



Queen's
UNIVERSITY at Kingston

Strategic Research Plan

for the Canada Research Chairs and Canada Foundation for
Innovation Programs

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Queen's University Strategic Research Plan for the Canada Research Chairs and Canada Foundation for Innovation Programs

1. QUEEN'S RESEARCH MISSION

Queen's University is one of Canada's leading research intensive institutions. Our aim is to further enhance the level of research of national and international distinction. We are dedicated to promoting research and scholarship that will enrich the academic environment, contribute to the cultural and economic growth of our country, and contribute to creating a just and equitable world. We encourage partnerships and multidisciplinary initiatives that support our traditional strengths and emerging areas of research. Encompassing the spectrum of disciplines, from the humanities and social sciences, to the natural and engineering sciences, to health sciences, we are building an infrastructure that supports the full spectrum of research activities that range from creation and discovery to application and transfer to society.

2. A FRAMEWORK FOR PLANNING

Research at Queen's University is conducted at the highest levels of inquiry. We attract and retain faculty and students with outstanding ability and diverse backgrounds from across Canada and around the world. The high quality of our faculty and students creates a rich, innovative and dynamic research environment. This integrated approach to learning and research is part of a long tradition that has been affirmed regularly and has been central to our planning process.

Our strategic research objectives are:

- to expand internationally recognized research programs,
- to develop internationally recognized research programs in emerging areas,
- to encourage diversity by actively seeking qualified candidates from under-represented groups, including women, visible minorities, aboriginal persons, persons with disabilities, and persons of diverse sexual orientation,
- to enhance the quality and breadth of our programs of education and the training of highly qualified personnel,
- to promote collaboration and multidisciplinary,
- to enrich society with the results of University research, and
- to respond promptly to new opportunities.

The planning process at Queen's recognizes that all members of our community contribute to the success of the institution. Therefore, our approach to the establishment of a research plan builds on the strength and commitment of our researchers, Departments, Faculties and Research Centres and Groups. The University brought together representatives from all Faculties to construct its strategic research plan. During this process, inter-Faculty initiatives were integrated and the University Senate subsequently approved the plan.

We will continue to use the Canada Research Chairs (CRC), the Canada Foundation for Innovation, and the Ontario Ministry of Research and Innovation programs to enhance areas of research strength and ensure that we have the critical mass of researchers and the associated infrastructure in strategic areas. Almost all CRCs awarded to Queen's to date have resulted in new faculty being appointed to the CRCs. In the few cases where existing faculty were awarded a CRC, the University has made special effort to hire faculty in research areas that are complementary to our appointed CRCs. This also applies to many instances where external CRCs were hired. Queen's remains committed to actively seeking qualified candidates from under-represented groups and has taken additional steps to address any imbalance that occurs among our CRC nominees. Our research efforts will build on national and international

partnerships, programs, and projects where our expertise and resources complement the research activity. Special efforts will be made to disseminate research findings and to ensure that the benefits find their way back to society and industry. For example, where appropriate, intellectual property will be transferred to industry through PARTEQ, the highly successful commercialization arm of the University.

Queen's success in meeting its objectives will be measured, as appropriate, by:

- the quality of new faculty attracted to Queen's University,
- the proportion of faculty positions filled by under-represented groups, including women, visible minorities, aboriginal persons, persons with disabilities, and persons of diverse sexual orientation,
- the quality and number of publications, (e.g. books published by highly respected publishers and papers in top tier journals),
- the level of research funding and the number of industrial contracts,
- the calibre and frequency of invited lectures and leadership in national and international symposia,
- the calibre and number of national and international awards and prizes received by our faculty,
- the visibility and impact of research,
- the number of invention disclosures filed by the University, and
- the quality and number of graduate students, post-doctoral fellows and other highly qualified personnel and their ability to win awards for funding.

3. RESEARCH CLUSTERS

We have identified our research strengths under eight multidisciplinary research clusters. Within each of these clusters are internationally recognized researchers who have received the country's highest recognition for their work. Their excellence has been recognized by major awards including Fellowships in the Royal Society of Canada, Steacie, Killam and Trudeau Foundation Fellowships, the Herzberg Gold Medal, Canada Council Molson Prizes and Killam Prizes. In addition, research in these clusters has attracted significant funding from one or more granting councils, the Premier's Research Excellence Awards, the Canada Foundation for Innovation, the Ontario Ministry of Research and Innovation, and the Ontario Research and Development Challenge Fund.

