

**UNIVERSITY OF WATERLOO
SENATE GRADUATE & RESEARCH COUNCIL
NOTICE OF MEETING**

DATE: Monday 8 May 2017
TIME: 10:30 a.m. – 12:00 noon
PLACE: Needles Hall, Room 3318

Chair – J. Casello

AGENDA

<u>Item</u>	<u>Action</u>
1. Declarations of Conflict of Interest a. Excerpt from Bylaw 1, section 8*	Information
2. Minutes of 10 April* and Business Arising	Decision (SGRC)
3. Co-chairs' Remarks	Information
4. Renewal of Senate-approved Centres and Institutes a. IQC*	Decision (SGRC)
5. Proposals for New Centres and Institutes a. Centre for Bioengineering and Biotechnology (CBB)*	SEN-regular
6. New and Continuing Membership to Research Ethics Committees*	Decision (SGRC)
7. Curricular Submissions a. Arts* b. Engineering* c. Theology*	Decision (SGRC) Decision (SGRC) Decision (SGRC)
8. Other Business	Information
9. Next Meeting: Monday 12 June 2017 from 10:30 a.m. to 12 noon in NH 3318	Information

* material attached

** to be distributed separately

“SGRC” to be approved on behalf of Senate

“SEN” to be recommended to Senate for approval

1 May 2017

Alice Raynard
Associate University Secretary

Excerpt from Senate Bylaw 1

8. Declarations of conflict of interest

8.01	At the beginning of each meeting of Senate or any of Senate's committees or councils, the chair will call for members to declare any conflicts of interest with regard to any agenda item. For agenda items to be discussed in closed session, the chair will call for declarations of conflict of interest at the beginning of the closed portion of the meeting. Members may nonetheless declare conflicts at any time during a meeting.
8.02	A member shall be considered to have an actual, perceived or potential conflict of interest, when the opportunity exists for the member to use confidential information gained as a member of Senate, or any of Senate's committees or councils, for the personal profit or advantage of any person, or use the authority, knowledge or influence of the Senate, or a committee or council thereof, to further her/his personal, familial or corporate interests or the interests of an employee of the university with whom the member has a marital, familial or sexual relationship.
8.03	Members who declare conflicts of interest shall not enter into debate nor vote upon the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).
8.04	Where Senate or a committee or council of Senate is of the opinion that a conflict of interest exists that has not been declared, the body may declare by a resolution carried by two-thirds of its members present at the meeting that a conflict of interest exists and a member thus found to be in conflict shall not enter into debate on the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).

University of Waterloo
SENATE GRADUATE & RESEARCH COUNCIL
Minutes of the 10 April 2017 Meeting
[in agenda order]

Present: Raouf Boutaba, Jessica Brake, George Dixon, Bernard Duncker, Lowell Ewert, Rhona Hanning, Bruce Hellinga, Lynn Judge, Robert Hill, Julie Joza, Tim Kenyon, Srinivasan Keshav, Raymond Legge, Bruce Muirhead, Simron Singh, Richard Staines, Jackie Stapleton, Mike Szarka, Lucy Vorobej, Linda Warley

Secretariat: Alice Raynard

Resources: Trevor Clews, Jennifer Kieffer, Amanda McKenzie, Kerry Tolson

Guests: Trevor Charles (2), Tobi Day-Hamilton (5a), Maren Oelbermann (2), Kevin Resch (5a)

Regrets: Thouheed Abdul Gaffoor, Robert Bruce, Jeff Casello*, Adam Dor On, Claude Duguay, Anwar Hasan, Samantha Shortall, Aaron Thompson, John Thompson*

*regrets

Organization of Meeting: George Dixon, co-chair of the council, took the chair, and Alice Raynard acted as secretary. The secretary advised that due notice of the meeting had been given, a quorum was present, and the meeting was properly constituted.

1. DECLARATIONS OF CONFLICT OF INTEREST

No conflicts of interest were declared.

