

# McMASTER UNIVERSITY STRATEGIC RESEARCH PLAN

## May 2014

### **Introduction**

The role of universities in the 21<sup>st</sup> century extends far beyond traditional knowledge creation and dissemination to encompass new expectations for innovations that will have broader, social and economic benefits. As a research-intensive university, McMaster is committed and well-poised to play a leading role in the economic development of Canada and, equally important, its social and cultural fabric. Over the past decade, McMaster has, together with substantive investments by federal, provincial and municipal governments and the private sector, continued to build world-class infrastructure and critical mass. Building on our research strengths, McMaster has acquired world-competitive facilities, attracted and retained researchers of promise and stature, spawned new leading edge cross-disciplinary training programs and expanded its collaborations and partnerships within the academic, public and private sectors. These investments now offer many opportunities, equally exciting and challenging, with timing being crucial.

The defining characteristic of McMaster University that underlies all of its planning processes is research intensity. McMaster has, since 2005, ranked on average 3<sup>rd</sup> highest for research intensity in Canada (Research Infosource). This Strategic Research Plan (SRP) defines McMaster's broad research directions and areas of strategic priority, and provides the context for institutional research applications and investments. The University continues to review its strategic priority areas to ensure they support our core mission while embodying, in a transparent fashion, emerging directions and opportunities. This flexibility is essential in allowing us to respond to opportunities presented by an ever changing research landscape, internationalization objectives, the needs of highly qualified personnel (HQP), and the demands of the public, private and not-for-profit sectors.

Our vision, mission and strategic directions continue to evolve, reflecting the expanding and critical role of Canadian universities in creating a productive, internationally competitive economy through progressive training programs and critical partnerships. Our strategy enables McMaster to be fully engaged in addressing and tackling challenges stemming from changes in the global environment. This is demonstrated by the progressive steps taken within defined areas of strategic priorities to pursue new opportunities including: water ecology and health; digital information; interactive digital media encompassing arts, technology, and humanities; clean and sustainable energy; and transportation. These research initiatives have been furthered through investment at all levels of the University. McMaster's strategic areas have been the launching pad for new research ideas, approaches and opportunities aimed at creating new knowledge and the next generation of highly qualified personnel (HQP). These HQP will be able to translate and apply their training as well as resulting research innovations to the well-being and productivity of local and regional communities, and to the nation at large within the global context.

**Planning Framework:** McMaster University began its strategic planning in 1995 in consultation with the University community and planning bodies. Our strategic plan defined McMaster's vision, direction and its contribution to society in the 21<sup>st</sup> Century – achieving international distinction for creativity, innovation and excellence. McMaster has since that time continued its planning process, building on those strong foundations while ensuring an adaptive, dynamic planning framework capable of maintaining its relevance through the foreseeable changes in the university environment. Our most recent planning strategy identified McMaster's goals and targets as:

- To achieve the next level in research results and reputation by building on existing and emerging areas of excellence
  - Target: To be consistently among the top three Ontario universities in terms of the quality of students we attract and graduate from our undergraduate and graduate programs as measured by appropriate indicators.
- To attract and retain highly-qualified students by making discovery the centre of the learning experience
  - Targets: (1) To be consistent among the top three Canadian universities as measured by appropriate indicators of research excellence and (2) To increase the importance of graduate education so that McMaster's graduate population reaches 20% of the University's total full-time enrolment and is highly ranked in indicators of graduate educational excellence.
- To build a community with a shared purpose.
  - Target: To ensure that all members of the McMaster community feel recognized and valued for their contributions to this shared purpose.