Democracy, Economy, and Public Policy in a Global Era

The challenges of the global era are formidable: globalization; rapid technological innovation; the restructuring of organizations in the public, private and non-profit sectors; human conflict over power, wealth and security; the need for a highly educated citizenry; growing social diversity and demographic transitions; new conceptions of democratic governance; and the historic challenge of maintaining Canadian unity. Queen's University has deep research strength in these areas. This strength is rooted in the Faculties of Arts & Science, Law, and Education, and in the Schools of Business, Policy Studies and Urban and Regional Planning. This is further reinforced by a set of active research institutes, including the Institute for Intergovernmental Relations, the John Deutsch Institute for the Study of Economic Policy, the Centre for International Relations, the Centre for the Study of Democracy, the Southern African Research Centre, and the Monieson Centre. Sub-clusters and themes in this area are as follows: (1) Communities, Conflict and Negotiation in a Globalized Environment, (2) Democracy, Identity and Citizenship: Aboriginal Education, Citizenship and Education; Collective Rights, Group Rights and Individual Rights; Democracy and Global Governance; Globalization and Citizenship; Globalization and Social Cohesion, (3) Health Policy and Law, (4) International Relations and Development: Development in National and International Contexts; International and Development Education; Regulating the Conduct of International Relations, (5) Knowledge-Based Enterprises, (6) Organizational Behaviour and Change: Human Resources and Workplace Change; Management in the Public, Private and Nonprofit Sectors, (7) Social and Economic Development, Regulation and Policy: Economic and Social Policy and Legislation; Finance and Banking Law and Policy; Tax Law and Policy, and (8) Values, Laws and Policies.

Enhancement of Human Health

The Enhancement of Human Health cluster is home to many research initiatives that share a common interest in improving the human condition by enhancing understanding of health, wellness, and disease and in applying this understanding to improve a wide range of aspects of both individual and social health. Research in this cluster includes the full range from basic biomedical research, applied clinical research, research on health care systems and services, biomechanics and human performance, to research on society, culture, public health and the health of populations. Queen's University has strength in health education, practice and research. Considerable cross-disciplinary health research takes place in the Faculty of Health Sciences and its affiliated hospitals, the Faculties of Arts & Science, Education, Law, and Applied Science, and the Schools of Policy Studies and Business. In addition, health research is enhanced through various research groups such as those in public health and population health, the Centre for Health Services and Policy Research, the Cancer Research Institute, the Centre for Neuroscience Studies, the Human Mobility Research Centre, the Centre for Obesity Research and Education, the Centre for Studies in Primary Care, the Queen's Biological Communication Centre, the Gastrointestinal Diseases Research Unit and the Protein Function and Discovery Group. The research sub-clusters and themes are: (1) Biomolecular Studies: Molecular Biology; Medicinal and Biological Chemistry; Structural Biology/Protein Function and Discovery, (2) Genetics, (3) Cancer Research, (4) Cardiorespiratory Sciences, (5) Environment and Human Health, (6) Gastrointestinal Diseases, (7) Reproductive Sciences, (8) Health and Society: Demographic Change and Health Care; Epidemiological Research; Health Education; Health Law, Policies, Services, and Outcomes; Health Promotion, Disease Prevention, and Human Performance; Medical Ethics, (9) Musculoskeletal Diseases: Biomechanical Human Mobility Research, (10) Neuroscience, and (11) Primary Care.

Environment and Sustainability

Queen's has established a strong foundation for environmental research involving multidisciplinary activity related to the ecological and human aspects of developing healthy environments. This encompasses socio-cultural, legal and economic aspects, as well as the application of scientific principles to sustainable development. Major environmental initiatives include the creation of the School of Environmental Studies, a multidisciplinary initiative through the Centre for Water and the Environment, continued support of the Queen's University Biological Station and its 7,000 acres of land holdings, and BIOCAP, a national research initiative exploring the policies and science of mitigation of greenhouse gas emissions through applications of biology. There are several research groups and laboratories that enhance these initiatives. Environmental measurement, monitoring and modelling is conducted in the Laboratory for Remote Sensing of Earth and Environmental Systems, the Environmental Variability and Extremes Lab, and the Lab for Landscape and Ecosystem Analysis among others. The Paleoecological Environment Assessment and Research Laboratory is a world leader in the study of climate change, an important initiative linked to BIOCAP. In addition, the Analytical Services Unit is a laboratory equipped with state-of-the-art instrumentation for probing environmental systems and the GeoEngineering Centre and Coastal Engineering Research Laboratory both have world-class physical and numerical modelling facilities.

Environment and Sustainability is one of the foci of the Queen's Strategic Research Plan. The vision of Queen's University is to become the national leader in bridging the gap between research (both scientific and policy-based) and policy-making at the federal and provincial levels in energy and environmental policy in cooperation with its post-secondary institutions and corporate partners across the country. As a result of strategic hiring decisions, targeted deployment of the Canada Research Chairs, and support for innovative research, we now have considerable strength in research areas such as: ecosystem management; alternative energy sources (e.g., fuel cells and solar power); energy systems and design; materials science (e.g., nuclear materials, modeling materials behaviour, and nanomaterials); and, biochemical engineering (e.g., bioremediation, bioreactor design, and waste treatment). Queen's is the

home of the Solar Calorimetry Lab, which develops and evaluates test methods and standards for solar heating systems and components. In addition, the Queen's-RMC Fuel Cell Research Centre includes faculty members from Chemical Engineering and Mechanical and Material Engineering at Queen's as well as the Royal Military College.