2. WATERLOO CENTRE FOR MICROBIAL RESEARCH

Council heard a motion to recommend the establishment of the new Waterloo Centre for Microbial Research. Duncker and Muirhead. Carried.

3. MINUTES OF 20 MARCH 2017 AND BUSINESS ARISING

The minutes were approved as distributed. Hills and Staines. Carried.

4. CO-CHAIRS' REMARKS

Dixon informed council that further information on Tri-Council funding would be presented at the next Senate meeting; success rate of Insight Grants has risen, as well as the dollar value of equipment grants; NSERC discovery grants to be released soon; Naylor report to be issued on 10 April 2017.

5. RENEWAL OF SENATE-APPROVED CENTRES AND INSTITUTES

a. IQC. Day-Hamilton and Resch presented on the renewal of the Institute for Quantum Computing. Members discussed: breadth of consultation on the report; role of advisory board of directors; approval of renewal versus approval of constitution; status of initiatives on equity and inclusivity. The motion was tabled, pending further information on the constitution of the institute and clarification on equity matters.

6. CURRICULAR SUBMISSIONS

a. Applied Health Sciences. Council heard a motion to recommend modifying the wording in the graduate calendar for all SPHHS programs to state that the minimum grade average be 75% in courses presented for the degree and that grades of $\geq 70\%$, to be forwarded to Senate for approval. Hanning and Warley. Carried. Council heard a motion to recommend modifying the admission requirements for all programs in the School so that the "Graduate Studies accepted examinations and alternative higher scores" be required for English Language Proficiency, to be forwarded to Senate for approval. Hanning and Staines. Carried. Council heard a motion to approve course inactivations as presented for the Collaborative MSc and PhD Programs in Public Health and Health Systems – Water. Hanning and Staines. Carried.

b. Arts. Council heard a motion to approve new courses in fine arts, as presented. Warley and Kenyon. Carried. Council heard a motion to approve changes to admission requirements in the masters of arts in intercultural German studies. Warley and Judge. Carried.

Council heard a motion to approve course inactivations and changes to theory courses in the master of arts in sociology and in the master of arts in sociology – co-operative program. Warley and Ewert. Carried.

c. Engineering. Council heard a motion to approve new courses, as well as changing the admission minimum grade requirements for the master's level programs, to a minimum average of at least 75%, in electrical and computer engineering. Hellinga and Judge. Abstentions: Boutaba and Keshav. Carried.

d. Environment. With regard to the school of environment, enterprise and development, Council heard a motion to approve one course inactivation and to recommend closure of the graduate diploma in social innovation, to be forwarded to Senate for approval. Singh and Hanning. Carried.

With regard to the school of environment, resources and sustainability, Council heard a motion to approve course inactivations. Singh and Hellinga. Carried.

With regard to the school of planning, Council heard a motion to approve course revisions. Singh and Hill. Carried.

e. Science. Council declined hearing of a motion to approve the manner of delivering core content of nanotechnology courses, based on the fact that the power to approve this matter rests with the department. Council heard a motion to approve deletion and addition of courses to the program's list of nanotechnology electives to the collaborative nanotechnology program, as presented, effective in Spring 2017. Hill and Kenyon. Carried.

Council heard a motion to approve new courses, course revisions and course inactivations, as presented. Hill and Duncker. Carried.

7. GRADUATE AWARDS

Council heard a motion to approve items (a), (b) and (c). Legge and Warley. Carried. Item (d) was presented for information.

8. ACADEMIC PROGRAM REVIEW REPORTS

Council heard a motion to accept the final assessment report on behalf of Senate re: master of computational mathematics, and to affirm that the program is of good quality. Dunker and Legge. Carried.

9. OTHER BUSINESS

There was no other business.

10. NEXT MEETING

The next meeting will be on Monday 8 May 2017 from 10:30 a.m. to 12 noon in NH 3318.

