University of Toronto

OFFICE OF THE VICE-PRESIDENT - RESEARCH AND INTERNATIONAL RELATIONS

March 5, 2002

MEMORANDUM

TO: **Planning and Budget Committee**

FROM: **Heather Munroe-Blum, Vice-President, Research and International Relations**

Re: **Revised CRC/CFI Strategic Research Plan**

Enclosed is a recently revised version of the University's Strategic Research Plan (SRP), which is a required document for the University's ongoing participation in the Canada Foundation for Innovation and the Canada Research Chairs programs.

I forward this document to you for your information and for review by the Committee on Planning and Budget.

Some of the changes in this revised document are as follows:

- One clear, concise document will be provided to CRC. In the past, the University submitted both a summary and a more detailed full version. The CRC College of Reviewers did not use the full version in previous competitions; therefore, some important information was not taken into consideration. This new version will eliminate any confusion as to which document should be used.
- Descriptions of clusters and nodes have been removed entirely from the SRP to eliminate confusion for external reviewers. However, cluster priorities have been included in the new descriptions of areas and themes.
- Highly similar themes, such as "Advanced Materials" and "Materials and Manufacturing", have been combined, resulting in new theme names such as "Advanced Materials and Manufacturing". All existing theme and cluster priorities remain evident, but are structured more clearly.
- Cumbersome theme titles have been simplified. For example, "Comprehensive Program in Medical Imaging" has been renamed "Medical Imaging". The meanings of the theme titles have been preserved consistently.
- The theme "Physical, Environmental, Earth and Space Science Related Studies" was unwieldy both in its title and in its grouping of disparate

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academic fields. In its place, there are now three clear themes: "The Planet Earth", "Aerospace Science and Technology", and "The Structure of the Universe".

- Research areas containing only one theme each have been subsumed under larger research areas. Thus, "Mathematical and Computational Sciences", an area with only one theme, becomes a theme in the "Science and Technology" area. This practice simplifies and clarifies the document's structure and more fairly reflects the University's priorities.
- Repetitive sections in the previous version of the SRP have been streamlined or eliminated.
- The new version of the document has been circulated to all appropriate constituencies for feedback and revised accordingly.

Once the Committee on Academic Policy and Programs has reviewed the document, we will forward it to Ottawa to be posted on the Canada Research Chairs website and used for adjudication of the University of Toronto's future submissions to the above-noted federal programs.

If you have any questions regarding this document please contact Judith Chadwick, Associate Director, GRIP at 416-978-5129.

Heather

xc: Ian Spence, Director, GRIP
Judith Chadwick, Associate Director, GRIP

Strategic Research Plan
for the University of Toronto

15 February 2002

STRATEGIC RESEARCH PLAN (SRP)
FOR THE UNIVERSITY OF TORONTO AND ITS FORMAL AFFILIATES

Introduction

The advancement of excellence in research is a defining feature: our mission is to rank among the top 10 public research-intensive universities in the world. The development of research, scholarship, and research training is an integral element of the academic planning and budgeting process. Our plans reflect consultations within and across the divisions of our three campuses and with our nine fully affiliated teaching hospitals. This process has defined academic and related infrastructure objectives which form the basis for the Strategic Research Plan (SRP) for the Canada Research Chairs (CRC) and Canada Foundation for Innovation (CFI) programs, as well as other new government research and infrastructure programs. These programs are essential to attract and retain outstanding researchers, to develop new areas of excellence in research, and to strengthen synergies between teaching and research. They provide an exceptional opportunity to increase Canada's talent pool and research infrastructure and thus boost Canada's productivity and international competitiveness.

The University of Toronto encompasses 18 divisions, 82 departments, three campuses, and nine fully affiliated teaching hospitals. There are approximately 3,000 campus-based faculty members and another 3,000 faculty who are based in the affiliated teaching hospitals. Academic programs span the disciplines and professions, supporting approximately 50,000 students, including 10,000 at the graduate level. The University and its affiliated teaching hospitals attract over $400M per year in external research funding, and more than 100 productive Canadian companies owe their origins to research conducted at the University of Toronto and its affiliates.