Specific research sub-clusters and themes have been identified as follows: (1) Ecology, Evolution and Conservation of Biodiversity, (2) Environmental Measurement, Monitoring and Modelling, (3) Environmental Chemistry and Toxicology, (4) Environmental Change and Planning, (5) Environmentally Sustainable Technologies: Energy and Fluid Systems; Environmental Process Engineering; Infrastructure; Renewable Energy Technologies; Resource Development; Waste Management, (6) Northern Environments, Resources and Policy, (7) Society, Culture and Economic Sustainability: Risk Management and Risk Communication; Optimized Design for Minimum Life Cycle Costs; Sustainable Development of Cities; Sustainable Development of Watersheds; Environmental Education; Environmental Law; Aboriginal Peoples and Resource Management, (8) Remediation and Protection of Soil and Groundwater, (9) Water and the Environment, and (10) Integrated Environmental and Energy Policy.

Foundations of Science

Foundations of science research currently engages a large number of faculty and research groups primarily from the Faculty of Arts and Science representing several disciplines including Geology, Mathematics, Physics, Biology, Chemistry, Geography, Linguistics and Psychology. These researchers are linked by a common desire to more deeply understand Nature's workings at a variety of scales from the Cosmos to ecosystems, to the brain, to the atomic scale, using various combinations of theory, experiment and computation. Research in this cluster is foundational because it is driven by curiosity about the way the world works and because it provides the conceptual foundation for more applied research at the University. The work in this cluster is supported by significant funding from NSERC, research projects and centres such as Boreal Ecosystem-Atmosphere Study, Geomatics for Informed Decisions and BIOCAP, and superior research facilities such as the Queen's Facility for Isotope Research and the High Performance Computing Virtual Laboratory (a four-university consortium led by Queen's that provides a leading-edge facility for complex calculations, data extraction and manipulation) and the Sudbury Neutrino Observatory, a world-leading basic subatomic physics research laboratory led by Queen's University. The research subclusters and themes are: (1) Cognitive Science, (2) Chemical Processes, Structure and Synthesis, (3) Earth System Science, (4) Evolutionary Science and Genetics, (5) Nanoscale Structures and Interactions, (6) Origins and Structure of the Universe, and (7) Theoretical Science and Mathematics.

Information and Communications

There is a significant concentration of researchers at Queen's University working on information and communications technology within the engineering and science disciplines. A unique aspect of this research is the joint strength in the School of Computing, Electrical and Computer Engineering, and Mathematics and Statistics. The research covers fundamental and applied aspects of (i) telecommunications and (ii) computer architectures and interconnection networks. Research in the area of telecommunications includes information theory, lightwave and wireless technology, microelectronics, signal processing for telecommunications applications, and statistical communication theory. Research in the area of computer architectures and interconnection networks includes multiprocessor networks, network protocols, parallel computer architectures, parallel computing, and Very Large Scale Integration architectures. The research in information and communications extends beyond these technology-based activities to include computer-intensive research in the Sciences, Applied Sciences, Social Sciences, Law, the Fine Arts, Humanities, Education, and Business. This research ranges from computing applications and high-performance computing, to research on the application of new information technology devices to teaching and learning, and to business practices. In addition, multi-disciplinary work involving the Fine Arts, Geography, Philosophy and Psychology explores such issues as the relations between

technological innovation and creativity and the interaction between technological change and social and scientific thought. Laboratories and groups supporting this research include the Queen's-led High Performance Computing Virtual Laboratory, the Power Electronics Applied Research Laboratory, the Computer Architecture Laboratory, the Image Processing and Communications Laboratory, the Lightwave Systems Research Laboratory, the Wireless Communications Laboratory, the Software Engineering Group, Robotics, Control and Biomedical Engineering Group, and the Human Media Lab. Research at Queen's is exploring a broad spectrum of challenges, both technological and societal, introduced by rapid advances in information and communications, and includes the following sub-clusters and themes: (1) Computer Architectures and Interconnection Networks, (2) Computational Science: Computing Applications, (3) Management Information Systems, (4) Technological Innovation and Society: Educational Application of New Information Technology; Information and Communications Technology Law; International Study of Design and Technology Education; Math, Science and Technological Education, (5) Telecommunications: Communications Research, and (6) High Performance Computing.