"Forward with Integrity", McMaster's President's letter to the McMaster research community, states that we must uphold above all else the obligation of the University to serve the greater good, beginning with our immediate community, our city, and extending outwards to the world at large. This philosophy is in alignment with the priorities of our Strategic Research Plan (SRP) whose key objectives are to:

- Build on our strengths; seize new opportunities to achieve (world-class) excellence in selected research areas;
- Help achieve institutional academic goals such as the promotion of inter-disciplinary research and the integration of research and teaching;
- Strengthen and expand existing undergraduate and graduate programs, and develop innovative new programs, to attract high-quality students and increase enrolment of postgraduate trainees in the identified areas of research thrust;
- Protect our investment in areas of strategic importance by recruiting and retaining excellent faculty whose efforts are key to our long-term strategic plans;
- Capitalize on the diverse range of funding opportunities and partnerships, particularly with our affiliated hospitals, to realize integrated capital, infrastructure and faculty renewal objectives;
- Develop the capacity for effective knowledge transfer to maximize the benefit of research to society and
- Foster collaborations and building of research partnerships nationally and internationally.

### **Institutional Strategic Areas of Priority**

Today's research environment is more complex than in years past. There is increasing recognition that solving complex scientific and societal problems requires a blend of perspectives and that employing complementary expertise from other disciplines, sectors and even countries is key to providing optimal results. The most effective way to ensure that our strategic research objectives are realized is through rigorous pursuit of these types of partnerships. McMaster, which has a strong history of partnerships with the private sector and other community organizations, has sought to strengthen its ability to impact society through partnership with the Fraunhofer Institute, Europe's largest application-oriented research organization. It is anticipated that planned McMaster-Fraunhofer inter-disciplinary projects will attract both academic and industrially-based researchers from around the globe to participate in joint projects where society is the ultimate benefactor.

Significant research excellence and societal benefit are expected from areas where McMaster has developed the highest levels of strength and expertise. Critical to the selection of strategic areas is multi- and inter-disciplinarity, and the potential to forge effective links between research strengths and student and societal demand. McMaster's strategic areas are not mutually exclusive and are intended to inform priorities in research and teaching at both the undergraduate and graduate levels. The University has invested heavily in these areas through new faculty and staff appointments, student support, capital improvements to relevant facilities and promotion of strategic research initiatives, including strategic emerging fields. The six (6) strategic areas identified through extensive consultations reflect core strengths and ambitions that will remain indicative of long-term potential and relevance and, together with Faculty priorities, will continue to direct institutional initiatives and investments.

The six (6) multi-disciplinary (cross-Faculty) strategic areas resulting from Strategic Planning Exercises are:

- Molecular Biology
- Integrated Health Research
- Information Technology
- Globalization and the Human Condition
- Work and Society
- Science-based Innovation in Manufacturing (and Materials).

Strategic Research Plans cannot be static but must maintain flexibility in order to respond to changing environments and societal demands, both at home and abroad. Ongoing review of our strategic priority areas ensures they embody the leading edge research grounded and interfaced where feasible, within these areas as well as with opportunities that emerge. The identification of "emerging areas" allows the University to recognize and respond to evolving opportunities and promising areas of strength.

### **Brief Description of Strategic Research Areas:**

**Molecular Biology:** Our emphasis on molecular biology is broad-based and fundamental to the support of research excellence in health, biomedical, life and environmental sciences. This thrust includes investigations of mechanisms of fundamental molecular processes (such as signaling, transcription and metabolite profiling), application of molecular knowledge and techniques to the design of innovative therapeutic agents, and problems in environmental toxicology, forensics and evolutionary theory. We will continue to develop our research strengths in this area, which have resulted in the establishment of the Biointerfaces Institute, the Centre for Microbial Chemical Biology, the Centre for Functional Genomics, and Insight: The Centre for Advanced Ophthalmic Materials. These

initiatives draw upon the expertise and facilities that are part of the Science-based Innovation of Manufacturing (and Materials) strategic areas such as the Canadian Centre for Electron Microscopy (CCEM), the Center for Advanced Polymer Processing and Design, and the Centre for Emerging Device Technologies. With increasing frequency this area of strength intersects with one or more of our other strategic areas with collaborations among physical scientists, health scientists and engineers at the core. Interdisciplinary research includes studies into disease diagnosis and management, bioprocess control, advanced cell therapies for cancer and infectious diseases and investigations into antibiotic resistance.