Although this scale of operation is large, the strategic planning process fosters distinctiveness as well as excellence; collaboration and synergy are strongly encouraged and the selective investment of resources is consistent with these aims. Resources to support research derive from government programs, private-sector partners, and other organizations in Canada and around the world. In spite of considerable success, the challenge remains to create a resource base that is competitive with the great public research-intensive universities in other countries. A significant gap still remains in this regard.

Major Objectives of the Strategic Research Plan (SRP)

- Maximize opportunities for discovery and innovation;
- Strengthen internationally competitive research and scholarship in highly promising areas;
- Foster excellence in selected areas of research that are currently undeveloped;
- Foster collaborations across disciplinary and institutional boundaries;
- Strengthen the capacity to disseminate new knowledge;
- Ensure the most effective use of our research and scholarship resources and realize the full value of intellectual property;
- Enhance the education of undergraduate students and research training of graduate students and postdoctoral fellows; and
- Enhance our ability to attract, retain, and develop outstanding faculty, students, and research staff.

Research Areas and Themes

Our high-priority research **themes** fall into four major **areas**, encompassing major fields of inquiry in the humanities, the social sciences, the physical sciences, and the life sciences. The range of

disciplines and departmental units varies by theme; some themes are entirely or almost entirely located within a given discipline or sub-discipline, while others are multi-disciplinary in nature. Given the size and complexity of the University of Toronto and its excellence in a wide range of research fields, the listing of high-priority research themes is longer than might be expected at a smaller institution:

1. Humanities

1.1. Literature, Arts, and Culture
1.2. Medieval Studies
1.3. Values: Their Origin and Transmission
1.4. History and Culture

2. Social Sciences

2.1 Urban Environment
2.2 Public Policy
2.3 Economics, Finance, and Competitiveness
2.4 Global Development
2.5 Peace, Conflict, and Security
2.6 Groups, Networks, and Localities

3. Science and Technology

3.1. Information Technologies
3.2. Advanced Materials and Manufacturing
3.3. Biotechnology
3.4. Nanoscience and Nanotechnology
3.5. The Planet Earth
3.6. Aerospace Science and Technology
3.7. The Structure of the Universe
3.8. Mathematical and Computational Sciences

4. Health and Life Sciences

4.1 Molecular Biology and Applied Genomics
4.2 Models and Mechanisms of Disease
4.3 Neurosciences
4.4 Improvement in Health and Function
4.5 Health Information and Knowledge Transfer
4.6 Medical Imaging

Research Areas and Theme Descriptions

1. Humanities

1.1 Literature, Arts, and Culture

This theme encompasses the study of cultural structures and discourse in the context of ancient and modern societies. Research strengths include identity and nation, print culture, visual structures as a component of performance, and body representation. This theme brings together many disciplines (architecture, literary studies, music, drama, and physical education) and complements the other themes in the humanities.

1.2 Medieval Studies

International scholars are attracted to the world-renowned Pontifical Institute for Medieval Studies and the Centre for Medieval Studies. Projects such as the Records of Early English Drama, the Dictionary of Old English, and the Rhymed Office project in the Faculty of Music exemplify the range of disciplines. Researchers study the convergence and interdependence of different branches of medieval culture and knowledge. A particular focus is the study of religion and popular spirituality as revealed in the drama, literature, and music of medieval society.

1.3 Values: Their Origin and Transmission

This theme examines how values are shaped and transmitted throughout history, in the movement of peoples, and through changes in national identity. This area stands at the interface of the humanities and social sciences, and explores values through the perspective of writers, artists, philosophers, historians, and other arbiters and analysts of society and culture.

1.4 History and Culture

A broad range of disciplines is focused on understanding the complex interplay between history and culture. Understanding of how cultural movements are transformed as they move across nations and through time is a particular emphasis. For example, one focus concerns how the ancient Greek culture influenced other cultures and nations, and how transitions in ancient thought and philosophy shaped medieval culture.

