Proposal to Establish

The Waterloo Institute for Complexity and Innovation

at the

University of Waterloo

January 30, 2010 revision

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1. *NAME OF THE INSTITUTE*

Waterloo Institute for Complexity and Innovation (WICI).

2. *OVERVIEW*

2.1 Rationale and Background

At the end of the first decade of the 21st century, surprise is no longer surprising. We are seeing a steadily higher incidence of unanticipated and sometimes catastrophic change, such as financial crises, pandemics, sharp spikes in food prices, disruptive meteorological events, and severe social and political unrest.

The 20th century's disciplinary-based approach to research and policymaking cannot address such problems effectively, because they are intrinsically transdisciplinary. Human beings are embedded in a nested and interconnected hierarchy of complex socio-ecological systems, including the biosphere and the global economy. These systems are increasingly perturbed by powerful, simultaneous and often interacting stresses, including rapid population growth, systemic imbalances in the global economy, enormous gaps between rich and poor classes, worsening scarcity of high-quality energy, and severe damage to Earth's environment.

In this context, innovative problem solving demands a complex-systems approach that integrates knowledge across disciplines. The study of complex systems, which has developed over the last several decades, lies at the intersection of the physical, biological, and social sciences. Contributors come from biology, computer science, ecology, economics, history, mathematics, philosophy, physics, political science, and sociology. The field's research ranges from the investigation of general principles of self-organization to the modeling of specific real-world systems like forest ecologies.

This work has produced a substantial body of methods, ideas and results, including deep insights into the processes behind the extraordinary rates of innovation in complex adaptive systems as diverse as modern markets and mammalian immune systems.

But despite enormous promise and high expectations, the study of complex systems has yet to produce practical results that significantly better our world. It has not, for instance, helped improve real-world processes of social and technological innovation, nor has it helped policymakers address more effectively the world's most urgent problems. This disappointing outcome is not entirely the result of the limited progress of complex-systems studies: human societies' procedures and structures are deeply resistant to change, in part because most societies remain firmly grounded in "mechanistic" world views that have guided apparently successful problem solving in the past.

The University of Waterloo, with its extraordinary strength in relevant fields, is uniquely situated to unlock this promise. We therefore propose to create an interdisciplinary institute – the *Waterloo Institute for Complexity and Innovation* – that will integrate complex-systems knowledge from the university's faculties, departments, centres and schools and that will draw complex-systems expertise from around the world to address the most pressing problems of the 21st century.

2.2 Mission

The Waterloo Institute for Complexity and Innovation will facilitate and undertake rigorous, transdisciplinary, collaborative research that promotes innovation and resilience within the complex adaptive systems at the core of human well being in the 21st century.

Under this overarching mission, WICI has three discrete sets of goals, relating to:

1. the pursuit of leading-edge research;
2. the creation of a university-wide research community in the field of complexity and innovation studies; and,
3. the strengthening of the university's reputation in this field.

The institute's *research* goals are:

- To combine existing ideas from complex-system studies with complementary ideas from relevant fields[1] to develop enhanced and integrated conceptual frameworks and methods for the study of complex natural and social systems; and
- To apply these integrated concepts and methods to stimulate rapid innovation that either:

  1. enhances the resilience of complex systems vital to human well being that are economically viable, socially equitable, and ecologically sustainable, or

  2. hastens the beneficial transformation of complex systems with irremediable and fundamental flaws.

The institute's *community-development* goals are:

- To encourage the synthesis of disparate knowledge on the University of Waterloo campus through collaborative research, seminars, workshops, conferences, and high-quality publications;
- To draw together the expertise of researchers from existing university departments, centres and institutes and associated institutions to create a community focused on using complex-systems ideas to promote innovation to solve practical problems;
- To develop a shared foundation in concepts and research tools;
- To provide university-wide training and support in the use of complex-systems research and modelling tools; and
- To act as a hub for graduate students across campus and related institutions who are studying complexity and innovation.

The institute's *reputation-strengthening* goal is:

- To establish the University of Waterloo as a world leader in efforts to use complex-systems ideas to promote innovation to solve multi-scale, systems-level global problems.

[1]"Relevant fields" include theoretical neuroscience, systems engineering, economic geography, theoretical physics, and climate science.

With a director and a small staff, the institute will be managed by an Executive Committee and a Board and guided by an International Scientific Advisory Council consisting of leading thinkers in the fields of complexity and innovation.

Within the University of Waterloo, WICI will act as a "centre of centres" for research on complex systems. Within the region, WICI activities will bring together scholars, practitioners, and policy makers working on both theoretical and applied complex systems problems. Beyond the University of Waterloo and the immediate geographic scope of Southern Ontario, WICI will use online and interactive technologies to disseminate its findings and to engage vigorously with complexity researchers around the world.

The institute will thus further the university's reputation as "an outward-looking university, aware of and responsive to the needs of society [and] committed to discovering new knowledge and finding ways to use that knowledge for the benefit of all."[2]

2.3 Importance

Surprisingly, given the importance of the field, the global landscape of complexity-focused centres and programs – especially those with substantial reputations and activities – is sparsely populated. The number with good educational programs is very small. And virtually none emphasize three things that will be at the heart of WICI's efforts: discerning the similarities and differences between complex natural systems and complex social systems, identifying the nature and sources of innovation in complex systems, and applying the results of this research to practical problems of policy and governance.

A brief review of the major North American complexity-focused research centers with similar focus and scope highlights the University of Waterloo's opportunity. (WICI members have formal and informal contacts and collaborations with the complex systems groups at each of these programs, and efforts are underway to

[2][2]Quoted from the "About UW" section of the University of Waterloo Website: http://www.uwaterloo.ca/aboutuw/ (accessed on June 30, 2008).

strengthen these connections. Section 2.6.4 lists other North American, European, and Asian centers in the field.)

- The Santa Fe institute (SFI) is the pioneering research centre in the field of complex systems. Although SFI was the home of major theoretical advances in the early days of complex system research, its influence has diminished as other centers have grown. SFI has also traditionally focused on natural science research, with a high proportion of physics faculty and relatively little ongoing work in the social and environmental sciences.
- The Center for the Study of Complex Systems at the University of Michigan is the most well-established cross-disciplinary university complex systems research center, and it provides a relevant model for WICI. The University of Waterloo, however, has potential to build a stronger centre in the areas of inter-and cross-disciplinary social and environmental sciences, while taking advantage of its comparable strengths in computer science and the technical preparedness of the student body.
- The Center for Social Dynamics and Complexity at Arizona State University (ASU) also hosts seminars, workshops, and provides coordination for complex systems research projects. The university is undertaking a targeted complex adaptive systems hiring initiative. While ASU has embarked on major investments in new, cross-disciplinary institutional structures and has hired many high-profile senior scholars, and while it has established itself as a global centre of research on resilience, it lacks the University of Waterloo's institutional cohesion and existing strengths in technical fields.
- The Center for Social Complexity and the Department of Computational Social Science at George Mason University host seminars and conferences, offer support and coordination for research initiatives, and offer a PhD in computational social science. Program development has also been supported by targeted faculty hiring. George Mason's programs are focused at the intersection of social, computer, and neural science, and its research is primarily centered in political science with a strong emphasis on defense and national security, economics, and urban modeling and a minor emphasis on environmental science. George Mason University also lacks the University of Waterloo's institutional maturity and its body of technically prepared undergraduates.
- The most prominent private universities in the United States, including Harvard, MIT, Yale, the University of Chicago, and Stanford, have little or no

substantive programs for the study of complex systems. The exception is Northwestern University's Northwestern Institute on Complex Systems, which hosts seminars, coordinates cross-disciplinary research, and is home to the popular Netlogo software for modeling complex systems.

The University of Waterloo is extremely well-situated to exploit the opportunity provided by the relatively small number of substantially resourced and active centres of complexity studies. It has an entrepreneurial intellectual culture that encourages transdisciplinary research; it has a long-established strategic vision that promotes innovation; it has enormous program strengths in fields of central relevance to complexity studies, including applied math and computer science; and it has close associations with research centres such as the Perimeter Institute and the Centre for International Governance Innovation that have a deep interest in the behavior of complex systems.

In this context, by establishing the Waterloo Institute for Complexity and Innovation, the University of Waterloo will:

Create Canada's first institute on applied complexity and innovation: Canada currently has no research institute focusing on the study of complex systems or on applications of findings from complexity research to practical problems of innovation and policy. In creating WICI, the University of Waterloo will automatically lead Canada in this critical field. And given the stature of its founding members, their many linkages to national and international research activities, and Waterloo's deep research strengths in relevant disciplines, within a few years WICI will likely propel the university to a position of global leadership in complexity and innovation studies. The institutewill be recognized as a centre of informed complexity analysis, research, and debate, as well as a generator of ideas and strategies for the practical application of findings derived from complexity research. It will quickly become a magnet for recruiting additional outstanding faculty and students in this field from Canada and abroad.

Enhance interdisciplinary research at the university: The University of Waterloo already has many faculty members working directly or indirectly on topics of complexity and innovation, and this expertise will help make WICI a successful initiative from day one. Unfortunately, though, this expertise is often compartmentalized: the individual researchers and groups communicate little with each other, especially across faculty boundaries. As a result, the university has not

*realized even a small fraction of its full potential in the field of complexity and innovation studies.

The institute will address this challenge directly. Its membership will be drawn from all Faculties: Applied Health Sciences, Arts, Environment, Engineering, Mathematics, and Science. It will aid collaborative interdisciplinary research among Waterloo faculty, across Faculty boundaries, and between Waterloo faculty and off-campus researchers. By helping to integrate the university's research communities, the institute will magnify the university's already recognized strengths in several areas, including social innovation generation, systems design engineering, water technology and policy, and the modeling of social, ecological, climate, and cognitive systems.

Provide new graduate and post-doctoral training: Through support of research and employment, the institute will provide graduate student and post-doctoral training opportunities beyond conventional disciplinary boundaries. Graduate students and post-doctoral fellows will work under the supervision of core or affiliated WICI faculty members to study specific questions that link complexity and innovation, such as:

- Are the processes of innovation in complex biological and human systems fundamentally similar or different?

- What are the similarities and differences in theories of innovation across biology, ecology, economics, neuroscience, cognitive psychology, sociology, organizational theory, and the arts?

- What kinds of social and/or technical innovations are required to restore, redesign, or maintain the major ecological systems that constitute humanity's fundamental life-support system?

- What is the optimal relationship between disorder and order in social systems to promote rapid innovation?

- How do individuals and communities innovate within their complex meaning systems to change their perceived self-identities, and how does this innovation promote cooperation or conflict between groups?

- How do different paths of evolutionary innovation affect the infectiousness, incubation period, and lethality of pathogens in human populations?

- What is the relationship between innovation in complex humans systems such as modern economies and the opaqueness of these systems to oversight and direction?

- How do new information technologies facilitate or impede innovation in different social networks like human-rights and terrorist networks?

- What normative perspectives should guide applications of new knowledge about complexity and innovation to human problems?

Develop practical knowledge to solve critical problems: A core aim of the institute – and an aim that sharply differentiates it from similar enterprises elsewhere – is to make complexity research and its findings *usable* by policymakers, social entrepreneurs, and others in their efforts to create practical and beneficial change.

Inform and educate the public and the next generation of decision makers: The institute will develop an outreach program that brings knowledge about complexity and innovation research to the broader public and to key communities of experts, policymakers, and high-school students.

Strategically position the university to take advantage of interdisciplinary research funding opportunities: The institute's initial research program is outlined in section 6. Complexity and innovation studies are increasingly fundable. A bias is also emerging among granting agencies towards innovative interdisciplinary research that explicitly focuses on developing solutions to real-world problems. By creating WICI, Waterloo will place itself in a strategic position to take advantage of funding opportunities in wide range of disciplines, from climate science and epidemiology to economics. Also, because its research is integrative, the institute will impart strategic flexibility to the university as research funding agendas change over time. The institute's staff will help its members identify potential sources of funding and encourage and aid preparation of major research grant proposals.