21 April 2017

Alice Raynard
Associate University Secretary

MEMORANDUM

TO: Alice Raynard, Senate Graduate and Research Council
FROM: Tobi Day-Hamilton, Institute for Quantum Computing
DATE: 1 May 2017
SUBJECT: **Institute for Quantum Computing – Senate Renewal 2017**

Hello Alice, please find attached an updated version of IQC's Senate Renewal document. Note changes are highlighted in yellow on pages 7, 8, and 27.



SENATE RENEWAL 2017

Submitted to:

Senate Graduate and Research Council

05/08/2017

Revised



UNIVERSITY OF
WATERLOO



Institute for
Quantum
Computing

FROM THE EXECUTIVE DIRECTOR

Over the past 15 years, I have had the privilege to have a front row seat to the creation of a Waterloo success story. The growth and impact of the Institute for Quantum Computing (IQC) displays the power of incredible vision, sustained commitment and collective efforts to build something truly unique in a way particular to Waterloo.

Thanks in large part to Mike Lazardis' vision and the university's commitment to research excellence, Waterloo quantum research now stands among the top research institutes globally. Under the leadership of Feridun Hamdullahpur, Quantum has become a research priority for the university and has helped to secure the largest research grant in the university's history through the Canada First Research Excellence Fund. In total, IQC has attracted over \$530 million in funding to the university.

In partnership with the Faculties of Science, Mathematics and Engineering, we have attracted the highest caliber researchers to Waterloo, welcomed graduate students and postdoctoral fellows from around the world. Together, these researchers have not only contributed to their disciplines but also advanced the field of quantum research, building on Waterloo's reputation of research excellence.

Beyond research discoveries, the last five years have brought new people, new space and new opportunities to IQC. We have welcomed 13 new faculty, 62 postdoctoral fellows and 178 graduate students to our IQC community. Graduates of the collaborative quantum information program are now in academic and industry positions such as MIT, the Centre for Quantum Technologies in Singapore and the Canadian Securities Establishment, to name just a few.

In 2012, we opened the Mike and Ophelia Lazaridis Quantum-Nano Centre. This building solidified Waterloo's commitments to quantum research and provided quantum research facilities of global standard. The Quantum NanoFab allows researchers from across campus to access new tools and techniques that have the capacity to expand their research and to forge new collaborations.

IQC aims to impact all corners of the campus. As example, IQC has collaborated with the Games Institute, our first collaboration with the Faculty of Arts. As part of our equity committee, we have developed Guidelines for a safe and equitable community that have been shared with many units across campus and there are many other examples.

As we look to the next five years, Waterloo and IQC have tremendous opportunities. I am excited by the research that continues to emerge from our labs and how quickly new ideas are moving toward commercialization. Together with the Perimeter Institute, the Lazaridis School at Laurier, Quantum Valley Investments and the many startups emerging from IQC research, the University of Waterloo is playing a critical role in building the Quantum Valley. New IQC members will open up new areas of research and expand our community in exciting and interesting new ways. In the coming year, a new Director will also set a path forward for IQC that will continue to shape and impact our quantum research agenda nationally and internationally.

I am continually humbled by the generous support IQC has received not only over the last five years, but over its lifetime. The University of Waterloo, the Government of Canada, the Province of Ontario, Mike Lazaridis and the many industry and research partners from every corner of the globe have contributed to IQC's success in immeasurable ways. It is with this continued support, commitment and vision that Waterloo will continue to be a global leader in quantum information research. I look forward to continuing to watch IQC's trajectory and participate in its success for many years to come.

Thank you to the University of Waterloo and to colleagues for believing in the quantum vision, encouraging excellence in all that we do and for providing me with a front row seat to an incredible journey that has only just begun.

