

Understanding and Sustaining the Environment and Energy Systems

Exploring Human Dimensions

Securing Safe and Successful Societies

Creative Production and Expression

Engineering and Applied Science

Natural and Physical Sciences

Medicine

Infrastructure

Policy Studies

Knowledge Ecologies

Public Policy

Democracy, Economy and

Health Sciences

Ecology and the Natural Environment

Rehabilitation Therapy

Human Health and Wellness

Creating, Discovering and Innovating

Energy and Environmental Policy

Law Education

Business Materials

Graduate Studies

Human Aspects of Healthy Environments

Arts and Science

Information and Communications

Nursing

Society, Culture and Human Behaviour

Advanced Technologies

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This document is an abridged version of the 2012-2017 SRP. For the full SRP, please visit:
The Office of the Vice-Principal (Research) website at <http://www.queensu.ca/vpr/SRP.html>
The SRP Blog at <http://www.queensu.ca/connect/vpr/>
The Office of the Vice Principal (Research) at 613.533.6933

Introduction

It is with great pleasure and excitement that I introduce to you the Queen's University Strategic Research Plan (SRP) 2012-2017. One of several major objectives I set for my first two years in my role as Vice-Principal (Research) at Queen's was to renew the SRP. This Plan is a result of extensive work and collaboration graciously contributed by the Queen's community, I am extremely proud of what we have managed to accomplish together. The following is the abridged version of the Senate-approved Plan.

Research is a core component of the mission of Queen's University and is the cornerstone for providing the best possible educational experience for students at both the undergraduate and graduate levels, for training post-doctoral fellows to become research leaders of the future, for creating a vibrant environment of inquiry, for attracting human and physical resources and for creating partnerships with our local and global communities, including industry, governments, and other institutions. At Queen's, there is an inextricable link between teaching and research; the fundamental thread is learning.

The origins of Queen's SRP coincided with the establishment of the Canada Research Chairs and Canada Foundation for Innovation programs, which required comprehensive planning by all institutions receiving funding. While it is essential that such a plan continue to serve this purpose, it is vital also to have a plan that represents Queen's collective vision, aspirations and priorities for the future.

In September 2010, I announced that renewal of the Queen's SRP would be a priority for the research portfolio, given that it had last been updated in 2006, and a renewal would coincide with the development

of the new Queen's Academic Plan. To align with the priorities of the Academic Plan, from the start, it was imperative that the SRP recognize and respond to the changing research landscape and develop an ongoing transparent process to guide us through it. It was important that this multidimensional SRP address not only the strategic research priorities, but also the processes and criteria used to set strategic directions and institutional investments, as well as the ways that the University provides core support to all faculty members in their research, regardless of their research focus or relationship to priority areas.

A comprehensive and broad-consultative process, involving internal and external stakeholders, was developed for undertaking the SRP renewal over a 14 month timeline. The penultimate draft of the 2012-2017 SRP was approved by Queen's Senate in May 2012 and made public later that month.

The Plan is divided into two parts: Part One, *Guiding and Supporting the Research Enterprise*, sets the goals, principles and objectives of the Plan and outlines the support mechanisms, structures and resources needed to facilitate Queen's continued success. Part Two, *Thematic Focus*, outlines four major research themes reflecting emerging and core strengths and the potential to work together across disciplines to address the complex and diverse problems faced by society today.

The 2012-2017 SRP sets forth our vision for the next five years; its purpose is to provide a roadmap for guiding and supporting research excellence at Queen's. I welcome your feedback and encourage you to explore, discover, and engage in the research enterprise at Queen's.



PART ONE

Guiding and Supporting the Research Enterprise

REFLECTIONS ON THE HISTORY OF RESEARCH AT QUEEN'S

Since its founding in 1841, Queen's has supported a variety of research activities, but identifying a particular point when research became a strategic focus for the University is difficult. The University took tentative steps toward innovation and commercialization as early as the 1920s and 1930s, but Queen's present position as Canada's 9th most research-intensive university stems from decisions beginning in the late 1960s, when an influx of new faculty and the establishment of the School of Graduate Studies and Research provided a significant boost to Queen's research capacity.

The deliberate investment in administrative support and competitive pursuit of funding combined with research excellence, curiosity and creativity led to an enviable record of achievement at both a national and international level. By 1991, Queen's stature as a research university resulted in it being an inaugural member of the G10, an alliance of Canada's top ten research universities, the goal of which was to increase Government and other support for research funding.

Historically, Queen's has been home to some of the most distinguished scholars and contributors to Canadian society. This tradition continues today with scholars who continue to garner national and international awards for scholarship of the highest quality. To this day, success in attracting awards, competing for funding, establishing large research initiatives, and transferring scientific knowledge to the marketplace is a testament to the quality of the scholarly work carried out on campus and the dedication of faculty and staff to the research enterprise.