Advance the university's strategic goals: Creation of WICI will substantively advance the university's long-term strategic goals, as laid out in its 2005 Strategic Research Plan (SRP) and its Sixth Decade Plan (see Section 2.7).

2.4 Director and Other Positions to Be Established

Director
The institute will be led by a director, proposed as Professor Thomas Homer-Dixon, who will be responsible for the overall management of the institute, preparation of its annual budget, supervision of staff members, and (with input from the institute's membership) guiding the research and outreach agendas.

Associate Director
The director will be assisted by an associate director, proposed as Assistant Professor Dawn Parker, who will be responsible for the detailed direction and support of the institute's research activities, including research-related workshops, seminars, and public talks.

Shortly after the creation of the institute, the director will seek funding to create the following additional permanent positions:

Administrative Assistant
Funding has already been obtained to support the term appointment of a post-doctoral fellow, Dr. Steven Mock, who has acted as the institute's administrative assistant in 2009-10. Once further funding is in place, a permanent administrative assistant will be hired to manage the institute's operations, provide organizational and logistical support, and serve as the initial point of contact between the institute and internal and external individuals and organizations.

Computational Training and Modeling Support Staff
The institute's research will often involve computer-based modeling of multi-agent systems. It will therefore need an IT Specialist to: 1. provide technical support to members who want to develop and run complex models and simulations, and 2. create links with relevant technical experts elsewhere on campus (for instance, in computer science and systems engineering). The institute will also need a network of computers and in some cases (in coordination with the university's IT support staff) access to outside high-performance computational resources such as those of SharcNet.

As the research and outreach agenda of WICI evolves, other professional and support staff positions will be created, including a Program Development Officer and a Policy and Education Outreach Coordinator.

2.5 Scope of Activities Envisaged

The Waterloo Institute for Complexity and Innovation will undertake and facilitate basic research on complex systems and innovation. It will develop tools for the application of knowledge gained through this research to address real-world problems. This practical focus distinguishes WICI from other complex systems research groups.

In support of this research, and depending on needs and circumstances, WICI's activities will include workshops and conferences and its output will include journals articles, occasional papers, monographs, and books.

One possible model of activity is the *Complex Adaptive Systems (CAS) Workshop*. Each such workshop would be structured around a weeklong visit by a *Distinguished CAS Visitor* who would provide a public keynote lecture; a day-and-a-half CAS training session for around twenty selected university graduate and undergraduate students and post-doctoral fellow; and meetings and discussion groups with university faculty. Students taking part in the CAS training sessions would also engage in small research projects connected to the research of a faculty member interested in exploring CAS research methods and modelling tools. The products from these projects would be presented in short papers and in posters at later WICI workshops and conferences. (See Appendix B for further details.)

Complex systems research is inherently transdisciplinary, and WICI will provide a means to bring the right mix of thinkers together to advance complexity research. This mix will include people from many specialties and even from outside academe. Indeed key to WICI's success will be direct and ongoing engagement with various communities *outside* the university. Policymakers and other practitioners will direct questions and hypotheses directly to WICI researchers and, in turn, examine WICI research results for real-world verisimilitude and relevance.

Because WICI aims to make complexity theory relevant to the real world, the Institute will undertake an active program of outreach to the public, private sector, and government. Outreach activities will include public lectures, public sessions at conferences, practitioner training in useful tools of complexity science, publication of articles and op-eds aimed at non-specialists, and development and ongoing support of Web-based sources of data, research, and debate on complexity science and innovation.

2.6 Opportunities

2.6.1 Harnessing University Strengths and Resources

The University of Waterloo already provides an intellectual and research environment uniquely suited to this kind of project. The environment's key elements include:

- World-class research, teaching, and faculty in mathematics, computer science, and engineering that WICI can tap to build the university's expertise in complexity research methods and modelling tools;
- Emerging research communities in social innovation, the energy/climate/security nexus, and global environmental governance that can provide both the initial catalysts for discussions of complex global problems and become key first-users of WICI-developed complexity methods and tools;
- The new Balsillie School of International Affairs that provides additional research expertise, an engaged student community, and an international forum encouraging research and discussions centred on complex global problems;
- Partner institutions in the Perimeter Institute for Theoretical Physics and the Centre for International Governance Innovation that will attract experts in complex adaptive systems methods and a wide spectrum of global complex problems; and,
- A proud tradition of multidisciplinary, problem-oriented, and outward-looking research and student training.

2.6.2 Building Research Capacity in Complexity Science

Excellent basic resources are already in place at the University of Waterloo to give WICI a fast start; the needed kernel of expertise is present on campus. The institute's long-term success, however, depends upon bringing this expertise together and augmenting it in order to achieve and maintain a critical mass. The institute requires a large and integrated pool of researchers explicitly dedicated to complexity studies and with deep knowledge of state-of-the-art complex systems concepts, methods, and tools. A mid-range goal for WICI, therefore, should be to recruit several additional complexity experts to the university to expand the existing community.

In the near-term, however, WICI can build the university's expertise and capabilities in complexity science through well-designed workshops that draw upon outside expertise (see Appendix B for a detailed proposal).

2.6.3 Fostering On-Campus Interactions

The institute will interact closely with other centres and institutes in the university community already pursuing research related to complexity and innovation and/or developing policy solutions to pressing global problems, including Social Innovation Generation (SIG), the Centre for International Governance Innovation (CIGI), the Balsillie School for International Affairs, the Interdisciplinary Centre on Climate Change (IC3), and the Perimeter Institute for Theoretical Physics (PI). At the moment, these entities are engaged in discrete research programs. The institute would draw out the complementarities of these programs in ways that encourage collaboration between them.

Beyond those centres and institutes cited above, the institute will also encourage interactions with:

- Canadian Water Network (CWN)
- Water Institute
- Centre for Theoretical Neuroscience
- Conflict Analysis Group within the Department of Systems Design Engineering
- Institute for Risk Research (IRR)
- Waterloo Institute for Sustainable Energy (WISE);
- Mathematics of Information Technology and Complex Systems Group;
- Institute for Knowledge Innovation and Technology;
- Centre for Knowledge Integration (Faculty of Environment);
- Centre for Ecosystem Resilience and Adaptation (Faculty of Environment)
- School of Environment, Enterprise and Development (Faculty of Environment)
- Huntsville Summit Centre for Environmental and Ecological Sustainability; and,
- Centre for Business Entrepreneurship and Technology (CBET).

2.6.4 Developing National and International Linkages

The institute plans to establish additional links with relevant institutes, centres, and researchers both nationally and internationally, including:

In Canada:

- **The Innovation Systems Research Network** (ISRN), a network centered at the MaRs Discovery District in Toronto;
- **Institute For Research on Public Policy** (IRPP) at the University of Montreal;
- **The International Institute for Sustainable Development** (IISD) in Winnipeg; and,
- **Institute for Biocomplexity and Informatics (**IBI**)** at the University of Calgary.

In the United States:

- Santa Fe Institute
- New England Complex Systems Institute (NECSI)
- Center for the Study of Complex Systems - University of Michigan
- Institute on the Environment - University of Minnesota
- Nelson Institute for Environmental Studies, University of Wisconsin
- Center for Complexity in Business, University of Maryland
- Center for Complex Network Research (CCNR) - University of Notre Dame
- Center for Social Complexity – George Mason University
- Complex Adaptive Systems Initiative – Arizona State University
- Center for Complex Systems Research (CCSR) - University of Illinois
- Center for Complex Systems and Brain Sciences- Florida Atlantic University
- The Center for Interdisciplinary Research on Complex Systems- Northeastern University
- The Center for Complex Quantum Systemsformerly The Ilya Prigogine Center for Studies in Statistical Mechanics and Complex Systems - The University of Texas at Austin
- Center for Complex System Studies- Kalamazoo College
- Complex Systems Research Center- University of New Hampshire
- Duke Center for Nonlinear and Complex Systems- Duke University
- The Volen Center for Complex Systems- Brandeis University

- Center for Human Complex SystemsCenter for Human Complex Systems – UCLA
- Colorado Center for Chaos and Complexity- University of Colorado
- Complex Adaptive Systems Group- Iowa State University
- Institute for the Study of Complex Systems (ISCS)
- Center for Computational Analysis of Social and Organizational Systems (CASOS)- Carnegie Mellon University
- T-13 Complex Systems Group- Los Alamos National Laboratory
- Washington Center for Complexity and Public Policy
- Northwestern Institute on Complex Systems

In Europe and the Asia-Pacific:

- Centre for Advanced Spatial Analysis, University College, London
- Club of Rome (Zurich, Switzerland)
- Chatham House (London, UK)
- Stockholm Resilience Centre
- James Martin 21st Century School (Oxford University)
- Young Foundation (UK)
- National Endowment for Science Technology and the Arts (UK)
- Institute for Applied Ecology Berlin and Freiburg, Germany
- International Institute for Applied Systems Analysis (IIASA)
- Dynamics of Institutions and Markets in Europe (DIME) an EU-funded social sciences Network of Excellence, which includes DRUID
- The Centre for Complexity and Change - The Open University, UK
- Complexity and Management Centre- University of Hertfordshire
- Center for Complex Systems and Visualization- University of Bremen
- Interdisciplinary Center for Dynamics of Complex SystemsCenter for Dynamics of Complex Systems - University of Potsdam, Germany
- Programme Européen MCX - Modélisation de la CompleXité- Aix en Provence, France
- The Complex Systems Lab- Universitat Pompeu Fabra, Spain
- Bandung Fe Institute- Bandung, Jawa Barat, Indonesia
- Center for Complexity Science– Romania
- ARC Centre for Complex Systems (ACCS)– Australia
- ARC Centre of Excellence for Mathematics and Statistics of Complex Systems (MASCOS)– Australia
- ARC Complex Open Systems Research Network (COSNet)– Australia

- Complex Systems Society- Europe
- Evolution. Complexity and Cognition Group (ECCO)– Belgium
- IFISC (Institute for Cross Disciplinary Physics and Complex Systems, CSIC-UIB)– Spain
- Institut des Systemes Complexes Paris Ile-de-France (ISC-PIF)
- Institute for Biocomputation and Physics of Complex Systems (BIFI), University of Zaragoza - Spain

2.7 Advancing UW's Strategic Plans

The institute will help the university achieve the goals laid out in the university's Strategic Research Plan (SRP). The Plan's broad objectives include facilitating synergies between basic research and its applications, stimulating "high impact inter-disciplinary research on societal problems," and increasing knowledge exchange – all core components of the WICI enterprise. The institute's research also spans three of the five research thrust areas identified in the Plan, namely: Environment & Energy, Information Technology and Innovation, and Society and Culture.

The institute will likewise help the university achieve the goals in its Sixth Decade Plan, which promotes interdisciplinary research and teaching and endorses the creation of new research institutes and centres to this end.

3. CONSTITUTION

3.1 Objectives

The Waterloo Institute for Complexity and Innovation will facilitate and undertake rigorous, transdisciplinary, collaborative research that promotes innovation and resilience within the complex adaptive systems at the core of human well being in the 21st century.