2. Social Sciences

2.1 Urban Environment

Linked to the rise of the new economy, urban regions are experiencing sweeping transformations related to society, culture, and health: increasing diversity, mobility of populations, and the emergence of competing forms of management, regulation, and governance. Investigations include: exploration of cultural and ethnic pluralism and its interaction with the arts; and planning culturally diverse urban communities to create effective, safe, attractive spaces in which to live, work, and learn.

2.2 Public Policy

This diverse theme encompasses studies in society, health, education, environment, public economic management, and human development throughout the life cycle. Researchers study social, ethical, and economic issues and the implications these have for public health policy and management. In studies of society and education, points of focus include social justice, diversity, socio-legal studies, educational policy, and language and literacy.

2.3 Economics, Finance, and Competitiveness

How can jurisdictions and nations prosper in the new economy? This research adapts financial risk management techniques to enhance Canada's capacity to deal with the challenges of complexity and uncertainty. Investigations focus on the structure of economies, including the Canadian economy, and how leaders in business, government, education, and healthcare can understand the complex global forces that shape them. Canada's strategy must take account of economic, cultural, and social dimensions, uniting business, government, and the academy to build knowledge and develop strategy.

2.4 Global Development

Scholars approach global development, health, and prosperity from interdisciplinary perspectives. The gap between developing and developed countries is growing and important issues include: sustainable development; public health issues; the role of legal institutions; strategies for economic competitiveness; history and culture in developing countries, including colonialism and post-colonialism; transfers in the evolution of national cultures; regionalization, globalization, and inequality; and peace-building and security.

2.5 Peace, Conflict, and Security

This theme reflects the University of Toronto's impressive capacity in peace and conflict studies, and promotes interdivisional collaboration among Arts & Science, Law, Medicine, and the Ontario Institute for Studies in Education. Researchers grapple with new variations on fundamental questions: What do peace and security mean in the aftermath of the Cold War? How can scholarly research be useful in fostering well-being and order while also analyzing their absence or collapse?

2.6 Groups, Networks, and Localities

This theme promotes the study of the evolution of social, legal, health, educational, and governing institutions in the context of heterogeneous groups, networks, and nations. New information

technologies facilitate flows of information, people, groups, organizations, or capital through networks. The consequent accumulation of information, people, etc. in localities (neighbourhoods, communities, regions, nations) makes traditional analyses problematic. Global markets, new transportation modes, and information technologies which speed up and direct these flows have an impact on the stability of local units, affecting their internal organization, culture, homogeneity, and unity.

3. Science and Technology

3.1 Information Technologies

These include high performance computing and innovations in computational technologies, such as digital media, methods to improve human-computer interaction, and intelligent infrastructure. Specific projects include understanding human communications and developing technologies and algorithms for solving large-scale complex problems in information processing. Studies of fibre-optic systems, real-time monitoring of complex systems, and wireless transmission of information are critical elements. Research in the computational sciences melds with other fields of research, including biology, physics, advanced materials, design, education, philosophy, communications, and engineering, as well as psychology and sociology to explore the role of human factors in the development and application of information technology.

3.2 Advanced Materials and Manufacturing

Close interaction among materials scientists and engineers, physicists, and chemists is required to develop advanced materials with novel properties and function. Innovative advanced manufacturing technologies and processes for materials synthesis will result in advanced alloys, polymers, composites, semiconductors and superconductors, that are fundamental to the development of new engineering materials of higher quality and/or lower cost in the microelectronics, photonics, biomaterials and manufacturing sectors.

3.3 Biotechnology

This theme includes molecular and functional imaging, biomaterials, and tissue engineering and regeneration. Scientists in the Faculties of Applied Science & Engineering, Dentistry, and Medicine investigate replacement tissues and their biocompatibility, study the physiology and genetics of biofilms, including their relation to infection, and advance knowledge in diverse areas such as nerve regeneration, orthopaedic and dental implants, vascular grafts, biodegradable polymers, and artificial organs.