ACADEMIC PLANNING 2010-11

Renewal of the Queen's University Strategic Research Plan (SRP) has followed the development, promulgation and subsequent approval of the 2011 Academic Plan. Milestones in the process were described in *Where Next? Toward an Academic Plan for Queen's University* (January 2010)¹ and *Imagining the Future, Towards an Academic Plan for Queen's University* (August 2010)² and the University Senate approved *The Queen's University Academic Plan 2011*³ in November of 2011.



1 <http://www.queensu.ca/principal/wherenext.html>

2 <http://www.queensu.ca/awt/index.html>

3 <http://www.queensu.ca/saprf/>



Research intensity and the transformative educational experience form the centre piece of the academic vision for *Queen's*. The plan contains a number of principles, priorities and recommendations that specifically relate to research and scholarly work. An emphasis in the future on research intensity is proposed in all aspects of the University's operations, including recruitment. There is also a focus on greater recognition of trainees, graduate students and post-doctoral fellows, their contribution to research and to advancing *Queen's* University. Career trajectories of these trainees are more complex and uncertain than in previous times. Partnerships, collaborative research, interdisciplinarity, global engagement and internships in non-academic settings (e.g. industry and not-for-profit organizations) are seen as essential to enhance training experiences and to increase future employment opportunities for our Highly Qualified Personnel (HQP).

In updating the SRP, we have an opportunity to recalibrate our research orientation with an emphasis on people. We will increase opportunities for undergraduates to participate in research as part of their educational experience, promote and support interdisciplinarity, and find ways for researchers, including visiting scholars, to engage in greater reflective scholarship with each other.

The Academic Plan highlights the need for increasing recognition of the humanities and arts and the central role these areas play in research, particularly as it applies to the human experience. To address many of the world's greatest challenges, innovative ideas and technological advances brought about by discoveries in science, engineering and health will be required. With the creative energy of the human spirit, *Queen's* can offer an unparalleled environment to foster this.

GUIDING PRINCIPLES AND OBJECTIVES OF THE STRATEGIC RESEARCH PLAN

Our SRP is a framework for those who have the collective vision to embrace its principles and capitalize

upon the supports and structures in place to create a vibrant environment of inquiry, whether as an individual scholar or as a researcher that utilizes a collaborative and/or interdisciplinary approach to resolving the complex issues facing global citizens today. This is an institutional plan, which is informed by Faculty and Departmental/School plans. It does not replace, nor does it diminish, the value or importance of the unit plans.

Key to achieving the objectives of the SRP will be the selection of specific strategic priority areas of research strength (existing or potential). We must recognize the need for continued support, including the establishment of new mechanisms, structures and resources promoting alternative operating structures, such as collaborative and interdisciplinary models such as Research Centres and Institutes. We must also support the recruitment and retention of HQP, including top flight or up-and-coming researchers with strengths in the priority areas.

THE PLAN IS GUIDED AND INFORMED BY A SET OF PRINCIPLES:





THE OBJECTIVES OF THIS SRP ARE TO:

- 1 Foster and enhance internationally recognized research programs and emerging research strengths
- 2 Promote and enhance our research and scholarly activities that provide transformative experiences for undergraduate and graduate students, and post-doctoral trainees
- 3 Promote and enhance opportunities for collaborative and interdisciplinary initiatives between faculty across the University and with other universities and institutions
- 4 Promote and enhance research partnerships that expand on our research strengths, increase the support for research, and enhance the delivery of research to stakeholders and partners locally, regionally, nationally and globally
- 5 Advance diversity and inclusivity through research that leads to increased understanding of cultures and communities within Canada and abroad, and research that enables connections to people and the quality of their lives
- 6 Encourage and support the translation and transfer of research outcomes, new knowledge and innovation for the betterment of society

MEASURING OUR SUCCESS

There is increasing reliance on metrics from government and the public for accountability and transparency. There is no single measure of research performance; promotion and tenure committees use a variety of metrics both formally and informally to gauge success – research funding, quality and impact of peer-reviewed publications, prizes, conference proceedings, memberships, and favourable reviews of exhibitions, books, art, and plays. The breadth and depth of information required for new and emerging metrics, including partnerships, career trajectories of trainees, industry participation, knowledge translation and commercialization, requires that the University collect and analyze data on research performance related to these areas.