Sincerely,

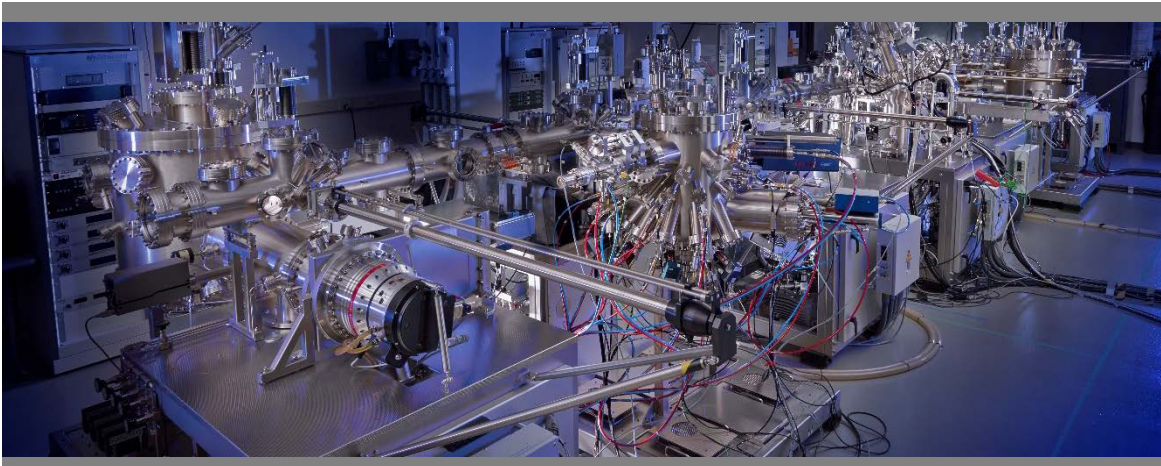
A handwritten signature in black ink, appearing to read 'Raymond Laflamme', with a long horizontal flourish extending to the right.

Raymond Laflamme
Executive Director Institute for Quantum Computing
University of Waterloo

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ABOUT QUANTUM



The field of quantum information science and technology arose from considering the relationship between two insights.

The first is best summarized in the words of Rolf Landauer: "Information is Physical". Information must be stored in the properties of some physical system, such as pulses of light in an optical fibre, magnetic zones on a hard drive, ink on a piece of paper, or a chemical process in the brain. The second is the theory of quantum mechanics, one of the pillars of modern physics and the best description we have of the behaviour of atoms, molecules and light. These quantum systems can exhibit fascinating behaviour that are not available in the classical world: entanglement, the superposition principle, and Heisenberg's Uncertainty Relations, to name a few. Since information is physical, and physical systems are ultimately described by quantum mechanics, then the ultimate limits of how well we can process, share, and extract information are necessarily governed by quantum principles.

Quantum information science and technology is about understanding these limits, harnessing the quantum properties of physical systems, and developing practical technologies based on quantum systems which will have widespread societal impact. Technologies based on quantum phenomena have the proven ability to significantly outperform today's technologies and in some cases, perform task that are simply impossible without a quantum solution. Quantum information is a very broad field and progress will be achieved with a multidisciplinary effort. Theorists with expertise in mathematics, physics, and computer science are at the forefront of developing quantum information protocols and understanding the limits of quantum technologies. Experimentalists—chemists, materials scientists, physicists—are striving to understand, harness and control quantum systems and develop quantum materials exhibiting robust quantum behaviour. Engineers are building quantum devices which will be taken out of the laboratory into everyday practice.

ABOUT IQC

Established in 2002 to seize the potential of quantum information science, IQC's vision was bold: position Canada as a leader in quantum information research.

OUR VISION

To harness the power of quantum mechanics for transformational technologies that benefit society and become the new engine for economic growth in the 21st century and beyond.

IQC's vision was bold: position Canada as a leader in quantum information research and provide the necessary infrastructure for Canada to emerge as a quantum research and technology powerhouse. Just 15 years later, IQC is a model for global research collaborations, infrastructure and education. Leaders in all fields of quantum information science come to IQC to conduct research, share knowledge and encourage the next generation of scientists.

OUR MISSION

To develop and advance quantum information science and technology at the highest international level through the collaboration of computer scientists, engineers, mathematicians and physical scientists.