3.4 Nanoscience and Nanotechnology

Multidisciplinary groups from physics, chemistry, and engineering interact in order to understand and develop new materials. Focusing on structures at the atomic and molecular levels, this research unites physicists, who are developing the underlying microscopic descriptions of the physical phenomena; chemists, who are exploring the techniques by which such nanostructures can be formed through processes such as self-assembly; and engineers, who are applying these new materials to develop technologies in areas such as photonics and optical devices. Related research in microelectronics ranges from the design and fabrication of semiconductor devices and integrated circuits to the effective assembly and packaging of such devices. Important aspects include manufacturing processes, electrical design and modelling, photonics packaging, and packaging materials development.

3.5 The Planet Earth

This theme focuses on the earth and its environment. Large-scale studies of atmospheric chemistry and dynamics and studies of the earth's crust and deep mantle are a particular emphasis. Research activities range from understanding the complex physical and biological interactions that occur

at multiple levels—from the molecular and cellular to individual organisms within the integrated ecosystem. Researchers employ diverse techniques ranging from proteomics at the biomolecular level to the use of sophisticated remote sounding satellite observation of the planet.

3.6 Aerospace Science and Technology

This interdisciplinary theme focuses on the fundamental understanding and engineering design of aircraft and spacecraft flight systems. The core disciplines include: flight dynamics, control, and simulation; experimental and computational aerodynamics; fluid, gas, and plasma dynamics; combustion and propulsion; materials and structures; satellite technology; space robotics; and systems simulation and integration.

3.7 The Structure of the Universe

The fundamental structure of our universe, at its most microscopic level, is intricately connected with the very largest scale structures in our universe and their evolution since the Big Bang. This theme integrates the study of our universe, bringing together theoretical and experimental studies of new unified models such as string theory, astrophysical studies of the early universe, and astronomical observations of current galactic and stellar structure.

3.8 Mathematical and Computational Sciences

The University of Toronto is a world leader in mathematical and computational sciences and is host to the national Fields Institute in Mathematical Sciences, where mathematical scientists from Canada and around the world gather for periods of intensive collaborative research. Research includes the study of mathematical foundations, mathematical modeling, and scientific computation. Important applications include processing and exploring large data sets, mathematical finance, and the development of fast, reliable algorithms. Mathematicians interact with a broad spectrum of scholars in Applied Science & Engineering, Arts & Science, and the Rotman School of Management.

4. Health and Life Sciences

4.1 Molecular Biology and Applied Genomics

The focus is on fundamental and applied research in proteomics and bioinformatics, functional genomics, and molecular medicine. Researchers investigate the interaction of genes with environmental, behavioural, nutritional, and psychosocial factors in health and disease; the design and safety of new drugs; and the associated ethical and social issues. Long-term objectives include understanding the mechanisms of enzyme catalysis, ion channel and transporter function, and drug activity.

4.2 Models and Mechanisms of Disease

This theme encompasses inflammation, infection, trauma, repair, and vascular and metabolic biology. The research involves the use of transgenics, "knockouts," and other models, such as isolated cells, tissues, tissue culture, and computer modelling, in order to study gene functions in health and disease. Strategic scientific goals include developing a platform of vertebrate and non-vertebrate models of human disease, along with appropriate imaging and telemetry monitoring techniques for the purpose of gaining a better understanding of the natural history of disease processes in humans.

4.3 Neurosciences

Modern neuroscience, including neurobiology, involves multiple departments in several Faculties and Divisions on all three campuses, and at the institutes of the affiliated hospitals, such as the Rotman Research Institute at the Baycrest Centre. The spectrum of projects ranges from molecular to functional. Molecular neuroscience includes the study of the molecular genetics of the brain and nervous

system in animals and humans, in both normal and clinical states. Functional neuroscience examines how neural systems support functions and behaviours like perception, learning, memory, and action. Research on the neurochemical causes of pain, as well as its assessment and management, is an important focus.