To ensure that we effectively measure our research progress and successes, we will:

- Identify key performance indicators and an appropriate set of metrics to be used to inform decision-making and investments
- Develop a performance monitoring template where research performance and successes in meeting targets will be closely tracked
- Ensure we retain the ability to recognize new evolving research programs that have a high potential for growth and success

PROCESSES/MECHANISMS TO ADVANCE RESEARCH AT QUEEN'S

VICE-PRINCIPAL (RESEARCH) (VPR) PORTFOLIO

The goal of the VPR Portfolio as defined in its mission statement is, "Helping people achieve excellence in research and scholarship." The Portfolio currently consists of the OVPR, the Office of Research Services (ORS), the eQUIP Taskforce (eQUIP), the Office of the University Veterinarian (OUV), Innovation Park at Queen's University, and Industry Partnerships. The OVPR is also responsible for the oversight of PARTEQ, the arm's-length technology commercialization office of the University, and provides oversight of Senate-approved University-based Research Centres and Institutes.

Various critical research services are provided by the VPR portfolio, including: communication of funding opportunities; proposal development and application review prior to submission to external funding agencies/sources; negotiation of sponsored research and collaborative research agreements and contracts; promotion of researchers through national and international research award nominations, researcher recognition events and other communication opportunities; guidance and support to Research Centres and Institutes; certifications associated with compliance requirements (ethics, animal care and biohazards); post-award changes, workshops, financial management, monitoring and reporting; and the development of research partnerships.



Working with Internal Audit, the VPR provides yearly feedback on the research enterprise, flagging potential concerns⁴ or soliciting support in keeping issues impacting research moving forward through the appropriate administrative channels. Queen's, as with all universities, is subject to ongoing audits by the Tri-Council, CFI and the Ministry of Economic Development and Innovation (MEDI – formerly MRI).

Changing regulations and economics in higher learning institutions have put increasing pressure on universities to produce accurate and detailed reporting. It is critical and essential that Queen's University have a robust electronic research system to manage research projects (up to 4,700/year) and the millions of associated dollars. A new system, Tools for Research Administration at Queen's (TRAQ), is in the process of being implemented to:

- Capture data on research awards, contracts, and clinical trials
- Manage daily workflow
- Manage certifications (e.g. human ethics, environmental health and safety, and animal care)
- Provide efficient customer service

Given the important role of communications in promoting our research programs and success, both internally and externally, greater emphasis will be given to digital content, development, maintenance, and renewal of the VPR website, and implementation of internal and external communication strategies. We are committed to reintroducing an annual report of our activities and successes, to producing strategic publications for the purposes of promoting and advancing research strengths, to hosting researcher recognition events, and to strengthening our communications with internal, as well as external, stakeholders.

ENHANCING RESEARCH: UNDERGRADUATE, GRADUATE, AND POST-DOCTORAL FELLOW CONTRIBUTIONS

Queen's is dedicated to providing opportunities for students at all levels and in all academic areas to participate in research regardless of discipline. For example, the University fosters undergraduate research experiences, such as with the Undergraduate Student Summer Research Fellowship (USSRF)⁵ launched in 2011, as well as through programs such as Inquiry@Queen's.⁶

Graduate students and post-doctoral fellows are also essential contributors to quality research and teaching at Queen's. To compete both nationally and internationally for qualified graduates and post-doctoral fellows, we must provide top facilities for conducting research and attract and retain stellar faculty.

RESEARCH INFRASTRUCTURE

State-of-the-art research facilities such as the High Performance Computing Virtual Laboratory (HPCVL), SNOLAB, and the Magnetic Resonance Imaging facility, and other unique initiatives including the Queen's University Biological Station (QUBS), Innovation Park and The Isabel Bader Centre for the Performing Arts (under construction) are key ingredients for delivery of high-quality research and training programs in support of the University's strategic research priorities.

Greater coordination and engagement of all stakeholders in planning and governance of our research infrastructure is required. The requirements to initiate, sustain and enhance these facilities are often unique. The infrastructure must be of the highest calibre at the time it is acquired/established, its operation must be adequately resourced, maintained and staffed. Appropriate mechanisms must also be in place to support sun-setting and decommissioning of facilities when these are no longer required or can no longer be supported.

4 For example: changes in funding programs, compliance and reporting

5 For more information, see <http://www.queensu.ca/ors/USSRF.html>

6 For more information on Inquiry@Queen's, see <http://www.iatq.ca/>



LIBRARIES AND TECHNOLOGY

Since its inception, Queen's has invested in its libraries, developing excellent research collections, services and facilities. In addition to our physical libraries, the Internet and other advances in technology have provided unparalleled opportunities for expanding the availability of research resources.

Queen's researchers must be able to participate fully in the emerging e-research paradigm, which encompasses all digital research creation and output. Working together and in collaboration with regional and national groups, the Library and IT Services are working towards a seamless distributed infrastructure of services for the deposit and repurposing of data.

Queen's is already part of an advanced data infrastructure. Scholars Portal stores and provides access to over 11 million journal articles and has developed a robust numeric data infrastructure and a geospatial portal. Scholars Portal is in the final steps towards ISO certified Trusted Digital Repository status. Locally, Queen's has substantial experience with data infrastructure, such as with the HPCVL, a Statistics Canada

Research Data Centre and a strong social sciences data service in the Library.