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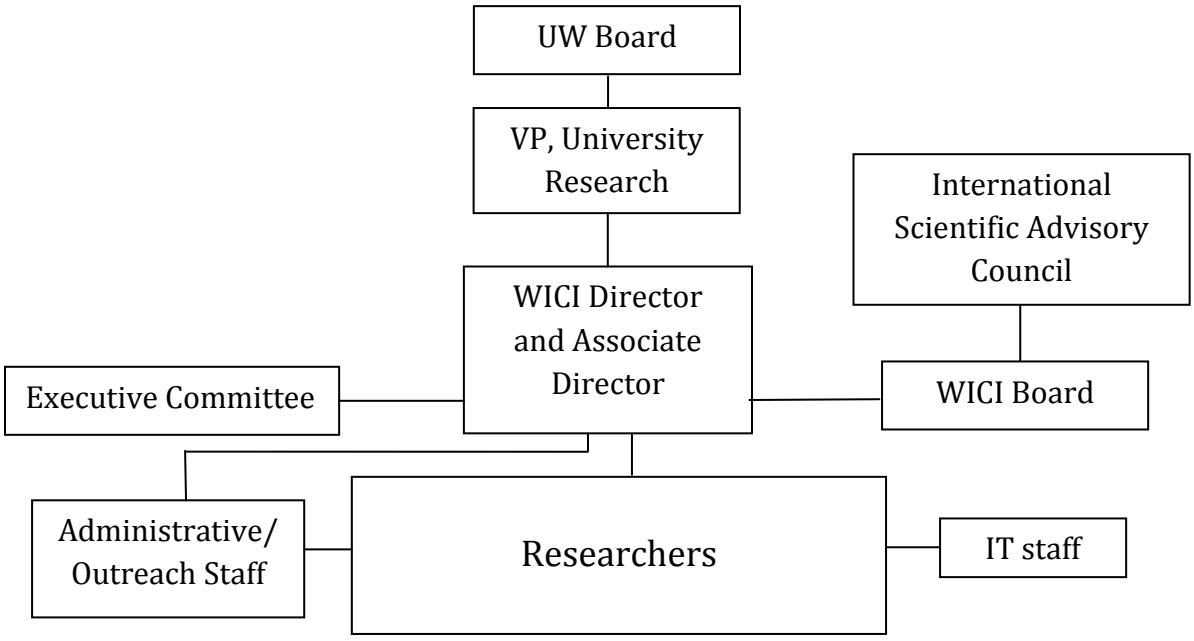
3.2 Administrative Structure and Officers

Figure 1: WICI organizational chart



3.2.1 Director

The institute will be led by a director, reporting to the Vice-President, University Research. The director will be appointed by the Vice-President Academic and Provost on the recommendation of the Vice-President, University Research for a term of up to three years, normally renewable once. The director will be responsible for the overall management of the institute, preparation of its annual budget, supervision of WICI staff members, and (with input from the institute's membership) guiding the research and outreach agendas. It is proposed that the institute's first director be Professor Thomas Homer-Dixon.

3.2.2 Associate Director

The director will be assisted led by an associate director. The associate director will be appointed by the Vice-President Academic and Provost on the recommendation of the Vice-President, University Research for a term of up to three years, normally renewable once. The associate director will be responsible for the detailed direction

and support of the institute's research activities, including research-related workshops, seminars, and public talks. It is proposed that WICI's first associate director be Assistant Professor Dawn Parker.

3.2.3 Executive Committee

The executive committee will provide advice to the director, associate director, and the Vice-President, University Research on matters relating to the regular operations of WICI, including its annual budget. The committee will meet three or four times per year. Members will consist of:

- Vice President, University Research or delegate.
- WICI Director
- WICI Associate Director
- Three Core Members
- Three additional members drawn from the university faculty, representing participating Faculties

3.2.4 International Scientific Advisory Council

The international scientific advisory council will provide advice to the board on the institute's research priorities; it will also help WICI establish connections and maintain its profile within the international complexity studies and innovation studies communities. It will consist of outstanding complexity and innovation researchers from the university, Canada, and abroad who are Core or Affiliate Researchers of WICI.

3.2.5 Board

The board will provide advice on the general and financial management of the institute and advice and guidance regarding the institute's operation, research directions, etc. The Board Chair will be selected in a manner acceptable to the board membership and will serve for a period of up to three years, normally renewable once.

Among its tasks, the board committee will review new membership applications and the annual budget, discuss new initiatives (e.g. grant proposals and partnerships) and infrastructure needs, and identify new areas for future growth. It is anticipated that the board will meet twice per year or as often as necessary. Members on the board will consist of:

- Vice-President Academic and Provost
- Vice-President, University Research
- WICI director
- Three Core Members or members representing participating faculties

- Three external members who are leaders in the fields of complexity science and innovation and members of the international scientific advisory council

3.3 Categories of Membership

Categories of membership recognize different levels and types of participation and commitment. The initial membership categories are: core, affiliate researcher, practitioner, student, and honorary.

3.3.1 Core Members

Core members are regular, research, or adjunct university faculty who lead a long-horizon research program under the auspices of the institute. Additions to the core membership will be determined by simple majority vote of the members of the board based on a candidate's submission of a letter of application and a CV. Membership lasts for the duration of the member's active research within WICI.

3.3.2 Affiliate Researchers

Affiliate researchers are regular, research, or adjunct university faculty or non-university researchers, including post-doctoral fellows, who actively participate in institute activities, including its research projects or committees. An affiliate researcher can at any time apply for core membership status if she/he meets the criteria of that category. Affiliate researcher status or changes from affiliate researcher to core membership status will be decided by simple majority vote of the board based on a candidate's submission of a letter of application and a CV. Membership lasts for three years and is renewable.

3.3.3 Practitioner Members

Practitioner members include people in government, the voluntary sector, and private sector interested in WICI's research and findings, who actively participate in WICI meetings, workshops, and conferences open to a general audience. Practitioner membership will be decided by simple majority vote of the board based on a candidate's submission of a letter of application and a resumé. Membership lasts for three years and is renewable.

3.3.4 Student Members

Student members are students from the university or affiliated institutions working towards a Master's or Ph.D. degree on a topic of relevance to complexity science and innovation relevant to the institute's work. Student membership will be decided by the director. Membership lasts for three years and is renewable.

3.3.5 Honorary Members

Once a year, a person may be nominated as an honorary member of WICI. Honorary membership will be reserved for scholars who have achieved exceptional international standing in complexity science and innovation. This person will be nominated by a core member of the institute and the nomination will be co-signed by a second institute core member or affiliate researcher. The board will review the letter of nomination along with a current copy of the nominee's CV and make its recommendation to the director. Membership lasts for three years and is renewable.

3.4 Responsibilities of Membership

All members are expected to participate in WICI's research, discussions, or activities, whether by contributing directly to one of its research projects, writing for its publications, attending its conferences and workshops, helping with policy and educational outreach, or sitting on one of WICI's committees. By majority vote, the board may take an extended period of non-participation as grounds for suspension or termination of membership. By majority vote, the board may also suspend or terminate a member for activities it regards as impeding or harming WICI's pursuit of its stated goals.

3.5 Changes to the Constitution

Any core member or affiliate researcher may table at any time proposed changes to the constitution. Changes will require the supportive vote of 75 percent of the institute's core members and affiliate researchers and a simple majority of the board members.

General decisions of the executive committee and/or the board will be by majority vote (50 percent + 1). A quorum will consist of 50 percent of the committee's members (either present or by proxy).

4. MANAGEMENT

4.1 Financial Responsibility

The director will have primary responsibility for the budgeting and funding of the institute, with day-to-day budget management overseen by an administrative

assistant. Final financial responsibility will rest with the Vice-President, University Research.

4.2 Reporting Mechanism

The director of the Waterloo Institute for Complexity and Innovation will report to the Vice-President, University Research. The director will provide an annual report on the institute's activities to the Vice-President Academic and Provost; the Vice-President, University Research; to the deans of the participating faculties; and to the heads of affiliated institutions. This report will include a description of:

1. Research projects (project title, faculty members and departments/schools involved, project funding, and a summary of progress and further work);
2. other scholarly activities (publications, presentations, seminars, and other activities);
3. administrative activities (promotional activities, major meetings and presentations, infrastructural budget and spending);
4. outreach activities; and,
5. overall progress towards WICI's goals.

5. PROPOSED INITIAL MEMBERS

At its inception, the institute will have 22 members. Short biographies are provided below. After the creation of the institute, new applications for membership will be accepted at any time.

Core Members:

Thomas Homer-Dixon (Director Designate) is the CIGI Chair in Global Systems at the Balsillie School of International Affairs in Waterloo, Canada, and Professor in Faculties of Environment and Arts at the University of Waterloo. He received his B.A. in political science from Carleton University in 1980 and his Ph.D. from MIT in international relations and defense and arms control policy in 1989. He then moved to the University of Toronto to lead several international research projects studying the links between environmental stress and violence in developing countries. He directed the Trudeau Centre for Peace and Conflict Studies and in 1999 received the Northrop Frye Award for Teaching and Research. He moved to the University of Waterloo in 2008. His research focuses on threats to global security in the 21st century and on how societies adapt to complex economic, ecological, and technological change. His writings have appeared in leading scholarly journals, popular magazines, and newspapers, including *International Studies Quarterly*, *International Security*, *Foreign Policy*, *Foreign Affairs*, *Scientific American*, *The New York Times*, *The Washington Post*, and *The Financial Times*. His books include *The Upside of Down: Catastrophe, Creativity, and the Renewal of Civilization* (Knopf, Island Press, 2006; Souvenir, Text, 2007), which won the 2006 National Business Book Award and was listed as a Best Book in Politics & Religion by *The Financial Times*; *The Ingenuity Gap* (Knopf, Jonathan Cape, 2000), which won the 2001 Governor General's Non-fiction Award; and *Environment, Scarcity, and Violence* (Princeton University Press, 1999), which won the 2000 Caldwell Prize of the American Political Science Association.

Jason J Blackstock is a Research Scholar at the International Institute for Applied Systems Analysis (IIASA) in Austria, and a Fellow of the Center for International Governance Innovation (CIGI) in Canada. Jason's research focuses on the interface of science and international affairs, where he has expertise in the areas of energy, nuclear proliferation, climate (particularly geoengineering) and nanotechnology. Currently, he leads several international collaborative research projects aimed at evaluating the scientific (climatic) and international political and governance implications of geoengineering concepts. Jason has received his PhD in Physics from the University of Alberta, his Graduate Certificate in International Security from

Stanford, and his Master of Public Administration from Harvard University. In 2009, he also guest lectured at Harvard's Kennedy School in a core course entitled "Managing a Living Planet," which he co-developed with Prof William C. Clark. Jason holds his Professional Physicist (PPhys) designation from the Canadian Association of Physicists, and from 2003-2007 he worked as a research associate with the Quantum Science Research group of Hewlett Packard Laboratories in Silicon Valley, developing nanoscale electronic and sensor technologies.

Keith Hipel is University Professor of Systems Design Engineering and Coordinator of the Conflict Analysis Group at the University of Waterloo. He is Senior Fellow at the Centre for International Governance Innovation and former Vice President of the Canadian Academy of Sciences. Keith enjoys teaching and is a recipient of the Distinguished Teacher Awardand the Award of Excellence in Graduate Supervision from the University of Waterloo. His major research interests are the development and application of conflict resolution, multiple objective decision-making and time series analysis techniques from a systems design engineering perspective. The main application areas of these decision technologies are water resources management, hydrology, environmental engineering and sustainable development. Keith is the author or co-author of four books, nine edited books, more than 200 journal papers, as well as many conference and encyclopaedia articles. He is Fellow of the Royal Society of Canada (FRSC), Canadian Academy of Engineering (FCAE), Institute of Electrical and Electronics Engineers (FIEEE), Engineering Institute of Canada (FEIC), International Council on Systems Engineering (FINCOSE), and the American Water Resources Association (FAWRA). Keith is also a recipient of the Norbert Wiener Award from the IEEE Systems, Man and Cybernetics (SMC) Society, Outstanding Contribution Award from the IEEE SMC Society, Most Active SMC Technical Committee Award, Docteur Honoris Causa from Ecole Centrale de Lille, W.R. Boggess Award from AWRA, and the University of Waterloo Award for Excellence in Research. He has held a Canada Council Killam Research Fellowship, Monbusho Kyoto University Visiting Professor Position, Stanley Vineberg Memorial Visiting Professorship, Centre National de la Recherche Scientifique (CNRS) Research Fellowship, and Japan Society for Promotion of Science (JSPS) Fellowship. Moreover, he is a Professional Engineer (PEng) and an Associate Editor of many international journals including the IEEE Transactions on Systems, Man and Cybernetics, Part A, Systems and Humans;Group Decision and Negotiation; and Systems Engineering.