Society, Culture, and Human Behaviour

Queen's University is committed to enhancing its strong research focus in the area of Society, Culture and Human Behaviour, which includes one of the largest number of scholars at Queen's. Cutting across numerous Faculties, Schools and Departments, the richness of this research is considerable as is the variety and magnitude of the research funding it attracts. This research explores the nature of human creativity through the examination of texts, the critical evaluation of elements of modern culture, the theory-informed study of past human activity, the study and regulation of human behaviour, the exploration of the human mind, the study of learned systems of understanding, and the creation of new knowledge and art. Scholars working in this cluster often work independently rather than in teams, but their research benefits from the presence of a critical mass of scholars and cross-disciplinary discussion and consultation. Of particular importance to the vibrancy of the research carried out in this cluster is a high-quality University intellectual infrastructure (libraries, colloquia, visiting scholar series) and the time dedicated to creative thought. Specific research sub-clusters and themes are: (1) Creation, Interpretation and Preservation of the Arts, (2) Contemporary Culture, (3) Mind, Language, Cognition, Knowledge, Ways of Knowing, and World Views, (4) Regulation of Human Activity, (5) Social, Cultural and Historical Change, (6) Teaching and Learning in Social Contexts: Exceptional Learners; Literacy, (7) Texts, Literatures and Contexts, and (8) Theories of Human Behaviour.

Materials Sciences and Manufacturing

Queen's has long recognized the vital role that materials science and manufacturing plays in enhancing our nation's prospects for economic growth and for facilitating and sustaining our competitive advantage in the global arena. We have built considerable strength in the understanding of the molecular properties of materials in advancing our ability to measure physical and chemical properties of materials, and in the application of sophisticated methodologies to model and control manufacturing processes. The Initiative for Photonic and Electronic Materials is a shared laboratory dedicated to work on discovery and properties of electronic, optoelectronic, and photonic materials. Queen's also has substantial research support from the Ontario Centres of Excellence (formerly Materials and Manufacturing Ontario). The Ontario Strategic Skills Investment Program is funding skills development through research in the manufacturing of advanced ceramics and nanomaterials through the Centre for Manufacturing of Advanced Ceramics and Nanomaterials. In addition, Queen's is a participating centre of the NCE ISIS CANADA (Intelligent Sensing for Innovative Structures). The significant strength in this area is further enhanced with a state-of-the-art chemistry building. The research sub-clusters and themes include: (1) Computational Methods for Manufacturing, (2) Innovative Materials: Ceramics; Polymers; Nanocrystalline; Rehabilitation of Concrete materials, (3) Materials Science, (4) Machine Performance Monitoring, and (5) Mechatronics.

Advanced Technologies

Advances in science and engineering must be translated into usable technologies. Some of the development of advanced technologies takes place as part of the original research, but the actual implementation of the results of research is a distinct and separate task that requires specialized knowledge and that should be separately recognized and funded. Because of the close link to the original research, many of the research projects in the other seven research clusters could also be included under this cluster. Advanced technology research is mainly conducted in the Faculties of Arts and Science, Applied Science and Health Sciences. Recent advances in molecular biology, biotechnology and bio-engineering have opened up exciting opportunities for the production of pharmaceuticals, fuels, industrial feed-stocks, healthier foods, specialty chemicals and pest control agents with significant benefit to humans and their environment. Queen's University researchers are developing plants that grow more rapidly and are less susceptible to disease and environmental stress. They are investigating resistance of insects to cold and desiccation and are developing bioencapsulation technologies for the immobilization of cells, enzymes, and biologically active materials such as brewer's yeast, anaerobic sludges, neutraceuticals (plant oils), DNA (genomic, polynucleotides), and enzymes (urease, chlorophylase). They have developed two-phase partitioning bioreactors, and they have applied statistical techniques, nonlinear control theory, and process models for analysis and control of chemical processes. Similarly, researchers are implementing new technologies using new materials for structural design and infrastructure replacement, and are applying computer science and equipment to computation, control and visualization of complex physical interactive processes. Application of computational science and visualization is conducted by a group of researchers from the School of Computing, Mechanical Engineering and Surgery who are developing and implementing world-leading computer assisted surgery techniques for orthopaedics. Sub-clusters and themes include: (1) Applications of Computational Science, (2) Biomedical Applications: Biomedical Computing, Bio-engineering, Bioencapsulation, (3) Biotechnology: Biotechnology for Sustainability, Biotechnology of Natural Products, (4) Design and Rehabilitation of Infrastructure, and (5) Modelling and Control of Processes: Control of Chemical Processes, Bioreactors (TPPBs).

4. SUMMARY

The Queen's University Strategic Research Plan reflects the Queen's tradition of building on our strength and innovation across the broad spectrum of disciplines. It reflects the University's response and commitment to meeting the challenges of the changing research environment. The quality of our faculty, students and research facilities provides a powerful basis for research performance that places Queen's among the top research universities in Canada.