**Integrated Health Research (IHR):** IHR has evolved as a new area of strategic priority replacing the earlier more narrowly defined Environment and Health. This strategic research thrust is inter-disciplinary in nature and brings together a broad range of fundamental and applied research strength with the objective of advancing the quality of health services for the benefit of society. In building on strength, we are investing in the further development of biomedical engineering, medical imaging, medical devices, neuroscience, systems and diagnostic techniques, health economics and policy analysis, health management and health care delivery. The university-wide Collaborations for Health initiative advances this strategic research area through four broad thematic areas: Health and the Environment, Health Systems, Development across the Lifespan, and Knowledge Translation.

The M.G. DeGroot Institute for Infectious Disease, established in 2007 is a cornerstone for pursuing interdisciplinary research spanning human and microbial genomics, infectious disease modeling and molecular biology, reflecting the cell to society approach. McMaster is known for interdisciplinary research and nowhere is the impact of these collaborations more evident than in Integrated Health Research. Investigations into how food and physical activity can interact to favourably impact human health and performance are supported through research expertise in health sciences, physical sciences and social sciences. McMaster is home to numerous researchers in a variety of disciplines studying ways to protect water with the identification of the emerging research priority, Water Ecology and Health, McMaster is seeking to further integrate these researchers and governmental partners to find solutions to preserve water safety and improve water treatment employing engineering, policy and scientific tools.

Among recent investments in Integrated Health Research are the creation of the McMaster Institute for Music and the Mind and the McMaster Institute for Neurosciences Discovery and Study. The collective talents and expertise of neuroscientists and digital media researchers present opportunities to create and integrate new technologies and innovative concepts for virtual reality media and cognitive neurosciences of memory and of language. Research in the emerging priority area of neurotechnology includes investigations of neuroimaging techniques aimed at speeding the diagnosis of brain disease, more effective monitoring of rehabilitation and recovery, and the development of smarter homes for better health care with a focus on the elderly in our community.

**Information Technology:** Initial emphasis on Information Technology was in Engineering, specifically, Electrical and Computer Engineering and the Department of Computing and Software where there has been a significant influx of new faculty in recent years. With the 2005 establishment of the School of Computational Engineering and Science connecting engineering, science, mathematics and computer science to create new, powerful tools for real-world discovery and understanding, the University had a head start in pursuing multidisciplinary research and education programs presented by new technological opportunities and needs. More recently Information Technology has been reflected in the priorities of social scientists and humanists and has been a bridge to our strategic area of Work and Society.

Emerging research furthering Information Technology and Work and Society will connect Digital Information and Innovation with Economic Policy; McMaster researchers are striving to address Canada's "innovation problem" and a fundamental challenge of the digital revolution: securely making electronic administrative, survey, personal and business data available for research to support evidence based policy. We are increasingly pursuing research initiatives which link multiple priority areas, as demonstrated through the emerging area of bioinformatics, where investigations will enable the analyses and integration of large and complex data sets emanating from both basic and clinical scientific fields, along with data networking and data storage. Building on our strength in embedded systems, we have developed in-depth expertise in the dependability of cyber-physical systems - the complex integration of computation, networking and physical processes.

**Work and Society:** This strategic area examines the impact of social, economic and demographic variables on workers and their workplaces. This research thrust encompasses investigators primarily in the Faculties of Social Sciences, Humanities, Business and Health Sciences. Formal research entities include the McMaster Centre for

Work in a Global Society and the Centre for Health Economics and Policy Analysis. Research in this area is far-reaching and includes such foci as investigations of occupational health and safety, women and work in the health sector, social policy influences on health and labour economics, and development of human capital through the educational systems, including associated education and health public policy. McMaster researchers pursue social sciences research which will increase knowledge of the differential impacts of social, economic and policy forces on the everyday lived experience of individuals; the study of evidence-based management and decision making in the corporate context; and evidence-based manufacturing policy, areas of interest to the private and public sectors.