Dawn Parker is an Assistant Professor in the School of Planning, Faculty of Environment, University of Waterloo and Associate Director (designate) of WICI. Her research focuses on the development of fine-scale models that link the drivers of land-use change and their socioeconomic and ecological impacts, with completed

and ongoing projects on organic agriculture in California's Central Valley, timber harvest and carbon sequestration in eastern deciduous forests in West Virginia, USA, and the effects of HIV/AIDS on smallholder agricultural households in Uganda. Her areas of technical expertise include agent-based modeling, environmental and resource economics, and geographic information systems. Previously to joining UW, she was a founding member of the Center for Social Complexity and Department of Computational Social Science at George Mason University, USA, where she served as director for the PhD program in computational social science. She serves on the steering committee of the Global Land Project and on the editorial boards of the Journal of Land Use Science and Computers, Environment, and Urban Systems.

Lee Smolin is a founding member and research physicist at the Perimeter Institute For Theoretical Physics. Professor Smolin received his Ph.D. in theoretical physics in 1979 from Harvard University, and held post-doctoral positions at the Institute for Advanced Study in Princeton, The Institute for Theoretical Physics (now Kavli Institute for Theoretical Physics) in Santa Barbara and the Enrico Fermi Institute at the University of Chicago. He has held faculty positions at Yale, Syracuse and Penn State Universities, where he helped to found the Center for Gravitational Physics and Geometry. He also held visiting positions at Cambridge and Oxford Universities and at SISSA and the Universities of Rome and Trento in Italy. He was a Visiting Professor at Imperial College London from 1999 to 2001. Dr. Smolin has made major contributions to the field of quantum gravity, which seeks to unify Einstein's general theory of relativity with quantum theory. With Abhay Ashtekar and Carlo Rovelli, he was a founder of the approach known as loop quantum gravity, but he has contributed to other approaches including string theory and causal dynamical triangulations. He is also known for proposing the notion of the landscape of theories, based on his application of Darwinian methods to Cosmology. He has contributed also to the foundations of quantum mechanics, elementary particle phyiscs and theoretical biology. He also has a strong interest in philosophy and his three books, *Life of the Cosmos*, *Three Roads to Quantum Gravity* and *The Trouble with Physics* are in part philosophical explorations of issues raised by contemporary physics.

Paul Thagard is Professor of Philosophy, with cross appointment to Psychology and Computer Science, Director of the Cognitive Science Program, and University Research Chair at the University of Waterloo. He is a graduate of the Universities of Saskatchewan, Cambridge, Toronto (Ph. D. in philosophy) and Michigan (M.S. in computer science). He is the author of *Hot Thought: Mechanisms and Applications of Emotional Cognition*(MIT Press, 2006)*, Coherence in Thought and Action* (MIT Press, 2000), *How Scientists Explain Disease* (Princeton University Press, 1999),*Mind:*

Introduction to Cognitive Science(MIT Press, 1996; second edition, 2005), *Conceptual Revolutions*(Princeton University Press, 1992), and*Computational Philosophy of Science*(MIT Press, 1988); and co-author of *Mental Leaps: Analogy in Creative Thought* (MIT Press, 1995) and *Induction: Processes of Inference, Learning, and Discovery*(MIT Press, 1986). He is also editor of *Philosophy of Psychology and Cognitive Science* (Elsevier, 2007). A new book, *Brains and the Meaning of Life,* will be published by Princeton University Press. He is a fellow of the Royal Society of Canada and the Cognitive Science Society, and in 2007 received a Canada Council for the Arts Molson Prize.

Frances Westley is JW McConnell Chair in Social Innovation at University of Waterloo, where she heads up Social Innovation Generation (SiG), a national initiative designed to build capacity for social innovation in Canada. Before joining University of Waterloo in 2007 she was Director of the Gaylord Nelson Institute for Environmental Studies at University of Wisconsin, Madison. She also held the position of the James McGill Professor in Strategic Management at McGill University's Desautel Management School, where designed and directed an MA program in National Voluntary Sector Leadership and the McGill Dupont Program for Social Innovation. Her research, writing, and teaching focuses on social innovation in complex problem domains, with particular emphasis on leadership and managing strategic change. She has published widely in the areas of social innovation, building resilience of linked social-ecological systems, new forms of knowledge generation, managing uncertainty and change in high risk situations, multi-stakeholder collaborations and visionary leadership. In 2004 she published *Experiments in Consilience (Island Press)*, which focused on the dynamics of inter-organizational and interdisciplinary collaboration in the management of ecological and conservation challenges. Her most recent book entitled *Getting to Maybe (Random House, 2006)* focuses on the inter-relationship of individual and system dynamics in social innovation and transformation. She serves on numerous editorial and organizational boards including: *Ecology and Society, Journal of Applied Behavioral Science, Stockholm Resilience Center, CBSG/IUCN, Evergreen, National Advisory Board NSF-LTER.* She has worked extensively internationally, designing and facilitating workshops for science based conservation and in management innovation. Dr. Westley received her PhD and MA in Sociology from McGill University and her BA in English Literature and Fine Arts from Middlebury College, Vermont.

Affiliate Researchers:

Claude Duguay is a Professor in the Department of Geography at the University of Waterloo. He received his Ph.D. in Geography from the University of Waterloo. Prior to returning to Waterloo in fall 2006, he held faculty positions with the University of Ottawa (1989-1996), Université Laval (1996-2002), and the University of Alaska at Fairbanks (2002-2006). He has published extensively in the areas of cryospheric science, hydro-climatology, remote sensing, and numerical modeling. His current research interests include: (1) the development of remote sensing methods for extracting freshwater ice and snow parameters, and for mapping frozen ground; (2) the development and application of a numerical model for simulating lake ice conditions for lakes of various sizes under contemporary and projected climate conditions; and (3) the development and analysis of historical databases for investigating the impact of climate variability and change on freshwater ice conditions in the Northern Hemisphere. Dr. Duguay is the current vice-president of the International Commission on Remote Sensing, International Association of Hydrological Sciences, and head of the Marine and Freshwater Ice Division, International Association of Cryospheric Sciences. He is also an active member of the Mission Assessment Group for the Cold Regions Hydrology High-resolution Observatory (CoReH2O) - an Earth Explorer candidate satellite mission of the European Space Agency. Dr. Duguay is a Fulbright Senior Fellow and an Associate Fellow of the Canadian Aeronautics and Space Institute.

George Francis is a Distinguished Professor Emeritus in the Department of Environment and Resource Studies at the University of Waterloo where he was originally appointed as its first Chairperson in 1970. His original academic degrees were an Honours BA in Biology, University of Toronto, a MA in Zoology (Ecology), University of British Columbia, a General BA in Political Economy, McGill University, and a PhD in Resource Conservation and Management, University of Michigan. His university-based career has been largely organized around a mix of collaborative research projects combined with experiential learning through work undertaken with international agencies (UN, OECD, CIDA), Canadian federal, provincial, and local governments, and with non-governmental organizations. Throughout these years George became increasingly interested in various approaches being taken to understanding complex adaptive systems. Activities included preparation of case study materials for comparisons between the environmental history of the Baltic Sea and Laurentian Great Lakes as part of an International Symposium on Ecosystem Redevelopment (Budapest 1987) sponsored in part by IIASA from initiatives by Buzz Holling when he was Director of IIASA, and contributions to Holling's "Barriers and Bridges to Renewal of Ecosystems and Institutions" project

at the University of Florida (1992-1995). At UW, George also worked closely with the late James Kay (ERS and Systems Design Engineering) and colleagues on applying an "ecosystem approach" that was explicitly grounded in thermodynamics (exergy, materials, and "information" flows). George's writings since the late 1980s have increasingly been in the context of complex social-ecological systems. Currently, he is participating in two SSHRC projects at UW on the theme of assessing governance issues for biosphere reserves and model forests in Canada, in part by applying perspectives from sustainability assessments, resilience analyses, social & environmental justice, and social innovations.

Ed Jernigan, PhD, PEng, is Professor and Director of the Centre for Knowledge Integration at the University of Waterloo. He is also a Professor and former chair of Systems Design Engineering. He joined Waterloo in 1976 after completing his BS, MS and PhD degrees at MIT in Electrical and Computer Engineering. His research is concerned with perception in the broadest sense, in particular vision and image processing, pattern recognition, non-linear and adaptive systems, and knowledge integration and design. He is a dedicated teacher and has been recognized with both the Distinguished Teacher Award of the University of Waterloo and the Teaching Excellence Award for the Faculty of Engineering. Since 1984 he has served as the Program Director for the Shad Valley summer enrichment program, living in residence with 48 high school students during the month of July. In 2004 he created a university wide enrichment program for high school students of exceptional potential, Waterloo Unlimited, which he continues to direct. In September 2008, he launched a new undergraduate degree program, the Bachelor of Knowledge Integration.

Matthew Hoffman is an Associate Professor of Political Science at the University of Toronto. He has a Bachelor of Science in Environmental Engineering from Michigan Technological University and a Ph.D. in International Relations from the George Washington University. His research and teaching interests include global governance, climate change politics, complexity theory, and agent-based modeling. He is the author of *Ozone Depletion and Climate Change: Constructing a Global Response* (SUNY Press 2005) and coeditor with Alice Ba of *Contending Perspectives on Global Governance* (Routledge 2005). His current research projects include a study of climate governance experiments through the lens of self-organized criticality, and a SSHRC funded project (with Mat Paterson, Steven Bernstein, and Michele Betsill) on the emergence and development of carbon markets.

Tim Lenton is Professor of Earth System Science at the University of East Anglia. He has a BA (first class) in Natural Sciences from the University of Cambridge (1994)

and a PhD in Environmental Sciences from the University of East Anglia (1998). His PhD, supervised by Andrew Watson, was on what regulates the nutrient balance of the ocean and the oxygen content of the atmosphere. He has collaborated extensively with James Lovelock in the development of Gaia theory and Daisyworld models. He worked for 6 years as an Earth system modeller at the Centre for Ecology and Hydrology in Edinburgh before returning in 2004 to the University of East Anglia. He has led the development of the GENIE Earth system model and produced some of the first projections of climate and carbon cycle change on the millennial timescale. His research on the potential tipping points in the Earth's climate system won the Times Higher Education Award for Research Project of the Year 2008. He has also been awarded a Philip Leverhulme Prize in 2004, a European Geosciences Union Outstanding Young Scientist Award 2006, the BA Charles Lyell Award Lecture 2006, and the Geological Society William Smith Fund 2008. He is currently writing a book on the 'Revolutions that made the Earth'.

Dan McCarthy is an Assistant Professor with Social Innovation Generation and the Department of Environment and Resource Studies at the University of Waterloo, Waterloo, Ontario. His research focuses on the exploration and application of insights from complex and critical systems thinking, resilience and social innovation to issues of environmental policy and planning in linked social-ecological systems. Dan works collaboratively exploring social change with stakeholders and reflective practitioners in two social-ecological systems: the Oak Ridges Moraine, Ontario; and, with First Nations Communities on the West Coast of James Bay.

Steven Mock completed his Ph.D. in Government at the London School of Economics and Political Science in 2009, specializing in the study of ethnicity and nationalism. He is a former chair of the Association for the Study of Ethnicity and Nationalism (ASEN) and served as assistant editor of the journal, Nations and Nationalism, before returning to Canada to teach Political Science at the University of Waterloo. His current research interests focus on modelling the myths, symbols and rituals associated with the constructs of national and other forms of political-cultural identity, further to understanding the impact of these constructs on conflict and conflict resolution.

Tara Vinodrai is an Assistant Professor in the Department of Geography and environmental Management and the School of Environment, Enterprise and Development and is an Assistant Director of the Economic Development Program at the University of Waterloo. Her research addresses issues related to local and regional economic development, the political economy of innovation and technological change, creativity and local labour market dynamics. She is currently

working on several projects related to highly skilled workers, mobility, and quality of place; the role of universities in economic development; and the role of local and national institutions in supporting design-led industrial upgrading in response to local economic restructuring and change. Prior to her doctoral studies, she worked as a Research Economist in the Microeconomic Analysis Division at Statistics Canada. She is a member of the Innovation Systems Research Network (ISRN), as well as a research affiliate of the Program on Globalization and Regional Innovation System (PROGRIS), the Cultural Economy Lab, and the Martin Prosperity Institute, all housed at the University of Toronto.