IQC has charted a path for Canada to lead the next great technological revolution – the quantum revolution. Quantum technologies and applications developed in IQC labs create the foundation for next generation technologies based on quantum information research conducted right here in Canada. This strategic private-public partnership with the University of Waterloo, Mike and Ophelia Lazaridis, the Government of Canada and the Government of Ontario has accelerated the advancement of quantum information research and discovery, not only in Canada, but around the globe.

STRATEGIC OBJECTIVES

IQC is guided by three strategic objectives developed in partnership with what is now the Ministry of Innovation, Science and Economic Development Canada:

1. To establish Waterloo as a world-class centre for research in quantum technologies and their applications.
2. To become a magnet for highly qualified personnel in the field of quantum information.
3. To be a prime source of insight, analysis and commentary on quantum information.

GOVERNANCE

IQC is a University Research Institute at the University of Waterloo as defined by Policy 44. IQC operates within the University of Waterloo policies and with an organizational structure that safeguards the independence of scholarship associated with the Institute and the academic freedom of its members.

CONSTITUTION

IQC's governance structure is outlined in its constitution, as defined by Policy 44. The IQC constitution was developed by the regular members of IQC over a series of 11 meetings spanning 14 months and was approved by IQC members on September 14, 2016. See Appendix A for the IQC Constitution.

EXECUTIVE COMMITTEE

As defined by Policy 44, IQC's governing body is its executive committee comprised of:

- VP Research (chair)
- Associate VP University Research
- IQC Executive Director
- IQC Managing Director (non-voting)
- Three regular members of IQC
- Chair of IQC Board of Directors (non-voting)
- Deans of Science, Mathematics and Engineering.

SCIENTIFIC ADVISORY COMMITTEE

IQC's Scientific Advisory Committee (SAC) is comprised of international scientists to assess IQC's scientific progress and advises the Executive Director on areas of strengths and weaknesses in terms of academic research opportunities. The SAC meets annually and currently includes the following members:

- Chris Monroe, University of Maryland (Chair)
- Harry Buhrman, Centrum voor Wiskunde en Informatica (CWI)
- Sir Anthony Leggett, University of Illinois at Urbana-Champaign Anthony
- Chris Monroe, University of Maryland
- Umesh Vazarani, University of California
- Anton Zeilinger, University of Vienna
- Wojciech Zurek, Los Alamos National Laboratory

See Appendix B for biographies.

ADVISORY BOARD

IQC's external Advisory Board is appointed by the President of the University of Waterloo. Its members provide advice to the Institute and serve as ambassadors and advocates communicating IQC's goals, programs and achievements to industry, government and the general public. Members include:

- Mike Lazaridis, Co-Founder of Quantum Valley Investments (Chair)
- Peter E. Brown, Senior Practice Partner, Deloitte Canada
- Tom Brzustowski, former President of NSERC (past Chair)
- Robert Crow, IQC Managing Director
- George Dixon, VPUR, University of Waterloo
- Robert Dunlop, former ADM Industry Canada
- Cosimo Fiorenza, VP and General Counsel, Quantum Valley Investments
- David Fransen, former Consul General in Los Angeles
- Raymond Laflamme (ex-officio) Executive Director, Institute for Quantum Computing
- Mark Pecen, CEO, Approach Infinity Inc.

See Appendix C for biographies.

LEADERSHIP TEAM



RAYMOND LAFLAMME

Executive Director



KEVIN RESCH

Deputy Director



DAVID CORY

Deputy Director

NOTE: In late 2016, a search committee was struck for the next Executive Director of IQC. The committee is chaired by the Vice-President, University Research and includes regular members of IQC. The committee is currently seeking applications for the Executive Director position.

Managing Director: Robert (Bob) Crow

Quantum NanoFab: Vito Logiudice

Administration: Lorna Kropf

Communications and Strategic Initiatives: Tobi Day-Hamilton

Finance: Matt Schumacher

Information Technology: Steve Weiss

SCIENTIFIC DIRECTION

Quantum information science is by its very nature a highly interdisciplinary field of research. Key advances in the field draw from a range of traditional academic fields including computer science, mathematics, chemistry and materials science, theoretical and experimental physics, and engineering.