**Globalization and the Human Condition:** Increasingly the outcomes of research have global reach and impact on societies outside of our own. This area supports the inter-disciplinary McMaster Research Institute on Globalization and the Human Condition. Areas of investigation include culture, social welfare, community identity, and economic trade and development as well as environmental sustainability, labour and the economy, and health and social policy. McMaster researchers are investigating evidence-based manufacturing policy development that would be helpful to governments in ensuring an innovative and globally competitive manufacturing industry. Researchers with expertise in sociology, economics, ethics and political science investigate factors which cause social inequalities in health, and issues related to a patient-focused approach to health care. McMaster's Faculty of Health Sciences and our affiliated hospital partner Hamilton Health Sciences support international clinical trials through provision of personnel as well as infrastructure to store specimens from many continents, and engage in large-scale investigations of population health. Research with impact on the human condition is diverse and can range from studying the impact of medical radiation on human health to the investigation of energy use and storage with impact on the environment. Many areas of research within this priority area are multi-dimensional and have significant overlap with other strategic priority areas.

**Science-based Innovation in Manufacturing (and Materials):** This strategic area was created to foster synergies between our internationally-recognized strengths in manufacturing and materials. It encompasses researchers primarily in Engineering, Science and Business and includes the Brockhouse Institute for Materials Research, the Centre for Electrophotonic Materials and Devices, the Intelligent Machines and Manufacturing Research Centre, the McMaster Manufacturing Research Institute, the McMaster Institute for Polymer Production Technology, the Computer-aided Polymer Process Analysis and Design Group, and the McMaster Advanced Control Consortium. The central aim of this area is to understand and optimize the process leading from the design of new materials to their manufacturing and application. McMaster's strength in research will benefit the automotive sector through the development of lighter, non-corrosive materials, more fuel efficient systems, the next generation of car battery technology, hybrid powertrain, the "cognitive car" and development of novel coatings to enhance productivity. It will support research critical to the energy sector and provide alternative, clean technology through the Laboratory for Advanced Photovoltaic Research, the Intense Positron Beam Facility and Centre for Advanced Nuclear Systems. We will investigate additive manufacturing aimed at developing new additive approaches to meet the needs of the mold/die, automotive, aerospace and biomedical fields. We will continue to invest in research in the School of Biomedical Engineering which reflects the synergy between this strategic area and Integrated Health Research.

#### **Integration of priorities within the McMaster community**

In addition to the university-wide strategic planning process, each Faculty implemented its own process to identify specific priority areas. Faculty priorities were informed both by the institutional strategic directions and by their key strengths and interests. The result is a cohesive and natural integration of University and Faculty focus, often with initiatives that span a number of identified priority areas. Decisions regarding investment in research and academic activities are grounded in our Institutional and Faculty strategic directions. Existing and planned initiatives include support for human capital, infrastructure, graduate and undergraduate training, as well as alignment with or creation of complementary institutes and centres, many of which are inter-disciplinary or cross-disciplinary in nature.

**Building Research Capacity** The growth of McMaster's research enterprise reflects our strong competitive pursuit of new research opportunities built upon research strengths, and commitment to the development of innovative training strategies and stakeholder collaborations spanning community, regional, national and international partnerships. Our institution-wide and faculty-specific strategic directions provide the framework for institutional research and infrastructure applications, institutional resource allocations (e.g., faculty appointments and capital expenditures) and for ongoing fundraising. McMaster University and its affiliated hospitals use an integrated approach to opportunities provided by partnership and strategic programs such as the Canada Research Chairs (CRC), Networks of Centres of Excellence, Ontario Research Fund, and tri-agency initiatives including the NSERC Collaborative Research Education and Training Experience (CREATE). These opportunities allow us to further