John Whalley is a William G. Davies Chair in International Trade and Professor of Economics at the University of Western Ontario, and a Distinguished Fellow at CIGI. Professor Whalley received his PhD from Yale University (1973). In addition to his roles at CIGI and the University of Western Ontario, Dr. John Whalley is a Fellow of the Economic Society, a Fellow of the Royal Society of Canada, and a Foreign Fellow of the Russian Academy of Sciences. He also served as the co-editor of the journal, The World Economy. He is involved with a number of research institutions around the world. At present, he is a research associate at the National Bureau of Economic Research in Cambridge, MA and a coordinator of the Global Economy Research for CESifo based at the University of Munich, Germany. He is associated with the field of numerical general equilibrium modeling as well as policy commentary in global trade policy and development. His recent work has focused on China's participation in the global trading system, as well as World Trade Organization (WTO) issues, trade and environment and trade in services. His work in these areas builds on his experience as guest professor at Peking University in China, where he spends approximately one month every year. With CIGI, he has also been involved in research on the emergence of the BRICSAM countries. His current research interests include globalization, the WTO, development strategies in the third world, global environmental issues, and psychology and economics. Dr. Whalley's writings in numerous subject areas have been published internationally, and he continues to have a variety of works in progress related to his research initiatives. At the University of Western Ontario he also serves as the co-Director at the Centre for the Study of International Economic Relations.

Student Members:

Nino Antadze is a PhD candidate in Planning at the University of Waterloo. Her research concerns municipal solid waste management, with the focus on Ontario. Prior to moving to Canada, Nino worked at the Organization for Security and Co-

operation in Europe, Mission to Georgia and was also involved in the research projects on waste management systems in Georgia. Nino's academic background is in environmental studies and management. She got her graduate degrees at the Central European University, Hungary and Lund University, Sweden.

Sean Geobey comes to SiG after working in policy, program development and research positions in a variety of organizations including the BC Ministry of Health Services, Sustainable Waterloo, and the Laurier Students' Public Interest Research Group. He continues to provide strategic planning and facilitation workshops, serves on the National Council of Fair Vote Canada, and is developing participatory and experience-based adult education models. Currently his research focuses on how to integrate different perspectives in group decision-making, an approach which has concrete applications in social finance, policy development and resource-allocation within coalitions. He holds a BA in Economics and Political Science from Wilfrid Laurier University, an MA in Economics from Queen's University focused on modeling voluntary sector organizations. Currently Sean is a University of Waterloo PhD student in Management Science specializing in the Economics of Technological Change.

Manjana Milkoreit, J.D., MPP is a PhD candidate in Global Governance at the Balsillie School of International Affairs. She received her law degree from the University of Heidelberg (Germany) and graduated with a Master of Public Policy as McCloy Scholar from the Harvard Kennedy School. Her research at Harvard focused on international relations, security studies (in particular nuclear non-proliferation), energy policy and global governance. Manjana's current research interests concern the nexus between climate change, energy and international security. Her professional experiences include international organizations (UN, European Commission), the public and non-profit sectors (German Embassy in New Delhi, Leuphana University Lüneburg) and the private sector (McKinsey & Company, Freshfields). Manjana has extensive experience in establishing and leading civil society organizations as a founding and board member of the *Student Forum within the Tönissteiner Kreis*, a co-founder and President of the *McCloy Alumni Association* and as executive board member of the *Tönissteiner Kreis*, an association of internationally experienced German professionals supporting the international orientation of leadership development in politics, economics, science and society (http://www.toenissteiner-kreis.de/en/index.php).

Michele-Lee Moore is a PhD candidate in Global Governance at the Balsillie School of International Affairs, a joint program between Wilfrid Laurier University and the University of Waterloo in Canada. Michele-Lee currently holds a McConnell

Graduate Fellowship with SiG@Waterloo. At Social Innovation Generation (SiG), her research has primarily focused on the role of networks in enabling social innovations to cross scales, refining the conceptual and methodological tools used for examining scale, and exploring national public policy efforts aimed at fostering social innovation and improving socio-ecological resilience. Michele-Lee is also a Balsillie Fellow at the Centre for International Governance Innovation. In the past, Michele-Lee acted as a water strategy advisor for the B.C. Ministry of Environment and served on the B.C. Provincial Drought Task Force secretariat.

Darcy Riddell has 15 years experience working in the field of sustainability and social change as a strategist, campaigner, consultant and facilitator. She is currently engaged in a PhD in Ecological and Social Sustainability at the University of Waterloo. Darcy's primary research interest is in understanding the relationship of social innovation to human psychological development, and the dynamics between emergent worldviews and institutional-systemic innovations. She is working to develop, apply and share more comprehensive approaches to social innovation and sustainability. Her recent consulting work focused on cross-sector collaboration, and leadership in complex systems. Darcy spent 7 years with Hollyhock Leadership Institute as program director and an internal consultant, developing leadership trainings and convening strategy sessions with environmental and social sector leaders from across Canada. She has worked with non-profits, foundations, corporate clients, and various levels of government, drawing on integral theory, her capacity-building experience, and almost a decade as a forest activist with Sierra Club and ForestEthics in British Columbia. She is a founding board member of Drishti – Centre for Integral Action (www.drishti.ca), and sits on the board of PLAN Institute (www.planinstitute.ca). She has a BSc. in Geography/Environmental Studies, and an M.A. in Philosophy, Cosmology and Consciousness.

Kirsten Robinson is a master's student in Electrical Engineering and a McConnell Fellow in Social Innovation at the University of Waterloo. She began in philosophy before studying Engineering. She's worked on creating ethanol from waste cellulose for vehicle fuel; and building underwater robots, adjustable high heeled shoes, BlackBerrys and energy models. Her current research, designing distributed mechanisms for responsive architectural membranes, uses evolutionary and agent-based models that mirror those used to understand systems ranging from cells to societies. Kirsten is interested in agency, complexity and social change particularly as they apply to stopping species loss and supporting the development of caring communities.

Ola Tjornbo completed his undergraduate degree in Anglo-Saxon, Norse and Celtic history and literature at Peterhouse Cambridge. He then worked in farming and the wine industry before returning to university in 2006 in Stockholm. At Stockholm he continued to explore the relationship between man and nature in his MSci in Natural Resource Management and Globalization. Working at the Stockholm Resilience centre he came into contact with complexity thinking and became especially interested in how governments at all levels can respond to the challenge of governing complex systems. After his master's he worked as a research assistant for Social Innovation Generation (SiG) at Waterloo University continuing to hone is academic skills particularly in interviewing and using qualitative methods. He also presented a paper on governance typologies at the Resilience Conference in Stockholm 2008. Since September 2008 he has been working on his PhD in Global Governance at the Balsillie School of International Affairs, University of Waterloo and Wilfrid Laurier University. As part of this program he has been involved with the Centre for International Governance Innovation (CIGI) as a Balsillie Fellow and has remained involved with SiG as a McConnell Fellow. In January 2009 he wrote a report on a CIGI workshop scheduled to be published by CIGI this year and he has recently completed a case study for SiG on the Great Bear Rainforest which will be published by SiG in the summer of 2009. His PhD research continues to be focused on complexity governance at the international scale.

6. RESEARCH & EDUCATION

6.1 Research Program

This section lists the broad themes proposed for the institute's initial research program. It is only an initial outline of the program. The institute's researchers will ultimately define its research agenda.

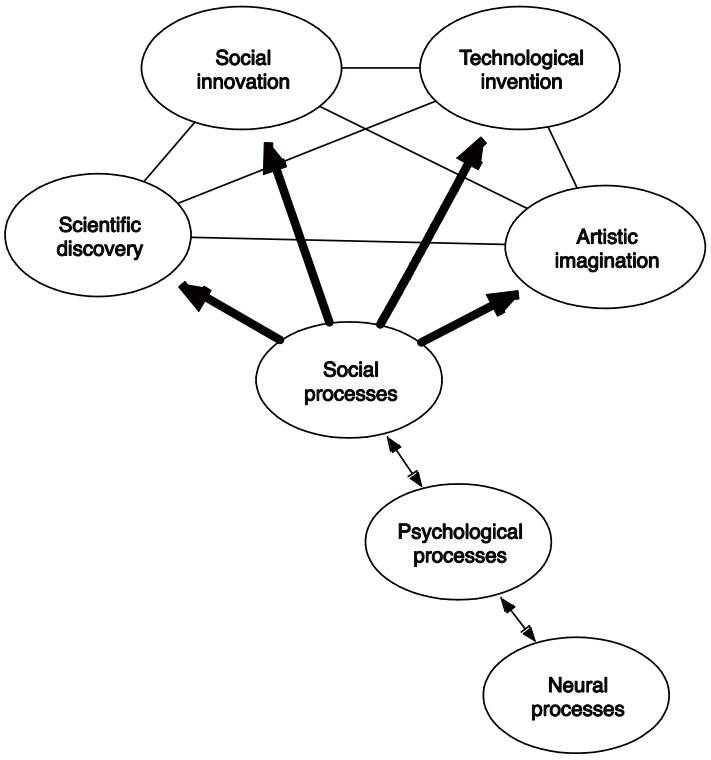
The institute is envisioned as a research hub. Its community of researchers will eventually be large and diverse enough to create many possibilities for productive interactions. A few of these researchers will be hosted and housed within WICI, but most will engage with the institute through its active network of research associations. The program of well-attended biweekly seminars – ongoing since Fall 2008 – has already begun to forge this network.

6.1.1 A Unified Theory of Complexity and Innovation

This research seeks to explain what complex systems can tell us about innovation and what the nature of innovation can tell us about complex systems. Building on an integrated account of the social, psychological, and neural systems that underlie

human flourishing, the aim is to develop a unified theory of innovation that would apply to social innovation, biological innovation, scientific discovery, technological invention, and artistic creativity.

Current complex systems theory cannot explain how the human mind/brain functions as the most innovative system in the known universe. Nor can it adequately explain the relationship between innovation and the temporal and spatial scales of human behaviour, from the individual through the international levels. Patterns of innovation have at times emerged and evolved as a result of human adaptation to a range of challenges. At other times, system rigidities have led to collapse. We need to understand the dynamics of effective innovation and what impedes or enhances its impact. Can we postulate a correlation between forms of innovation and the time and spatial scales of the challenges this innovation addresses? How well do forms of innovation match the temporal and spatial scales of the challenges we face? What are the roles of cross-scale dynamics? When do routines, habits or programs at one scale inhibit the flowering of innovation at another, and when do such interactions support and enhance innovation? Conversely, when does innovation at one scale result in pathologies at another? How can humanity optimize its ability to deal with challenges that emerge on time and spatial scales not be well-matched to human physiology, psychology, cultural conditioning, or political and economic institutions? Particularly, from a complexity perspective, how do we manage dynamics of emergence (a key quality of innovation at any scale) with deliberate efforts to counteract threats to our social or ecological well being?



6.1.2 Creative Conflict Resolution

All of the social problems that concern the WICI – poverty, energy shortages, economic crises, environmental degradation, and climate change – generate conflict among groups of people. Dealing with such problems requires developing new techniques of conflict resolution that go beyond ones that have so far been investigated by particular disciplines. This research will produce an integrated, multilevel system account of conflict resolution drawing on insights in many fields, including neuroscience, philosophy of science, political science, psychology, sociology, and systems engineering.

At the core of this effort is a new methodological tool of "cognitive-affective maps." This tool permits the dynamic graphical modeling of the detailed world views of individuals and groups participating in a conflict, including not only their beliefs about the ways the world "is," but also their emotional responses – both positive and negative – to significant symbols, historical events, places, and other actors, When fully developed and deployed, this mapping tool will allow researchers, mediators, and negotiating parties to trace the deep assumptions underpinning the

world views of actors to a given conflict, to identify zones of potential plasticity in these worldviews, and to suggest ways of achieving common understandings to reduce hostilities.