4.4 Improvement in Health and Function

Emphases include developing and testing: new modalities of diagnosis and management of disease; fetal, neonatal, and maternal health; approaches to promote maximum function among those who develop disease and disability; health-system-related strategies; and the promotion of health and wellness for large populations. Specific objectives include: to develop and apply clinical databases combined with genotyping to identify and manage vulnerable patient populations; and to apply mathematical and epidemiological methods to the study of health outcomes in such areas as cancer, cardiovascular disease, and stroke.

4.5 Health Information and Knowledge Transfer

Health systems and knowledge transfer shape fundamental and applied research in the delivery of clinical care through many different avenues, including home care. The University is committed to developing, refining, and applying a range of information technologies in health care. Long-term objectives are: to afford the potential for long distance provision of health services for diagnosis, surgical care, education, and prevention; and to develop multidisciplinary strategies to deliver health care and educational and rehabilitation services to the geriatric population.

4.6 Medical Imaging

The focus is on the development of preclinical models for visualizing molecules, cells, tissues, organs, and the whole body, with an emphasis on relating and interpreting images in normal and disease conditions. A long-term project will investigate quantitative non-invasive approaches for the diagnosis and evaluation of disease states. This process will require the development of a tool kit of chemical and physical probes, mathematical and computer models, and the use of state-of-the-art detection systems (MRI, PET, gamma spectrometers, etc.) for real-time monitoring of whole organ function.

Institutional Planning and Approval Process (including Affiliated Institutions) and Investment

The University's existing planning process takes account of CRC, CFI, and other government research and infrastructure programs. This integration has been extensively documented, and the Academic Board and Governing Council have endorsed this planning framework.

The Government Research Infrastructure Programs office (GRIP) coordinates and facilitates the development of research strategy and proposals. Proposals are vetted first at the departmental and faculty levels, and then reviewed by GRIP to ensure excellence and compliance with the SRP. The President, with his Executive Committee, then approves those proposals that advance the University's priorities and comply with the SRP. All plans receive final approval by the Governing Council.

Institutional Support for Research and Research Training

U of T has invested substantially of its own resources in its key research and academic priorities. This process has required appropriate restructuring of complement plans, the development of a successful advancement campaign, and the creation of an endowment to support faculty, students, and research. U of T has targeted the fundraising campaign to support these priorities and has built

significant, stable partnerships with industry to support key research programs and related research training.

The SRP and the Canada Research Chairs Program

Canada Research Chairs are sought for areas in which the University of Toronto's faculty and research programs are competitive with the best in the world, or could achieve that status in the near term with enhancements. The President of the University of Toronto is responsible for the allocation of Canada Research Chairs. An Executive Committee comprising the President, the Vice-President – Research and International Relations, and the Provost has defined the research areas and high-priority research themes in the SRP, in consultation with Principals, Deans, and other colleagues, on the basis of excellence and capacity for national and international impact.

Balance of internal and external appointments

The mix of internal and external appointments is consistent with the CRC program's primary purpose of adding to the complement of highly talented faculty at Canadian universities while acknowledging the need to retain existing outstanding faculty and effectively support their work. It is also consistent with the University's intention to allocate the Chairs in a manner that builds on areas of existing and emerging research strength. This balance of internal and external appointments will vary across research themes. In some cases, the priority is to retain key faculty at the peak of their careers, while building strength for the future by bringing in promising junior faculty. In other areas, a wave of recent retirements may require more external appointments.

Balance of Tier I and Tier II Chairs

The University allocates Chairs equally between Tier I and Tier II, but has some scope to increase the number of Tier II Chairs, consistent with its academic priorities. Normally, each research theme will contain approximately equal numbers of Tier I and Tier II Chairs.

Collaboration

Many areas lend themselves to the sharing of facilities, equipment, data, technical support, and other research infrastructure. In some cases, a theme may include individual scholars who work in related areas but whose research does not involve direct collaboration. These models of team vs. individual research are not exclusive to any one discipline, and other variations exist. A number of research themes span departments, divisions, and campuses. In the health and related sciences, a theme may involve a number of academic departments and hospital research institutes. In every case, the strategic research plan and reflected planning processes aim to create economies of scale and strong complementarities of research activity, research training, and research resources and facilities.