enhance our areas of research strength and to engage in inter-disciplinary, multi-institutional research initiatives. Critical to recruiting, retaining and supporting excellent researchers is the establishment of world-class infrastructure. The aligned support of the Canada Foundation for Innovation (CFI) and the Ontario Research Fund Research Infrastructure (ORF-RI) program is essential to maintaining McMaster's competitive edge. This blend of federal and provincial support has spurred several multi-institutional initiatives which could not have otherwise developed. Institutional priority for CFI and ORF-RI applications is given to research programs that most closely align with one or more of McMaster's strategic directions and take into account federal and provincial science and technology priorities. Emphasis is on coordinating CRC applications with major institutional initiatives to maximize the positive impact on the University's research enterprise. Many of our institutional research initiatives, including CFI/ORF-RI applications, are led by or include significant participation of CRC award holders and are aligned with groundbreaking and/or expanding training and educational initiatives. Finally, the research thrusts to which appointments are made through CRCs, endowed or industrial Chairs reflect ongoing academic planning which is guided by the key institutional goals and realized through strategic planning within departments and faculties.

The CRC program, as well as other Chair investments, allows us to build upon and advance research strength in foundational areas essential to a broad range of research activities. As such, some of our Chair appointments may not be directly related to a specifically defined strategic area. One such example is mathematics, a foundational discipline that plays a key role in many scholarly areas of inquiry. Our faculty in the Department of Mathematics and Statistics collaborate with researchers in fields ranging from epidemiology to theoretical physics and materials. Chair appointments are an important resource for expanding and sustaining excellence in mathematics; although this field is not identified as a specific institutional strategic area, it is in fact a strategic area within its Faculty.

### **McMaster's CRCs – Current Status and Planning & Approval Process**

Planning for the allocation of CRCs is driven by the Faculties within an overarching institutional framework developed by the Senior Academic officers and subsequently approved by the Senate Committee on Appointments. CRCs are allocated to Faculties proportional to the funding secured by each faculty from the tri-agencies. Each Faculty develops a plan to allocate CRCs in accordance with identified research thrusts, with plans reviewed and endorsed at the institutional level. Flexibility is built into this CRC process to allow for emerging opportunities that arise throughout the life of the program. Nominations for faculty with clinical or cross-appointments with affiliated teaching hospitals are consistent with established mutual priorities. External recruitment for clinical faculty is performed in conjunction with clinical program leaders and in consultation with the relevant teaching hospital. McMaster is committed to actively seeking qualified candidates from under-represented groups and is taking steps to address any imbalances that may occur throughout our CRC nomination and renewal processes.

### **Research Training**

Graduate education is central to research intensity at McMaster. Higher graduate enrolments are targeted among programs that are high quality, nationally and internationally recognized and inter-disciplinary programs which are consistent with the University's areas of strategic priority. Demonstration of the importance of the University's training role, recruitment of the best of the best and the provision of a broad range of resources towards training (undergraduate, graduate and postdoctoral) is the creation of the position of Associate Vice-President & Dean in the School of Graduate Studies. This position extends the resources of the School to the training environment at large, while complementary and aligned with the research objectives of the University.

### **Knowledge and Technology Transfer**

McMaster University is recognized and ranked nationally as a first-class research and educational institution. To support the research enterprise, McMaster has invested heavily in services to assist researchers in knowledge transfer activities, including commercialization of research results through the McMaster Industry Liaison Office and the creation of the McMaster Innovation Park (MIP), a vehicle for supporting research and development in key industrial areas, thereby facilitating and accelerating knowledge transfer and the impact of outcomes from recognized research strengths. MIP is designed to be a regional incubator hot bed, aimed at supporting, promoting and facilitating early-stage companies. McMaster has partnered with city, regional, provincial and national stakeholders with a focus on economic development activities to capitalize particularly on biotechnology and materials developments. These initiatives, together with a unique set of policies covering intellectual property management and inclusive of all work conducted with our affiliated hospitals, equip the University and our hospital partners with the ability to execute knowledge and technology transfer and commercialization in collaboration with our industry partners. Equally notable, the University has invested strategically in Hamilton's capacity for supporting and nurturing such initiatives through significant expansion of our industry liaison staffing.