6.1.3 Open-Architecture Democracy

Government, at all levels, is ill-equipped to cope with some of the key challenges facing societies around the world. From regulating financial markets to combating global terrorism, responding to climate change, and stopping viral pandemics, we face a range of threats that could plunge existing societies into catastrophic disorder. Traditional hierarchical and centralized stove-pipe models of government do not respond quickly and creatively to such systemic stresses or shocks.

Most governance literature to date has overlooked radical alternatives that new technologies might offer. Open-source technologies, in particular, could enable mass collaboration, harness collective intelligence, and dramatically alter the relationship between government and citizens to create new models of participatory democracy. The concept of collective intelligence is at the heart of this perspective – the notion that very large groups of people are capable of collaborating in order to solve very difficult problems. Mass collaborations of this type have become common in the Internet era, leading to the creation of encyclopaedias (Wikipedia), operating systems (Linux), and even motorbikes. Many of these efforts are impressive examples of what can be achieved when large numbers of people work together collectively.

In this model of governance, citizens take on new roles as policy generators, service deliverers, monitors and analysts. But realizing this potential is far from simple. Coordinating mass collaborations is a daunting task, particularly in a context of politically charged issues. A government based on mass collaboration would look very different from existing forms, with their honeycombs of specialized departments that concentrate – but also segregate – resources and expertise. A mass-collaboration government would act as network facilitator, brokering ideas and sorting information while simultaneously and continually feeding these ideas and information back to the public.

This research will examine closely the successes and failures of open-source communities as they generate, share, and sort information to solve problems. It will seek to identify the circumstances in which such institutional designs produce real innovation, or in which they become as rigid and non-responsive as traditional centralized and hierarchical governance mechanisms.

6.1.4 Plan Z: Global Responses to a Climate Emergency

Recent research has emphasized the largely irreversible contribution to climate change of humankind's carbon emissions. For all practical purposes, these emissions commit the climate to future warming that is irreversible in a time frame relevant to humanity. Additionally, a debate continues about the prospect of sharp nonlinearities in the behaviour of the global climate or in the behaviour of ecological and socio-economic systems closely coupled to the global climate.

The fact that carbon emissions produce an irreversible commitment to climate change suggests that mitigation efforts must be much more aggressive than those proposed in most plans currently under consideration. Indeed, some climate scientists now argue that humankind must move as quickly as possible to zero carbon emissions. The rate of reduction towards zero will depend partly on the climate crisis' perceived urgency and partly on the technical, economic, and social feasibility of the proposed ramp-down rate. Sharp nonlinearities in climate and climate-related systems critical to human well-being could produce a "climate emergency" that is widely perceived to require an immediate policy response. Steeper rates of emission reduction will demand more unconventional technologies and institutions and more state intervention in economies to mobilize human and financial capital. Very rapid movement to zero emissions would likely require social and economic mobilization on the scale and of the type seen in a major war.

The Plan Z project will provide a conceptual and theoretical starting point for thinking about a range of last-effort responses to a climate emergency. Drawing on research in complexity studies that investigates how and why systems sometimes experience threshold change – for instance, shifting suddenly from one equilibrium state to another very different state – the project will explore the socio-political, economic, technological, and ethical implications of various policy responses to climate emergency scenarios. The intent is to radically broaden the possibility space for future climate policy. To date, climate change debates have focused mainly on the technical and economic challenges of mitigation and adaptation. In contrast, Plan Z will focus on the largely neglected social, political and ethical implications of different trajectories towards zero carbon emissions and far lower material and energy intensities.

6.1.5 Critical Vulnerabilities in Global Human-Environmental Systems

The ever-tighter coupling of societal and natural systems, along with the vulnerabilities to change and shock this coupling creates for our global society, are now starkly evident. Disruptions in global energy, food and public health systems

and accumulating evidence of accelerating change and possible tipping points in the global climate system point to a systemic failure of international policies and institutions to govern the complex interdependencies of the global human-environment system.

Through a multi-staged approach involving both theoretical and practical case-based research and model development, this research will develop a suite of quantitative tools and qualitative processes for identifying, characterizing and governing the most critical vulnerabilities – those with significant potential to cause societal destabilization at regional to global scales – arising from the global human-environment interface. A series of targeted workshops will: 1. create and apply a framework for identifying these vulnerabilities; 2. create and apply a framework for selecting key early-warning indicators of vulnerabilities; 3. explore historical and propose new local, national and international decision/governance processes for responding to early warnings; and 4. create and apply a framework for assessing the utility of various types of interventions to moderate damage to society.

The project participants will span the academic and policymaking communities to ensure prescriptions have immediate real-world utility.

6.1.6 Tools for Complex Systems Analysis

This research will provide state-of-the-art complex-systems computational modeling support (training, model development, and modeling technique enhancement) along with qualitative process support (training, facilitation and process enhancement) for the institute's research projects.

The research would build a *complex-systems modeling platform* that consists of an integrated suite of computational modeling tools – specifically agent-based modeling, system-dynamics models, network analysis, and genetic algorithms. Although software to support such modeling exists, software tools are generally available in the form of low-level programming libraries developed for specific projects. Lacking is a set of tools easily adapted by users without a highly technical programming background, easily adapted to create new model implementations, and extensible. In partnership with WICI's topic-specific research programs, this tool-oriented research will push the boundaries of current complex-systems modeling techniques, while supporting the application of these techniques to WICI's specific research challenges.

The research project will also develop qualitative, holistic approaches to complex-systems modeling – including scenario planning – that can help integrate the

different types of knowledge (scientific, indigenous, local, cross-cultural) needed to address complex global problems.

6.2 Potential Funding Sources

Complexity research is fundable, and many current and potential WICI members already have funding for large, cross-disciplinary complex systems research projects. In addition, by the fall of 2010, WICI researchers intend to have two fully developed research funding proposals – one for the Plan Z project and the other for the Critical Vulnerabilities project (both described in the previous section). Proposals for the Creative Conflict Resolution and Open-Architecture Democracy projects will follow in 2011. Potential funders include the McDonnell and Hewlett foundations in the United States (the McDonnell Foundation has a long-established program for funding complexity research) and the Social Sciences and Humanities Research Council and the CFI New Initiative Fund in Canada. Institute staff will fundraise aggressively both inside and outside Canada to support the institute's research, outreach programs, and infrastructure.

6.3 Outreach Program

The institute plans to make the study of complexity and innovation relevant to the real world and accessible to non-specialists. It will therefore pursue a vigorous outreach program eventually incorporating a full suite of components, including public lectures, conferences, workshops, practitioner and policymaker training, publications aimed at decision makers and the public, and web-based forums to share the results of WICI research and bring innovative thinkers and ideas to Waterloo. Outreach efforts will build links with government agencies and the private sector to ensure reciprocal connections between the institute's research and its social context. These efforts will involve collaboration between the Director's office and the outreach officers of the faculties at the University of Waterloo. Eventually, WICI will seek funding for a full-time outreach position.

The institute will link its membership to the wider community in a number of ways:

- **Direct contact related to specific research.** The director or any institute member can initiate conversations with outside individuals or organizations to facilitate research or disseminate research results.
- **Regular invited lectures and workshops.** In Fall 2008, WICI began a successful seminar series that has continued through academic year 2009-10 (see Appendix A).

- **Practitioner and Policymaker Short-term Visitors.** The institute will invite practitioners and policymakers with interests in members' research to visit for periods of days to a few weeks.
- **Meetings**. Institute members will be encouraged to arrange meetings that advance the institute's goals.
- **Conferences.** Every two years, the institute will hold a conference to present the results of the institute's research, to exchange ideas between researchers working at the intersection of complexity and innovation, and to generate wide interest in the institute's activities. The conference will include skilled and knowledgeable practitioners, including policy makers and managers. A keynote speaker, invited after consultation with all institute members, will open the conference. Student participation will be encouraged, and an edited monograph or series of papers will be posted on the Web.

6.4 Opportunities and Potential Benefits

Previous sections of this proposal have discussed WICI's opportunities and benefits at length.

In sum, the institute will provide members and non-members an institutional home for discussion of new research ideas, for facilitation of collaborative research, and for exploration of the practical applications of complexity and innovation research to the world's most urgent challenges. Core members and affiliate researchers will be able to use the institute's resources to identify potential funding sources, develop research funding proposals, and provide their proposals with institutional credibility. Student members will gain knowledge from working on WICI projects and attending its seminars, workshops, and conferences. The institute will aid new researchers by connecting them to the existing international network of scholars working on matters related to complexity and innovation. The institute will also provide government and industry with a source of partners for long-term research, a means of accessing highly specialized expertise, and a stream of highly qualified personnel, including potential future employees.

The greatest challenge to WICI's success is likely to be disciplinary rigidity and the consequent unwillingness of established scholars, administrators (both inside and outside the university), and funding agencies to provide the institute with the moral and substantive support it needs to succeed. Nonetheless, the recognition of the need for creative interdisciplinary research and teaching and the commitment to

make this research and teaching possible are now so widespread that any such rigidity should be surmountable.

6.5 Measuring Success

Reasonable metrics of success are:

- level of research activity;
- number of members;
- frequency of seminar, workshop, and conference events;
- fundraising success;
- citations of research in scholarly journals;
- mention of activities in popular media;
- frequency of use of WICI tools, methodologies, and research findings by practitioners, clinicians, policy makers, and managers engaged in complex problem solving;
- appearance of innovative approaches to solving complex problems that have been directly stimulated by WICI research; and,
- frequency of consultation with WICI researchers by public policy professionals.

Institute staff will compile data regularly on all these metrics, track them over time, and include a summary of the results in the institute's annual report.

7. FACILITIES

7.1 Existing Space/Facilities

To date, the Centre for Social Innovation Generation has generously provided administrative support and meeting space to permit planning of WICI's development.

7.2 Required Space/Facilities

Within the first six to twelve months of the institute's formal establishment, it will require the space and facilities outlined in Appendix C. If funding is available, the institute may lease space directly beneath SiG in the former Public Utilities Building in downtown Kitchener or in the complex of offices associated with SiG on the building's second floor (funds have been budgeted for this latter purpose).

8. BUDGET

Listed below are estimate costs for start up in 2009-10, commitments of start-up funding, and estimates of ongoing expenses for the subsequent five years. A more detailed five-year budget will be prepared after the institute's first year of operations.

8.1 Start-up costs, 2009-10

Post-doctoral Fellow:	$38,000
Proposal preparation:	10,000
Rent and furniture:	12,000
Website development:	3,000
General administrative costs:	3,000
Affiliate member travel:	4,000
WICI Talks:	15,000

The Seminar Series will consist of ten events through the academic year: four day-long engagements (including a public keynote address, a private seminar, and dinner), each featuring a senior expert on complexity and innovation; four lunchtime seminars, each featuring a regionally located expert on complexity and innovation; and two day-long workshops focused on WICI's core research funding proposals.

Expected cost:

1. Travel, meals, and accommodation for four senior experts: $10,000;
2. Travel, meals, and if necessary accommodation for four regionally located experts: $2,000; and,
3. Lunches and room rental for ten lunchtime seminars and workshops: $3,000.

Total estimated start-up cost: $85,000

8.2 Start-up Funding, 2009-10

The Provost has provided $50,000 to support establishing the WICI, with a further commitment of $50,000 a year for an additional four years, contingent on Senate approval of the WICI's creation. Social Innovation Generation has committed a further $25,000 for 2009-10 ($5,000 in support of a post-doctoral fellow, $5,000 for rent (in kind), $5,000 for general administrative support (in kind), and $10,000 for the 2009-10 WICI seminar series); and Paul Thagard has contributed $10,000 for the support of a post-doctoral fellow in 2009-10. Total: $85,000.

8.3 Ongoing Expenses

Listed below are expenses for the subsequent five years of WICI's operation (i.e., 2010-11 to 2015-16). The institute will seek funding to cover these expenses from foundations, government agencies, and the private sector.