Moving forward, Open Access models will provide rapid, free access over the internet to works that scholars have traditionally produced without expectation of payment. Many academic institutions, including Queen's (through QShare), are supporting Open Access by building digital repositories to distribute faculty scholarly articles and other research outputs that are also peer-reviewed and published.

COLLABORATION, INTERDISCIPLINARY AND CROSS-FACULTY INITIATIVES

We recognize the value of, and will continue to support, individual scholarship within disciplines. Facilitating collaborative, synergistic research, however, is a focal goal of this SRP, as is interdisciplinarity. Increasingly, both individual and team researchers from across disciplines are working together to solve the complex and diverse problems faced by society today. Interdisciplinarity increasingly fuels both individual and team research activity. Collaboration, both disciplinary and interdisciplinary, is sustained by a diverse and fertile range of methodological strategies, as well as institutional structures for knowledge and resource sharing and dialogue.

Historically, Queen's researchers have been engaged in a wide variety of collaborative research projects and many of these collaborations have resulted in the development of Queen's signature Research Centres (e.g. the Centre for Neuroscience Studies and the GeoEngineering Centre) and Institutes (e.g. Cancer Research Institute). Research Centres and Institutes exist within all Faculties, within the Schools (currently Business and Law) and may also be University-based, which include those that are multi-disciplinary, crossing several Faculties, or even multi-institutional.

The creation of an Institute for Advanced Research/Studies represents a particularly important opportunity for Queen's to start a dialogue amongst the research community. Worldwide, such institutes have been





created to nurture research and intellectual engagement at the highest levels. Some are characterized by the community of scholars drawn to the institute and have no formal affiliation with a particular school, and others are oriented towards interdisciplinary research in advanced areas of institutional strength. Regardless, each serves as a beacon for research excellence, building an international reputation, providing a window and door to the world, and establishing their respective institutions as a destination for the world's best researchers and scholars.

ADVANCING INTERNATIONAL RESEARCH PRIORITIES AND GLOBAL PARTNERSHIPS

We propose that Queen's international reputation be augmented through increasing global engagement by developing and expanding international research collaborations, building sustained multinational partnerships, and understanding and addressing global challenges through international development projects.

Many of our faculty have significant international engagement through formal, as well as informal, research collaborations, MOUs, and participation in international initiatives. Additionally, several of our Research Centres and Institutes are already world-renowned in the research they undertake nationally and internationally, and enjoy extensive collaborations with individuals and teams around the globe. Commitment to international activity and collaboration is embraced by many, including the Clinical Trials Group, the Fuel Cell Research Centre, the GeoEngineering Centre, SNOLAB Institute, the Surveillance Studies Centre, and the Department of Global Development Studies.

Most of these international activities are pursued by the investigators themselves, with support coming from the University in terms of the application process and the provision of ongoing communication. If we are to achieve our strategic objectives, an integrated strategic and proactive approach is required. We are committed to developing this approach.



RESEARCH LEADERSHIP AND EXCELLENCE

Queen's has been fortunate to have benefitted from the leadership of many outstanding researchers. However, for the purposes of advancing institutional strengths and priorities, we must invest in a deliberate process: 1) to identify research leaders to serve as role models for early and mid-career researchers; and 2) where potential research leaders are systematically identified early in their careers, they are to be mentored and supported to develop their potential. Only with strong leadership – individuals or teams that can motivate, organize, and inspire – will priority research areas succeed.

SUPPORTING AND RECOGNIZING LEADERSHIP AND EXCELLENCE

Queen's supports a number of internal and external programs and opportunities to recognize the leadership and excellence of our faculty, including CRCs, sponsored chairs (NSERC/industry) and endowed/named chairs. We remain committed to these and to the development of a greater number of opportunities, including sponsored, endowed and named chairs.

However, in the face of budgetary constraints and shifting priorities, a number of internal supports for research leadership and excellence are proposed:

- The Queen's National Scholar (QNS) program, intended to enrich teaching and research in newly developing and traditional fields of knowledge, is particularly effective in support of early-mid-career researchers. Briefly suspended in 2009, the QNS program was reinstated in 2012, with the view that two new scholars will take post in 2013.⁷
- We propose the establishment of a Leaders Research Fund to recognize emerging opportunities and timely developments in the research trajectories of mid-career researchers. We propose that this fund replace the current Queen's Research Chair (QRC) program to allow for a larger number

of faculty members to compete for support at this critical career stage.

