Electrochemistry and interfaces.** Collaborations between researchers from across campus, include fundamental and applied studies on thin films both soft and hard, waste treatment, electrometallurgy, synthesis (electrosynthesis) and a wide range of analytical and spectroscopic tools for understanding the properties and dynamics of physical and biophysical structures. Emerging areas of research include nanotechnology and combining physical and biological structures (e.g. biosensors, biomimetics).
- **Biological mathematics and computing.** In many areas of the life sciences, significant progress relies increasingly on hard quantitative analysis. Examples range from genomics and biofilms to epidemics and global climate models. State-of-the-art mathematical and statistical methodology helps researchers to extract useful information from large data sets, model nonlinear dynamics and forecast future behaviour.
- **Probing structure and function through physics and chemistry.** The methods of the physical sciences play a critical role in research at Guelph. Techniques, synthesis of new materials or molecules, precise analytical determinations, and accurate molecular structures are at the centre of any deep understanding at the molecular level. Guelph research in this area covers foundational topics such as subatomic physics, quantum materials and gravitational physics.
- **Dynamics of biomembrane interactions.** A current frontier for research in cell biology is at the interface of biological membranes and their protein complement. Researchers from across campus collaborate to investigate the dynamics of protein interactions and their mechanisms of action within biomembranes. These studies include investigations of bacterial membrane proteins which may represent new targets for antibacterial drug development, or form complexes that confer multi-drug resistance in human chemotherapy.

### 3.4 Promoting health and preventing disease

Guelph has an integrated view of and approach to health related issues, from cultural to scientific, from individual to community, from theoretical to applied, and from animal to ecosystem. The development of policy recommendations based on effective management practices and risk analysis is a particular priority. Guelph is well-positioned to make significant and completely unique contributions to the improvement of human, animal and environmental health. This is consistent with the needs of Canadians who, as part of their concern about how a degraded environment could affect public health, are seeking a more integrated approach to health issues and health research. Research is conducted in the following areas:

- **Health research.** Research in genetics, neuroscience, human metabolism, and microbiology make Guelph an important centre of health research. In addition to work on human and animal health, Guelph has an enviable reputation for research which recognizes the interplay between animals, people and the environment. Our researchers have made significant contributions to the study of pathogens, toxins, nutrition, genetics, host response, host-agent, and environmental issues. A strong group of behavioural and cognitive neuroscientists are focused on understanding of learning, memory and addiction. University research has developed strong interdisciplinary collaborations for excellent research relating to human and animal health.
- **Comparative biomedical sciences.** Guelph has established programs investigating the fundamental biology of multiple species on a molecular, cellular, tissue and whole animal basis. Comparative cancer investigations will train future cancer health care specialists and scientists and lead to discoveries that benefit both humans and animals. Research into the genetic, nutritional and environmental influences that help treat and prevent cancer will be a focus of research undertaken at Guelph. There is extensive expertise in applying this knowledge to the diagnosis, management, and treatment of animals. This multi-disciplinary approach has a proven record in improving the health and well being of animals, but can also improve our understanding of the pathogenesis and treatment of human diseases. Guelph is well placed to develop a variety of these animal models because of the close proximity of clinical and fundamental biomedical scientists, together with specialized animal housing and research facilities.
- **Public health and health services.** Expertise in the areas of nutrition, applied nutrition, nutritional epidemiology, population medicine, and in related policy, leadership, and communication and management studies form a base from which Guelph's activity in public health research can continue to grow. Research programs in human nutrition, physical activity aspects of lifestyle, sexuality, addiction, child development, gerontology, and on service provision in urban and rural communities have major impacts on the health and well-being of individuals.
- **Individual and family well-being.** Many research groups contribute to research in well--

being, including human nutrition, health promotion, social and mental health, literacy, lifespan development, parent-child relations, and the analysis of children and youth at risk.