Item	Year 1	Year 2	Year 3	Year 4	Year 5
Administrative Assistant (f/t)	$35,000	$36,000	$37,000	$38,500	$40,000
IT Specialist (half time)		31,000	32,000	33,000	34,000
Speakers	10,000	10,500	11,000	11,500	12,000
Special events	50,000	55,000	60,000	65,000	70,000
Outreach	5,000	10,000	20,000	30,000	30,000
Supplies	5,000	5,000	5,000	5,000	5,000
Travel	10,000	12,000	15,000	20,000	20,000
Equipment	10,000	2,000	2,000	2,000	2,000
Space	10,000	15,000	15,000	15,000	15,000
Miscellaneous	5,000	6,000	7,000	7,000	8,000
Total	**140,000**	**182,500**	**204,000**	**227,000**	**236,000**
Funds to be raised over and above Provost's contribution (which expires at the end of year 4)	90,000	132,500	154,000	177,000	236,000

8.3.1 Budget Notes

The current WICI director will not require course release.
The "Speakers" line item applies to the WICI seminar series.
"Special events" refers to WICI's annual conference.
"Outreach" will be initially performed by the WICI administrative assistant, with help from sub-contractors; in later years, the institute will hire a part-time outreach officer.
"Travel" covers attendance of WICI members at conferences and research meetings.
The "Miscellaneous" category incorporates office supplies, phone, postages/courier, and equipment repairs.

9. STATEMENTS OF SANCTION AND COMMITMENT

Attached.

APPENDIX A: PROCESS FOR DEFINING THE INSTITUTE

The following steps have been taken or are underway towards the establishment of WICI:

1. June 16, 2008: Steering Committee struck; three subsequent meetings during the next six months.

2. Fall 2008 and Spring 2009: WICI seminar series, held in part to define ideas for the institute. For more information, see below.

3. Summer 2009: Drafting of WICI proposal. Consultation with Provost and VP Research. Meetings of Creative Conflict Resolution research team.

4. Fall 2009: Revision of WICI proposal. Consultations with deans and associate deans of research of all university faculties. Meeting of Plan Z research team. Continuation of WICI seminar series.

5. Spring 2010: Development of drafts of funding proposals for Plan Z and Critical Vulnerabilities research projects. Presentation of WICI proposal to the University of Waterloo SGRC and Senate.

WICI Events Held to Date

October 2008

Speaker: Stuart Kauffman—The Evolution of Economic Wealth and Innovation
Date: Monday, October 27, 2008

Stuart Kauffman, one of the founders of the field of complex systems, spoke on the principles which he proposes underlie innovation and economic growth. He illustrated these principles with real world examples from his experience in industry and the academe. He also had a private meeting with the WICI Steering Committee to discuss the prospects for and design of WICI. Online Video of Stuart Kauffman's Lecture

November 2008

Speaker: Paul Thagard—Changing Minds About Climate Change

Date: Wednesday, November 19, 2008

Why have most scientists come to believe that global warming is caused by human activity? Why do some politicians such as Sarah Palin resist this conclusion? Belief, change and resistance can be explained by neurocomputational models of explanatory and emotional coherence. Minds and societies are complex, multilevel systems that can be changed by intervention on feedback loops at multiple levels. Online Video of Paul Thagard's Lecture

December 2008

Speaker: Brenda Zimmerman–Applications of Complexity Science to Healthcare
Date: Thursday, December 11, 2008

Complexity science is impacting healthcare across the western world. In the UK, USA and Canada, the healthcare sector is looking to complexity for insights to address the clinical, public policy, and organizational challenges of healthcare. In this session, Dr. Zimmerman examined these three domains and outlined how complexity science has been applied or, at least, discussed. In each domain, she described how complexity science has changed behaviours, decision making, and design. And she compared the rhetoric of complexity science as a transforming force in healthcare with the reality of practice to date. Dr. Brenda Zimmerman is a professor of Strategic Management at the Schulich School of Business at York University in Toronto. Online Video of Brenda Zimmerman's Lecture

January 2009

Speaker: Thomas Homer-Dixon—Ingenuity Theory: Adaptation Failure and Societal Crisis
Date: Tuesday, January 13, 2009

Global warming. Emergent diseases. Infoglut. International financial instability. Mega-terrorism. Are the problems we are confronting as individuals, societies, and a species becoming more difficult? If so, can we solve them? Thomas Homer-Dixon addressed these questions by drawing on his research on social adaptation to complex change. He showed how and why our requirement for solutions to our complex problems is soaring, and he explored cognitive, scientific, economic, and political factors that impede the delivery of solutions when and where we need them. Online Video of Thomas Homer-Dixon's Lecture

Speaker: Keith Hipel— Trade versus the Environment: Strategic Settlement from a Systems Engineering Perspective
Date: Wednesday, January 28, 2009

Keith Hipel spoke on his experiences using graph theory and conflict analysis to talk about problems in the environment and make some links to complexity theory. The key goal of this research is to employ a Systems Engineering approach to conflict resolution that clearly identifies the ubiquitous conflict that takes place at the local, national and global levels between the basic values underlying trading agreements and those principles providing the foundations for environmental stewardship. The results of the work suggest some solutions as to how this most basic of disputes can be responsibly resolved.

February 2009

Speaker: Frances Westley—Social Innovation and Resilience: A Complexity Approach to Change and Transformation
Date: Tuesday, February 10, 2009

Social innovation is an initiative, product or process or program that profoundly alters the basic routines, resource and authority flows or beliefs of any social system. Successful social innovations have durability and broad impact. Achieving durability and scale is a dynamic process that requires both emergence of opportunity and deliberate agency, and a connection between the two. Frances Westley discussed how disruptive social innovations can address seemingly intractable social problems such as environmental degradation, poverty, and mental health and how the capacity of a society to create a steady flow of social innovations, can contribute to its overall social and ecological resilience.

Speaker: Matthew Hoffman—Governance Avalanches: A Self-Organized Criticality Perspective on Innovation in Global Governance
Date: Wednesday, February 25, 2009

This presentation explored the applicability of self-organized criticality to the study of innovation in global governance. After introducing the concept of self-organized criticality, the discussion turned to its utility for studying social systems. Matthew Hoffmann presented both an agent-based model of the evolution of social norms and empirical illustrations of innovations in global governance drawn from work on climate change and multilateral treaty-making. Matthew Hoffman is an Assistant

Professor in the department of Political Science at the University of Toronto and in the department of Social Sciences at the University of Toronto, Scarborough.

March 2009

Speaker: Lee Smolin—Symmetries in Economic Models and their Consequences
Date: Wednesday, March 18, 2009

In this talk Dr. Smolin explained the seminal model of neoclassical theory of market equilibrium, which is the Arrow-Debreu model. He raised the basic question that physicists ask when confronting a new system: what are the symmetries? He found a simple argument that many markets will have a large number of equilibria. He also discussed a principle of gauge invariance, originally introduced into economics by Malaney and Weinstein and explained some of its consequences. Lee Smolin is a physicist at the Perimeter Institute in Waterloo, Ontario, Canada. He is the author of *The Life of The Cosmos* and *Three Roads to Quantum Gravity*.

October 2009

Speaker: Dawn Parker - Exploring Complex Relationships Between Land Market Activity, Landscaping Behavior, and Carbon Sequestration in Ex-Urban Landscapes
Date: Thursday, October 1, 2009

The socioeconomic and ecological processes that drive landscape change exhibit classic signatures of complex systems. Both socioeconomic and ecological landscape patterns are influenced by path dependence, neighbourhood, and network effects. Alone and in combination, these complex spatial processes can lead to threshold effects and regime shifts. Dawn Parker reported on an ongoing collaborative research project with the University of Michigan that explores the complex dynamics of land-use change and carbon sequestration in ex-urban landscapes in Southeastern Michigan, with a focus on the landscaping behaviours of developers and residents and their carbon implications. The aim was to gain insight into land market dynamics and potential policy and market mechanisms that could provide critical missing feedbacks between land management behaviour, carbon balance, and land market activity.

Speaker: Karen Houle - Is Our Concept Of Moral Responsibility Newtownian?
Date: Monday, October 26, 2009

Karen Houle argued that although we have come to appreciate that certain issues facing us today are genuinely complex, not merely complicated, we have not built and mobilized interventions, whether epidemiological, architectural or economic, that are themselves sufficiently informed by complexity and thus able to "meet" their intended objects of concern. We have not put as much time and effort into rethinking the basic concepts with which we try to make normative judgments and recommendations in and around those same complex issues. The conceptual landscape of moral philosophy is oddly Newtonian. This is especially true in the case of climate change and collective responsibility. She discussed what features a concept of responsibility adequate to complex issues needs to have.

November 2009

Speaker: Brad Bass - Revitalizing Central Place Theory: Cities as Experiments on a Dynamic Fitness Landscape
Date: Tuesday, November 10, 2009

Brad Bass discussed the concept that cities can be thought of as analogues to peaks on a dynamic fitness landscape, illustrating this idea using a geographical analysis of the U.S. Patent Database. This analysis showed networked, authoritative and chaotic search strategies, shedding light on the stability of the central place structure. He argued that this could lead to a revitalization of central place theory, a theory that was once one of the cornerstones of a geographic education, but has since been largely ignored and left out of textbooks in the field.

Speaker: Philip Beesley - Responsive Environments, Transitional Fields
Date: Monday, November 23, 2009

A presentation of field-oriented experimental architecture installations including the recent Hylozoic Soil and Epithelium series, composed of densely massed flexible networks fitted with interactive kinetic components. Drawing from the interactive behaviours of these installations, Philip Beesley discussed the implications of interactive architecture in relation to the pursuit of mutually dependent post-humanist relationships.

December 2009

Speaker: J. Doyne Famer - Laws Of Technological Progress
Date: Monday, December 7, 2009

Doyne Famer of the Santa Fe Institute explored the question of whether the rate of technological improvement is predictable. The problem of global warming makes this a pressing question. Over the coming years we are likely to invest trillions of dollars on green energy technologies. Understanding the rate of improvement of different technologies could potentially allow us to invest more wisely, save vast sums of money, and achieve a carbon neutral world more quickly. He compared several different hypotheses for technological improvement on different examples of technologies, ranging from computers to energy, showing that it is indeed possible to make useful forecasts of technological progress. He also discussed ideas for why such laws exist and how one can use them to address problems like global warming.

Expanded WICI activities initiated in January, 2010

Beginning in January, 2010, the current WICI external seminar series was expanded to include several complementary activities, offering weekly meetings in a varied format.

- A Perimeter-Waterloo *Research Working Group* designed to engage perimeter and UW faculty sharing similar interests in structured investigation of topics of mutual interest. The first session will be held in Feb. 2, 2010.

- A hands-on *WICI Seminar* for local scholars to discuss ongoing work in an informal setting. This seminar provides an opportunity for scholars from all faculty and from other local universities to present ongoing work and gain feedback, especially related to modeling and analysis challenges. The first seminar on January 19 was titled, "Revitalizing the Georgian Bay Fisheries: Complicated, Complex, Contested, and Confused." Presented by David Robinson, Ivan Filion, and Kirsten Robinson, the seminar considered a project to re-imagine the ecosystems management strategy and its relationship to the local economy using an approach informed by complexity studies.

- A*WICI Forum* that provides a venue for loosely structured synthetic discussion to weave together complexity-theoretic themes from recent meetings, with the goal of making progress on larger theoretical issues. The first WICI forum on January 26 asked "What would a complex system worldview/research paradigm look like? How might it differ from currently established research paradigms in terms of scope (natural and social science, qualitative and quantitative research), experimental frame and design, and the role of stakeholder knowledge and participation?" Participants came from computer science, engineering, physics,

management science, environmental studies, urban planning, the Alternatives journal, political science, and outside the university.

The new activities are designed to:

- Engage researchers from the University of Waterloo and the Perimeter Institute in productive and concrete research collaboration.

- Provide a venue to expand the size and scope of the active complexity-theory group by drawing in other interested researchers across campus and the region.

- Facilitate the development of other themed working groups and research projects, many of which will involve support for current funded activities and/or submission of new research funding proposals.