- We propose the establishment of honorary Chancellors/University Professorships in recognition of a sustained and accomplished career in scholarly and research activities and in leadership in advancing the University's research reputation. We propose that this recognition be held by current faculty.
- For years, the Prize for Excellence in Research has been awarded to two researchers each year for major contributions while at Queen's. We propose that the number of Prizes be increased to up to five each year – one in each of the five fields of health sciences, natural sciences, engineering, social sciences and humanities. We do not propose changes in the basic eligibility or criteria of this Prize.



⁷ Principal Daniel Woolf announced the re-establishment of the QNS program at Senate, January 24, 2012.

PART TWO

Thematic Focus

Queen's has identified four major research themes reflecting emerging and core strengths:

THEME 1:

Exploring Human Dimensions

THEME 2:

Understanding and Sustaining the Environment and Energy Systems

THEME 3:

Creating, Discovering and Innovating

THEME 4:

Securing Safe and Successful Societies

Within each theme, a number of research clusters have been identified. Many areas of research within these clusters cross over two or more of the themes.



THEME 1:

Exploring Human Dimensions

Exploring human dimensions cuts across several Faculties, Schools and Departments, where the nature of human creativity is explored through the examination and analysis of texts, the restoration of works of art, the critical evaluation of elements of modern culture, the theory-informed study of past human activity, and the creation of new knowledge and art and its performance.

The study of the dynamics of human behaviour and the human mind provide a foundation for exploring the social dimensions of populations and communities and the study of learned systems of understanding. Increasing emphasis is being given to key and emerging ethical questions that arise in the relationships among life sciences, biotechnology, health, politics, law, and philosophy. Improving the human condition through an enhanced understanding of health, wellness, disease and aging is essential to improving a wide range of aspects of both individual and social health, including that of the most vulnerable populations and communities.

CLUSTER: SOCIETY, CULTURE, AND HUMAN BEHAVIOUR

Scholars working in this cluster often undertake their research individually, rather than in teams, but may engage in formative collaborative dialogue with other researchers and community partners in global communications and in a wide variety of cross-institutional and cross-disciplinary venues. For example, Queen's considerable science expertise in the School of Environmental Studies is strengthened

by complementary research programs in philosophy, religion, and literature. A similar critical mass of expertise and interdisciplinary dialogue at Queen's has emerged in Global Development Studies, which draws together our expertise in sociology, political studies, economics, health studies, religion, gender studies, film and media, literature and history.

Of particular importance to the vibrancy of the research carried out in this cluster is a high-quality University intellectual infrastructure (e.g. libraries, colloquia, visiting scholar series) and the time dedicated to creative thought and dialogue. The new Isabel Bader Centre for the Performing Arts (currently under construction) will be home to the School of Music, and Departments of Drama, Film and Media, and Art. The new Centre will include shared exhibition, performance and teaching spaces, and embrace the principle of interactivity and integration through common teaching rooms, joint courses, and shared public spaces and services.

CLUSTER: HUMAN HEALTH AND WELLNESS

Research in this cluster includes the full range from basic biomedical and applied clinical research, research on health care systems and services, biomechanics and human performance, to research on society, culture, and the health and wellness of individuals, populations and communities. This cluster is home to a number of research programs that span the social sciences, humanities and health sciences. Examples of such interdisciplinary research programs include: bullying, mental health and obesity, gender-based violence and HIV/AIDS, bioethics and end-of-life care, study of health economics, health and social service integration, reproductive and genetic engineering, reproductive ethics and social policy, and health and climate implications of urbanization.

Considerable cross-disciplinary health research also takes place in the Faculty of Health Sciences (FHS), its Schools (Medicine, Nursing and Rehabilitation Therapy) and its affiliated hospitals (Kingston General Hospital, Hotel Dieu Hospital and Providence Care), as well as in several other Faculties, Departments and Schools.



THEME 2:

Understanding and Sustaining the Environment and Energy Systems

Human well-being is increasingly dependent upon developing healthy human environments, understanding the external environment and the impact of human activities upon ecosystems, the adoption and development of renewable energy sources and sustainable energy systems and the implementation of informed energy and environmental policy. Knowledge of the ecology and fauna and flora in terrestrial and aquatic ecosystems across different biomes provides new insights and understanding of important factors associated with global climate change, human interactions, urbanization, and industrial activity. This is crucial information to better understand the threats to different species, habitat loss, habitat restoration and remediation, and to better inform policy development and actions that might be taken in relation to extractive industries, energy, water, and climate change.

CLUSTER: HUMAN ASPECTS OF HEALTHY ENVIRONMENTS

Queen's has established a strong foundation in environment and sustainability research involving multi-disciplinary activity related to the human aspect of

developing and enhancing healthy environments. This encompasses the workplace environment and occupational health, as well as the socio-cultural, legal and economic aspects of healthy environments. Examples of research within this cluster include: (1) identification and characterization of environmental causes of human health problems (2) labour and employment law and its advancement of workplace justice in ways attuned to today's economy and society (3) examination of the role of organizational leadership in effecting sustainable organizational practices (4) supply chain efficiency and the use of information technology to improve sustainable practices (5) examination of changes in consumer behaviour towards more sustainable practices and the role of consumption in contributing to environmental degradation.