### 3.5 Cultural transformation and social change

The arts, humanities and social sciences produce social change, reflect it, and critique it. Guelph embraces innovative research in both foundational disciplines and transdisciplinary areas of study. With major strengths in critical, historical, and philosophical enquiry, policy-oriented social research, and creative response, this theme addresses pressing issues such as gender, race, ethnicity, class, and nation which are at the heart of society and social change. Underlying technological innovation to support collaborative tools and global access to historical and archived documents are resulting in a new focus on digital humanities. Individual and collaborative research and creative practice build upon the following sub-themes:

- **Social and cultural transformation.** This sub-theme embraces projects that cross traditional disciplinary formations. Examples of collaborative research demonstrating the diversity of current projects that engage with and produce social transformation are: Canadian adaptations of Shakespeare; cultural memory; improvisation, community and social practice; intellectual property and agriculture; ethics and the environment; rural development; and the historical census database project.
- **Creative and critical studies.** Guelph has on faculty a number of distinguished senior artists with international reputations in the fields of fine art, literature, music, and theatre. Other faculty contributions emerge in the fields of art and literature criticism, as well as in philosophy. Guelph recognizes that these creative and critical practices are an important and integral part of its research mission. Creative practices enrich lives in polyvalent ways, providing texture, colour, sound, light, and dimension to the mundane. Critical studies by faculty provide insight and understanding into a wide range of historical, social and cultural contexts.
- **Family and community dynamics.** Several investigators are examining ways of strengthening the community's social fabric toward the goals of protecting and promoting the morale and well-being of citizens. Included in such initiatives are studies of parental safety practices, effective child care programs and policies, explorations of the representation of family and childhood, efforts to promote the adjustment and integration of immigrant populations, and studies of the relationship between socioeconomic conditions and social justice.
- **Public policy and governance.** The central foci of research in this theme include public sector management, population migration policies, international and community development policies, human resource management, labour market analysis, environmental governance, the criminal justice system, discriminatory practices, pay equity, homelessness, human rights, acculturation policies, and international politics. There are a number of cross college collaborations focusing on leadership, racial and gender

discrimination, and work-family policies.

- **World of work.** Numerous faculty from across campus share an interest in workplace and workforce dynamics including employment flows, the school-to-work transition, the meaning of work, gender wage gaps, and public-private sector wage differentials. There is keen interest in ways of promoting leadership that creates adaptive workplace structures, processes, and cultures. Ongoing investigations centre on public sector organizational change, the introduction of flexible work arrangements such as job sharing and telecommuting, conflict between employees' work and family responsibilities, and factors affecting employee morale, organizational commitment, and productivity.
- **Globalization studies.** This research encompasses both the meeting of various cultures, with their unique history, values, and worldviews, in the contemporary international arena, as well as the challenges of diversity and multiculturalism as it is found in Canadian society. The challenges of globalization are addressed from various disciplinary perspectives, including those found in geography, sociology, anthropology, history, philosophy, economics and political science.
- **Information and communication technologies.** Transdisciplinary faculty research from across the university demonstrates growing concern with the changing nature of human communication systems and Canada's media environments. Collaborative research considers information and communication technologies within the realm of digital citizenship, linking to inquiries that consider questions of access, equality, and social inclusion. Technology is also a research tool that is studied as part of the sociable web to foster innovation by way of open-source, open access, and open content projects. This research facilitates collaborative working and learning, innovation in knowledge production, organization and dissemination.

#### 4. Current and planned distribution of Chairs

Currently, Guelph is allocated 36 Chairs. These positions are allocated by granting council (CIHR, NSERC, SSHRC); by allocation year; and by level (Tier 1 and Tier 2). Guelph has received confirmation of its allocations up to, and including allocation Year 8.

Appendix I shows the current internal distribution of Chairs at Guelph by college and by granting council.

Appendix II, Table 1 shows the distribution of occupied Chairs by research area and by granting council.

Appendix II, Table 2 shows the distribution of vacant Chairs by planned research area and by granting council.

##### 4.1 Gender representation in Chair nominations

In accordance with Guelph's equity goals, all faculty appointments endorse the principle of employment equity. Relative to national statistics, Guelph has a slightly higher proportion of female Chairs. Currently, 25% of Chairs at Guelph are female (17.6% of Tier 1 Chairs; 31.6% of Tier 2 Chairs). Without reference to a specific quota, Guelph expects that female candidates will be nominated for most of the remaining Chairs, as well as for Chairs that become vacant.