- Begin to build unique complexity/resilience theoretical contributions that will define the "Waterloo Complexity School." We have already identified several related, interlinked themes:

    Critical thresholds/tipping points in human and natural systems;
    Integration of concepts from resilience theory, such as stressors, vulnerability, and adaptation into models of complex systems; and
    Drivers and pathways of innovation in complex social environments.

APPENDIX B: POSSIBLE STRUCTURE FOR A WICI WORKSHOP SERIES

We propose running a series of three weeklong Complex Adaptive Systems (CAS) Workshops, leading towards a year-end internal UW conference as a capstone fourth event. Each workshop would build around a weeklong visit by a Distinguished CAS Visitor who would give: a public Keynote Lecture; a day-and-a-half training session for around 20 select UW graduate and undergraduate students (and potentially post-doctoral fellows); and meetings and discussion groups with UW Faculty. The students taking part in the training sessions would also engage in small research projects connected to the research of a UW Faculty member interested in CAS research methods and tools—the products from these projects would be presented at the end of year internal UW CAS conference.

As currently envisioned, the proposed Workshop Series would involve a strong partnership between the Perimeter Institute (PI) and the University of Waterloo (UW). The drawing power and current CAS knowledgebase of PI would be used to attract the best Distinguished CAS Visitors, and the technically adept human resources of UW's student and faculty bodies would be engaged to build the foundations of a CAS research community within UW. It is envisioned that the Centre for Social Innovation Generation would act as the incubatory home for this WICI Exploratory Workshop Series.

Objectives for the Workshop Series

The main objectives of the proposed WICI Workshop Series are:

- To foster connections within and growth of the transdisciplinary community of UW researchers interested in complex adaptive systems (CAS) research;
- To establish a foundation of knowledge of CAS research methods and modelling tools within the UW community; and,
- To build connections between UW researchers and world-leading experts in CAS research methods and modelling tools.

Weeklong Distinguished Visitor and Training Model

Each CAS Workshop would be built around a roughly weeklong visit by a world-leading expert in CAS research who would be identified by the authors of this proposal. These experts would be given the title of Distinguished Complex Adaptive Systems Visitor to the Perimeter Institute and University of Waterloo, and given an

office at PI for their weeklong visit. The core responsibility of each Distinguished Visitor during their visit would be:

- To give a public Keynote Lecture (either at PI, CIGI, or UW) on their own work in CAS aimed at a general well-educated audience;
- To engage in a set of discussion groups and small meetings (or lunches) with the UW Faculty interested in CAS research—discussions would specifically focused on:
    - CAS methods and tools that specific UW faculty could begin integrating into their current research; and
    - The opportunities and challenges the evolving concept of WICI could face, and recommendations for how to best structure WICI;
- To provide training in specific CAS methods and modelling tools to a select group of around 20 UW students in the form of:
    - One full-day training session introducing students to the methods and modelling tools in the context of teaching materials and example cases;
    - One half-day modelling guidance session where the students discuss their concepts for a CAS model that could contribute to the research of a UW faculty member (guided by UW faculty—discussed further below).

      (To facilitate these sessions, the Distinguished Visitor would be given the option of bringing one student, post-doctoral fellows, or junior colleague who would help organize and run the training sessions. The Distinguished Visitor would be expected to teach the bulk of the training himself or herself; however, having the assistance of a colleague is expected to make for a much better educational experience.)

After the visit to UW, the Distinguished Visitor may be invited join the International Scientific Advisory Council providing input towards the development and operation of the WICI.

UW Faculty and Student Engagement: Student Complexity Scholars& Projects

In order to best integrate the CAS learning opportunity into the UW community, we propose to engage UW Faculty members, their research groups and undergraduate students in a team-oriented CAS small-project process. The core elements of this process would be as follows:

1. At the start of the year (and thereafter on a rolling basis) UW faculty interested in exploring the use of CAS methods and modelling tools in their research through this small-project process would be asked to submit a brief (1-2 paragraph) description of their research and how they believe CAS concepts could be integrated.
    a. No prior experience with CAS would be expected, though faculty would be encouraged to read two or three short summary papers addressing the CAS methods and modelling tools each Workshop would address.
    b. Collaborative research projects between multiple faculty—particularly cross-disciplinary collaborations—would be highly encouraged.
2. By a month prior to each Workshop, WICI administrators would examine these submissions to determine which five faculty members (or collaborations thereof) would be invited to run small-projects connected to that Workshop. Selected faculty would then send two members of their research team (graduate students or post-doctoral fellows) to the training sessions of the next workshop, giving a total of 10 graduate/post-doctoral participants in the workshop training sessions. With three Workshops during the course of the year, this would result in a total of 15 projects.

3. At the same time, a group of 10 undergraduates with strong technical/computational/modelling backgrounds (from Engineering, Environment, Science, or Mathematics) would be selected as UW Student Complexity Scholars to participate in the training and participate in the small projects with selected faculty and their graduate/post-doctoral students.

    a. At the start of the year, advertisements can be circulated within the Faculties to encourage interested undergraduates with appropriate backgrounds to apply to become a UW Student Complexity Scholars.
    b. Selected students would automatically participate in the CAS methods and modelling training of one of the Workshops (and will have access to recorded materials of the training sessions of the other Workshops), and would have direct personal engagement with the Distinguished CAS Visitor, and an honorarium of $500.
    c. The obligations of this position would be to commit 50 hours over the two months following the training to a CAS related small project with a selected faculty member and their graduate/post-doctoral students.

4. The faculty-led small project teams—comprised of two graduate/post-doctoral students from the faculty research group and two technically adept undergraduates—would meet at the start of Workshop week and develop the concept for the small project over the course of the Workshop, integrating advice and insights from conversations with the Distinguished Visitor along the way.
    a. By the end of the Workshop, the teams would be expected to have defined a short (2 months) small project related to the faculty member's research that integrates the CAS methods and modelling tools from the Workshop.
    b. On the last day of each Workshop (i.e., during the half-day modelling guidance session), time would be dedicated to discuss these small project concepts with the Distinguished Visitor.
    c. The projects would take no more than 50 hours of any students' time and no more than 20 hours of the faculty member's time and would extend for two (and no longer than three) months after the end of the Workshop.
    d. These small projects would not be intended to produce publishable research outcomes (though that may happen) but rather to introduce faculty members and students to CAS concepts and to encourage integrating further CAS methods and modelling tools into their work at UW.
5. The results of the small projects would be written up in a short report (5-10 pages) by the students in each team, which would be presented in a poster at the internal UW CAS Conference at the end of the year.
    a. The best (or top two) small projects would be identified by a panel of UW faculty judges, and the students associated with the winning research team(s) could be sent to an international CAS conference to present their work, thereby providing added incentive for students executing the projects and highlighting UW's new research endeavours at an international conference. (Such events are convened frequently by complexity-science specific associations and as special sessions in traditional disciplinary conferences.)

<u>Example Weeklong Workshop Calendar</u>

Day 1	Day 2	Day 3	Day 4	Day 5
Morn/Aft: Arrival and Settling at	Morning: 1.5hr Discussion Session	All Day: Time at Perimeter Institute (PI) for	All Day: CAS Training Session at UW Computer	Morning: Time at PI for Distinguished

Perimeter of Distinguished Visitor Evening: Public Keynote Lecture	with UW Faculty (WICI Concept) Afternoon: Individual or Small Group Meetings with UW Faculty {~4x30mins} (CAS methods)	Distinguished Visitor	Labs Lunch: with Students	Visitor Lunch: with UW Faculty Afternoon: Model Guidance Meetings with small project teams {5x30mins}
Small Project Team Agenda:	Afternoon: Team Discussion with Faculty Developing Project Ideas		All Day Student CAS Training	Morning: Discussion with Faculty of Project Focus and Group Work Afternoon: Model Guidance Meetings

Yearlong Workshop Series, Faculty Meetings and UW CAS Conference

The first in the series of three Workshops is envisioned to occur near the beginning of October, with the subsequent Workshops occurring roughly every month-and-a-half (mid-November and early-January). The capstone of this Workshop Series would be the internal UW CAS Conference, where the results of the 15 small projects from the Series are highlighted in a poster session, and where key UW Faculty in CAS (such as the authors of this proposal) present on the role of CAS in understanding and addressing a range of global complex problems.

The thematic foci of the three proposed CAS Workshops are envisioned to be:

- *Emergence/Evolutionary Systems* (Target date: early-October)
  Method and modelling focus: Agent-based models; genetic algorithms
- *Social Networks* (Target date: mid-November)
  Method and modelling focus: Dynamic network analysis
- *Critical Transitions* (Target date: early-January)
  Method and modelling focus: System dynamics

UW CAS Conference (Target date: early-March)
For each broad subject, the Distinguished Visitor would be engaged to help select the subset of CAS methods and modelling tools most appropriate to enable fruitful

small projects. Cumulatively, this series of workshops would provide an excellent initial exploration of the CAS landscape from which UW Faculty could gauge their interest in pursuing further CAS research.

In between the workshops, meetings or seminars for the faculty members involved in small projects and/or generally interested in CAS and the WICI concept could be held to further foster connectivity within the UW CAS community.

Attractiveness to Distinguished Visitors and UW Participants

The weeklong Workshop model proposed here offers benefits for all participants:

Distinguished Visitor: During the uncommitted time throughout the week (totalling roughly two days) the Distinguished Visitor would be encouraged to engage PI Faculty in research discussions. This opportunity to interact with the range of world-class physics faculty and post-doctoral fellows at PI in the unique and dynamic environment of the institute would provide help attract the highest calibre of CAS scholars in the world. The opportunity to bring a graduate student, post-doctoral fellow or colleague with them also adds to the value of such a visit.

UW Faculty: For UW researchers with an interest in exploring CAS concepts, methods, and modelling tools for their research—but with limited resources for such explorations—the proposed Workshop and small-project format would provide an ideal low-cost (and potentially high-reward) opportunity. The mix of free access to leading CAS scholars, free training for their graduate/post-doctoral students, and free engagement of technically adept undergraduate students in their research through the small projects provides an collection of strong benefits for UW Faculty.

UW Graduate/Post-Doctoral Students: The opportunity to receive hands-on training from leading CAS scholars that can then be applied in their own research with the help to technically adept undergraduates—and with guidance from their faculty supervisors—provides equally strong incentives for graduate/post-doctoral student participation.

UW Undergraduate Students: The hands-on training from leading CAS scholars and the application of those skills to interesting and diverse small projects with UW Faculty would provide technically adept undergraduate students excellent skill-building opportunities and the chance to explore research fields somewhat outside of their own fields of study. These students would also gain the CV-building benefit

of being a UW Student Complexity Scholar and the small (but not negligible) financial reward. (NOTE: Students would not be paid the $500 honorarium until the faculty member has indicated that they have completed their commitment to the small project.)

Initial Budget for WICI Workshop Series

Travel and accommodation for three Distinguished Visitors and their student/post-doctoral/colleague for 5 days each ($10,000 per Workshop): $30,000.

Honoraria for Distinguished Visitors ($10,000 per Visitor): $30,000

Honoraria for the UW Student Complexity Scholars (30 Scholars @ $500 per Scholar): $15,000.

Administration of the Distinguished Visitors' travel and accommodations; the itinerary of meetings for the Distinguished Visitor for the Workshop weeks; the organization of the public lectures and the student training sessions; and the UW Student Complexity Scholar applications and organization: $20,000

Computer Laboratory space for the training sessions and subsequent small project modelling work, including technical staff support to install appropriate CAS modelling software ahead of training sessions: $5000.

Total: $100,000

APPENDIX C: LOGISTICAL REQUIREMENTS

Office and lab space — immediate requirements

Item	Quantity	Size (ft x ft)	Total (sq. ft.)
Office space:			
Director's office	Not needed		
Reception area and secretary	1	10 x 15	150
Other offices (faculty, staff, students, visitors)	3	10 x 15	450
Other space:			
Photocopy, fax, mail room	Shared with other organizations		
Meeting room	1 (also likely shared)	15 x 15	225
		Total space:	825