CLUSTER: ECOLOGY AND THE NATURAL ENVIRONMENT

Major environmental initiatives include the creation of the School of Environmental Studies, whose main areas of focus are: Environmental Chemistry and Toxicology; Ecosystem and Human Health; Society,



Culture, Environmental Planning and Management, and Economic Sustainability.

Queen's University Biological Station⁸ includes more than 3000 hectares of land and plays an integral role in the attraction and retention of excellent researchers and students. Biology, Geography and Policy Studies are key players in research in Polar northern regions and are bringing national and international attention to Queen's. Research on water issues is represented across a wide variety of disciplines and the goal is to apply science and engineering innovation to move from unsustainable water use to long-term strategic fresh water systems throughout the world, tackling the water-related issues of the 21st century.

Researchers are addressing the impacts of natural-resource utilization (e.g. water, energy and minerals) on the environment and society, by bringing scientific knowledge of natural resources to bear on issues of social relevance nationally and internationally. They are also developing tools for municipalities to protect drinking water by developing both environmentally sustainable processes and new methods of environmental analysis. In civil engineering, researchers are working on environmental assessment, remediation, biotechnology and analysis and are also seeking to understand sustainable water supply and regional groundwater flow in complex fractured rock environments and groundwater-lake interactions.

Research groups and laboratories that enhance environment and sustainability initiatives include: the Groundwater Group/Flows Research Group and the Paleoecological Environmental Assessment and Research Laboratory (PEARL).

CLUSTER: ENERGY SYSTEMS

Queen's research encompasses all aspects of energy research from the conventional to the alternative.

Areas of research in conventional energy include: operations management, design optimization

through energy and environmental process engineering, pipelines, biorefining, combustion, and contamination and clean-up.

Carbon-capture and storage research includes: homogeneous catalysis, carbon and nitrogen cycling, systems modelling: life cycle and GHG impact analysis.

Areas of research and developing areas of strength in alternative energy include: thermal systems, photovoltaics, turbulence, power, instrumentation, controls and modelling, design optimization of hybrid drive trains, grid systems and energy storage.

With an NSERC Research Chair in Nuclear Materials along with the Nuclear Materials group, world-leading research is being carried out in the area of structural materials for nuclear power applications. Research Centres in support of energy and environmental research are the Centre for Energy and Power Electronics Research and the Queen's-RMC Fuel Cell Research Centre (FCRC), a multi-institutional Centre which includes faculty members from the Departments of Chemical and Mechanical and Materials Engineering at Queen's, as well as from the Royal Military College of Canada (RMC).

Other research groups and laboratories specializing in energy research include: the Thermal Hazards Laboratory, the Solar Calorimetry Lab, Solar PV and Wind Energy Research Field Laboratory, the Polymer Research Group, the Communication Laboratory, the Power Laboratory, and the Materials Physics Clean Room.

CLUSTER: ENERGY AND ENVIRONMENTAL POLICY

Queen's is emerging as a national leader in informing policy and investment decisions by government and industry by bridging the gap between research (both scientific and policy-based) and policy-making at the federal and provincial levels in energy and environmental policy. The School of Policy Studies, including Queen's Institute for Energy and Environment Policy, promotes bridging this gap between research and policy and its goal is to provide opportunities for the best academic research to intersect with the challenges of policy makers and industry.

⁸ For more information on QUBS, see <http://www.queensu.ca/qubs/index.html>

THEME 3:

Creating, Discovering and Innovating

Queen's researchers are dedicated to creating, discovering, and innovating across all areas of the University. The foundations for innovation at Queen's are deeply connected to the pursuit of knowledge driven by curiosity and creativity expressed across the humanities and arts, social sciences, science, health, and engineering.

INNOVATING THROUGH KNOWLEDGE ECOLOGIES

Innovation in its broader context is exemplified at Queen's in superior academic programs, research excellence, and international reputation. Innovation is also reflected in research that brings broad benefit to society as reflected in signature knowledge translation projects and through social innovation. We are seeking to innovate in new ways that build on our reputation and one of the ways is through the formation of knowledge ecologies. A knowledge ecology involves the clustering of disciplinary approaches around a particular question of social, political, or academic importance. Patient care in Ontario's hospitals offers a good example. Typically, the care of patients

has been the domain of the medical school. But in a province where government seeks improvements to patient care as well as cost savings to sustain the health care system, where patient-care advocates lament long waiting times and lack of personalized care, and where governments can provide research funds to grapple with such issues, Queen's is ideally positioned to provide a knowledge ecology around such a question. Medical faculty and basic science faculty are the natural partners for such a research task, but in a knowledge ecology approach so too could be humanities and social science practitioners.