There is a strong commitment to external research collaboration and partnership, reflected in many productive relationships with other universities and research institutes, industry, governments, and foundations. U of T participates in 17 federal Networks of Centres of Excellence and in each of Ontario's Centres of Excellence. We encourage and support research partnerships wherever possible, including those reflected in our CRC, CFI, and ORDCF submissions. The most important partnerships are with the nine affiliated teaching hospitals and their research institutes. These hospitals are: Baycrest Centre for Geriatric Care, Centre for Addiction and Mental Health, Hospital for Sick Children, Mount Sinai, St. Michael's, Sunnybrook and Women's College Health Sciences Centre, Toronto Rehabilitation Institute, Bloorview MacMillan Centre, and the University Health Network. Multi-institutional research collaboration, domestic and international, is a component of the majority of research themes in the SRP.

Teaching-Research Synergy

The University of Toronto is deeply committed to high-quality graduate and undergraduate education. Since every effort is made to benefit teaching practices via research, all University of Toronto Chairs, including Canada Research Chairs, have teaching as well as research responsibilities.

Linkages with Major Research Infrastructure

The research and scholarly themes in this document rely on significant research facilities and resources, ranging from libraries and data sets to major research equipment, labs, and other facilities. Our funded CFI programs (and future CFI and other proposals) are consistent with the SRP. Thus, we will build the resource base to fully leverage strategic resources in support of talent, research infrastructure, and research operations.

Expected Outcomes for Assessing Success in Attaining CRC Objectives

The targeted performance measures of the University of Toronto's CRC nominations will be included in annual reports from each of the University's CRCs.

National and International Status

The national and international status of the research programs led by our CRC applicants will be measured using the following criteria:

- publications in internationally recognized journals which result in numerous citations;
- other major forms of publication and dissemination including high-profile books;
- invited lectures and leadership participation in international conferences and symposia;
- international research collaborations involving the Chairs;
- recruitment of internationally renowned researchers, scientists and scholars;
- the number and calibre of national and international awards and prizes received by the Chairs;
- national and international media profiles of the Chairs;
- the demand for students graduating from CRC research programs to fill positions at prestigious academic institutions, companies, government agencies and not-for-profit organizations; and
- the scale of leveraged additional resources in support of related research and training goals.

Educational/Research Synergies

The synergy between research and the quality of the education and training of graduate students and fellows will be measured using the following criteria:

- attracting high-quality graduate students to the Chair's program, particularly at the doctoral level and in breakthrough areas at the interface of disciplinary fields;
- research and scholarship awards for the Chair's graduate students; and
- interdisciplinary interactions, networking, and sharing of resources.

Dissemination of New Knowledge

Several metrics can be used to monitor the extent to which new knowledge is disseminated, including:

- the increase in the number of graduate students associated with the Chair's program;
- the increase in graduate student participation in conferences and publications;
- the intellectual property generated from the research;
- the dissemination of research results via various modes of publication;
- the dissemination of research results via commercialization, licenses, start-up companies, and other means; and
- independent rankings of research performance relative to international benchmarks.

Conclusion

The University of Toronto has a critical role to play in Canada's future in a wide range of areas, involving intellectual, social, cultural, scientific, commercial, industrial, and national security issues. The strategic research plan and research planning process will significantly advance research capacity and productivity at the University of Toronto and the affiliated teaching hospitals, and will guide the University's CRC nominations and proposals to other government research and infrastructure programs.

The CRC program offers the prospect of renewing and enhancing the vitally important human resources of the University and the affiliated teaching hospitals, the quality and impact of its research and research training, and its ability to serve Canada at the highest level through our talent and knowledge. The University of Toronto undertakes to realize the full promise of this important program: to attract and retain superb talent; to build strategic research programs and linkages of research, education, and training; and to leverage strategic partnerships and resources for the benefit of Canada.