Further, Guelph will monitor its progress in addressing equity amongst its Chairs according to the methodology suggested in the context of the equity agreement reached between the Canada Research Chair program and Canadian universities.

#### **4.2 Chairs offered to current faculty**

Guelph expects to offer 50% of its Chairs to current faculty in order to enhance their opportunities and promote faculty retention.

#### **4.3 Chairs offered to other researchers**

Guelph expects to offer 25% of its Chairs to researchers in Canada, and the remaining 25% to researchers outside of Canada.

#### **4.4 Deviations from initial allocations**

Guelph's proposed allocation deviates from its initial allocation in two ways: 1) Guelph has increased the number of Tier 2 Chairs in order to more efficiently build a critical mass of researchers in areas identified above; and 2) Guelph has changed NSERC Chairs to SSHRC and CIHR Chairs to broaden the nature of research available to be undertaken by Chairs and to better reflect the diversity of research apparent in this SRP.

Guelph has one remaining flexible Chair which it will utilize strategically to better meet its research objectives and to accommodate its research areas identified above.

### **5. Institutional resources, collaborations and infrastructure investment by research area**

#### **5.1 Research institutes**

The CFI-funded Biodiversity Institute of Ontario has overseen the growth of a major research program in biodiversity science focused on DNA barcoding. The latter research has attracted broad international interest and has gained more than \$20M in additional support from Genome Canada, the Gordon and Betty Moore Foundation, NSERC, the MRI and all federal departments involved in biodiversity management. The Centre for Biodiversity Genomics, an organization devoted to the development and application of DNA-based approaches for biodiversity analysis will build upon this success and will place Canada at the forefront of leadership in the field of biodiversity genomics.

Guelph is home to the CFI-funded Canadian Research Institute for Food Safety (CRIFS). CRIFS is a state-of-the-art facility, including a level 3 laboratory, that allows for the study of microbial adaptation during food production and processing.

The Centre for Public Health and Zoonosis has been created in response to the growing concern for zoonotic diseases, those transmitted between animals and humans, and their enormous challenge to public health. Global trends, including urbanization, globalization of travel and trade, habitat destruction, and environmental changes all increase the risk of emergence of new zoonoses or changes in the geographic distribution of existing zoonoses.

## **5.2 Institutional resources and collaborations**

Significant institutional facilities and networks which represent collaborations at the municipal, provincial, national and international level include, but are not limited to: the Hagen Aquaculture; the Axelrod Institute of Ichthyology; the Alma Aquaculture Research Station; the Controlled Environment Systems Research Facility; the Limnotron; the Plant Growth facility within the New Science Complex; the Biotron; the Environmental Farm Plan Program; the Centre for Ecologically Sound Agriculture; the Advanced Analysis Centre; the Electrochemical Technology Centre; TRIUMF; the National Proton Microprobe Facility; the Canadian Light Source; SNOLAB; the Perimeter Institute; the Orlando Project; Linking Agricultural Research for Rural Radio in Africa; and the Institute on Critical Studies in Canadian Literature.

## **5.2 Major infrastructure investment by research area**

Appendix III, Table 3 summarizes CFI-funded research in the research areas described above.

## **6. Assessment**

Guelph is committed to evaluating research performance and excellence, especially in the strategic areas of research identified above. While there is no single measure of research performance, promotion and tenure committees use a variety of metrics formally and informally. Research funding, quality and impact of peer-reviewed publications, prizes, awards, fellowships, conference proceedings, membership of significant national and international groups, and favourable reviews of exhibitions, books, art, plays are examples of such metrics. In the context of the SRP, these metrics will be assessed along the research areas identified above.

Further, Guelph will evaluate its progress in the training of highly qualified personnel and collaborations through Chairholder and CFI project annual reports.

## **Planning and approval processes**

Guelph has recently updated its planning and approval processes with respect to nominations and renewals (see Appendix IV).