For example, a geographer might plot the layout of a hospital or develop the idea of the geography of grief, a literature specialist might investigate the narrative structures that underpin the medical case histories that are so vital to the practice of medicine, a philosopher might explore the underpinnings of the aspiration to cure, a playwright might work on patient-doctor interactions, and a political economist might shed light on the intersection between budget and ideology. Such an approach offers an inclusive research model that is adaptable to the changing interests of government and the private sector. It also yields richer, more complex, and more elaborate research findings.

CLUSTER: CREATIVE PRODUCTION AND EXPRESSION

Queen's is nationally and internationally renowned for its contributions to all forms of creative production and expression. Queen's is home to Juno award winning composers, published playwrights and filmmakers who have had major shows and screenings, experts in the restoration of major works of art, as well as specialists in art history. Cultural producers, from composers to documentary filmmakers, offer new ways of knowing, new means by which to reflect on experience and to engage with social, economic and technological change, as well as dimensions of citizenship, belonging and identity. Experimental and experiential learning and research are critical components of these programs for connecting researchers, artists and students locally, regionally and internationally.



Innovative research in creative production and expression is being undertaken by individual scholars as well as by researchers working across multiple disciplines. A specific example of this type of innovative research includes the collaboration of faculty members from classics, mechanical and civil engineering, physics and art conservation to develop 3D imaging tools.

CLUSTER: NATURAL AND PHYSICAL SCIENCES

Research in the natural and physical sciences currently engages a large number of faculty and research groups from a number of Departments across campus. 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 atoms, using various combinations of theory, experimentation 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 innovative and/or applied research.

The work in this cluster is supported by significant funding from NSERC. Research facilities include the Chernoff Hall Chemistry Facility, 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, as well as a portal to other national and international computing systems for complex calculations, data extraction and manipulation) and the Sudbury Neutrino Observatory Laboratory, a world-leading underground science laboratory specializing in neutrino and dark matter physics, led by Queen's and a consortia of four other universities.

CLUSTER: MATERIALS

Queen's has long recognized the vital role that materials and manufacturing processes 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 by advancing our ability to measure physical and chemical properties of materials. Advanced materials expertise is associated with CRCs in Mechanical and Materials Engineering, Engineering Physics, Chemical Engineering, Civil Engineering, an NSERC Chair in Nuclear Materials, and the Polymers Research Group.



CLUSTER: ADVANCED TECHNOLOGIES

Discovery-based research serves as the foundation for innovation leading to advanced technologies. Advanced technologies arise as a result of original research, but the actual implementation of the results of research is a distinct and separate task that requires specialized knowledge and resources. This is best exemplified by the role of PARTEQ Innovations and its success in advancing innovation arising from research at Queen's.

Queen's researchers have led, and continue to lead, in a number of areas. Advances in biochemical and chemical engineering have resulted in bioencapsulation technologies. Two-phase partitioning bioreactors have led to US/Canadian patents and commercial licenses. Neuroscientists are developing robotic and software technologies for probing brain function and dysfunction. At the interface of advanced manufacturing and photonics, researchers are developing automatic real-time laser machining with in-line ultrafast imaging.

Queen's leads in the field of green chemistry and engineering. Recent innovations include the development of switchable solvents and surfactants, which provide a greener and less-expensive alternative to costly and environmentally damaging organic solvents. This alternative allows for the extraction of bitumen from oil sands with minimal water consumption and without the generation of tailing ponds, as well as new methods for cleanly recovering and recycling homogeneous catalysts.

Researchers are implementing new technologies using new materials for structural design and infrastructure replacement. They are applying computer science and equipment to study 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 and Materials Engineering and Surgery who are developing and implementing world-leading computer-assisted surgery techniques for orthopaedics through the Human

Mobility Research Centre (HMRC). The Centre is a partnership between Queen's University and Kingston General Hospital and serves as a point of collaboration between the disciplines of medicine, engineering, health sciences, and information technology.

Other laboratories undertaking such multidisciplinary research include: the Percutaneous Surgery Lab, Medical Computing and Medical Image Analysis Lab, and the Medical Informatics Lab.

In addition to the advanced technology research on campus, Queen's researchers have access to the expertise of CMC Microsystems, located at Innovation Park at Queen's University. CMC delivers innovative and cost-effective services to microsystems researchers, facilitating the creation and application of micro- and nano-system knowledge by providing a national infrastructure and pathway to commercialization of related devices, components and systems.

GreenCentre Canada, founded by PARTEQ Innovations in 2009, and also located at Innovation Park at Queen's University, is a Centre of Excellence for Commercialization and Research and represents a growing cluster of strength in Kingston. Its purpose is to bring together academic researchers and industry partners in a common goal of developing clean, less energy-intensive alternatives to traditional chemical products and manufacturing processes. An important component to GreenCentre Canada's success is Queen's continued leadership in the field of green chemistry.



THEME 4:

Securing Safe and Successful Societies



In the 21st century, there is real awareness that a web of social, physical, and technological forces influence the well-being of citizens. Scholars, from a range of sub-disciplines at Queen's, are actively studying methods and outcomes of efforts to secure our human, financial, political, and physical assets. When catastrophic natural events like tsunamis and earthquakes and human events associated with political change occur, and as internet developments bring risks and opportunities, research serves as a framework for understanding how these events affect both individuals and society. Current and potential research interests are outlined in three seemingly disparate clusters, but many fruitful and important research topics also arise that connect these areas.

CLUSTER: DEMOCRACY, ECONOMY, AND PUBLIC POLICY

The challenges of the global era are formidable: globalization; the expanding public world; rapid technological innovation; the restructuring of organizations in the public, private and non-profit sectors; human

conflict over power, wealth and security; the increasing income disparity gap; the need for a highly educated citizenry; growing social diversity and demographic transitions; new conceptions of democratic governance; evolving foreign and defence policy; issues of international peace and security; rapidly changing workplace law as a result of influences such as changing demographics; and globalization and the increasing collection and processing of personal data, particularly surveillance post 9/11.

Queen's University has deep research strength in these areas, rooted in the Faculties and Schools across campus. This is further reinforced by a set of active Research Centres and Institutes, including the Centre for International and Defence Policy, the Centre for Law in the Contemporary Workplace, the Centre for Studies on Democracy and Diversity, the Institute for Intergovernmental Relations, the John Deutsch Institute for the Study of Economic Policy, the Monieson Centre, the Southern African Research Centre, and the Surveillance Studies Centre.

CLUSTER: 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, Mathematics and Statistics and Film and Media. The research covers fundamental and applied aspects of (1) wireless technologies and telecommunications systems, (2) interconnectivity, and (3) information security. Research strengths encompass telecommunications, computer architectures and interconnection networks. A number of labs support information and communications research including the Human Media Lab, focussing on human-computer interaction; the Smart Information Management Laboratory, developing sophisticated computerized screening programs to mine billions of bits of data for evidence of terrorism, fraud and corporate crime; the Queen's-led High Performance Computing Virtual Laboratory, which provides secure HPC, data storage, software and services; and Software Analysis and Intelligence Laboratory, Canada's only ULSS software research lab.

Across Faculties, Schools and Departments, 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. Laboratories supporting this research include the Energy and Power Electronics Applied Research Laboratory, and a number of other labs and research groups, including: the Reliable Software Technology Group, Formal Languages and Automata Group, Modeling and Analysis in Software Engineering, Parallel and the Unconventional Computation Group. Many of these Groups and Laboratories provide support across several theme areas.

CLUSTER: INFRASTRUCTURE

Security of infrastructure and water resources has been gaining heightened awareness within the public domain and Queen's researchers are undertaking important research to solve these security problems.

Research strengths include: modeling, simulation and control of mining systems, blasting and mineral processing. Queen's also has strength in structural engineering with a focus on various materials, such as concrete, steel, wood, and other composites pertaining to the design, construction, maintenance, and rehabilitation of structures such as bridges, building breakwaters, and guide ways.

Landfill design, landslide investigation, and modeling, long-term degradation of dams, design of surface and underground works for mining and tunnelling, studies on shallow and deep foundations, including pipes, culverts and other buried infrastructure, as well as earthquake engineering are just a few of the areas of specialization undertaken by the researchers in Civil, Mining and Geological Engineering. The GeoEngineering Centre at Queen's-RMC supports this research, as well as the following specialized laboratories: GeoEngineering large-scale buried infrastructure laboratory for buried pipe and culvert testing; geosynthetics liner longevity simulator laboratory, uniquely able to test durability under chemical, thermal, and mechanical loading; the Geotechnical shake table, focussed on reinforced walls; and the large reinforced wall test facility.



Summary

Queen's distinguishes itself as one of the leading research-intensive institutions within Canada. Our mission is to advance research excellence, leadership and innovation, as well as enhance our impact at a national and international level. Through undertaking leading-edge research, Queen's is addressing many of the world's greatest challenges, and developing innovative ideas and technological advances brought about by discoveries in science, engineering and health. We will capture the creative energy of the human spirit and foster new perspectives of people and communities past and present through scholarly and creative work in the social sciences, humanities and arts. We are dedicated through our research and scholarly work to enriching the academic environment, transforming the student learning and post-doctoral experience, and contributing to the cultural and economic growth of our country.



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