IQC researchers span the faculties of science, mathematics and engineering at the University of Waterloo, and work either collaboratively or independently to address a wide spectrum of research challenges at the forefront of quantum information science. Some of the central issues in these areas are given below.

Quantum information theory

Given that information is physical, and our fundamental physical theory is quantum mechanical, this means that we need to study how the laws of quantum mechanics enable and constrain our capability to transmit and share quantum information through the systematic study of quantum channels.

The behaviour to transmit and store quantum information has novel implications for a notion of currency, or quantum money, which IQC faculty member John Watrous has recently investigated. Debbie Leung discovered the surprising results that quantum channels with almost no capacity to communicate quantum data can be capable of transmitting classical data privately at high rate and that shared entanglement can improve the rate of classical communication. The latter result inspired an experiment between her group and Kevin Resch's quantum optics group. The transmission of quantum information in the real-world context of lossy quantum channels requires an understanding of the resources required to overcome these losses. This is the subject of recent work by IQC member Ashwin Nayak who developed a coding scheme that achieves a constant communication rate for constant error-rate (a goal that is desirable for realistic situations) for interactive quantum communication. Recent progress at IQC also includes work by Joseph Emerson who developed a resource theory for magic-state distillation.

IQC faculty will continue to engage in research projects concerning fundamental mathematical properties of quantum states, measurements, and channels, including for example, ongoing work on characterizing the amount of entanglement needed in certain quantum protocols and studying notions of information content of quantum messages in an interactive communication protocol, with potential applications to quantum algorithms and quantum complexity.

Quantum algorithms

Perhaps the most notable and disruptive capability of quantum information is the capacity of a quantum computer to execute algorithms which are not possible with conventional computers. The dramatic impact of this capability was made clear at the end of the 20th century when it was realized that a quantum computer could efficiently factor large numbers—a critical problem in modern cryptography—and to efficiently simulate complex quantum systems, which has broad applications including the design of quantum materials and quantum chemistry.

IQC faculty have played a key role in extending our understanding of the scope and practical realization of quantum algorithms. Notable past achievements include Nayak's general framework for using quantum walks in algorithms in a composable and efficient manner. This gave a unified, simple, and in some cases more efficient algorithms for important problems. It has also been used in several subsequent works for designing fast quantum algorithms. More recently, Richard Cleve and Andrew Childs made several important contributions, including an approach to simulating Hamiltonian dynamics with a truncated Taylor series, and demonstrating an exponential improvement in precision for simulating sparse Hamiltonians.

Future work in this area will include efforts to find more efficient methods to simulate complex and sparse Hamiltonian systems with small, near-term quantum information processors.

Quantum complexity theory

An important research aim is to clarify the capabilities of quantum computers to solve hard classical problems, a field known as quantum complexity theory. An important achievement in this area was provided by John Watrous' work on quantum interactive proof systems. More recently, work by Nayak proposed several notions of information content of quantum messages and studied these in the context of Augmented Index, a basic function in communication complexity.

This work established a trade-off between the amount of classical and quantum information two parties necessarily reveal about their inputs in the process of the computing the function in a distributed fashion. Nayak and collaborators also gave alternative proofs of the quantum substate theorem based on convex programming and SDP duality that are both shorter and conceptually simpler. The theorem has led to a number of important applications in quantum communication and information theory.

Future research directions in this area include studying the relationship and ramifications of one-shot information-theoretic concepts in communication complexity, and studying notions of information content of quantum messages in interactive communication protocols, with potential applications to quantum algorithms and quantum complexity.

Quantum error-correction and **fault-tolerance**

Quantum computing enables disruptive new capabilities over classical computation, such as Shor's algorithm and the universal simulation of complex quantum systems that will help advance material science, quantum chemistry and many other key fields. However, the same complexity also introduces novel challenges for the design and characterization of quantum information processors. Quantum computing is extremely sensitive to noise and control imperfections and thus requires a significant role for error-correction methods to mitigate the inevitable errors that accumulate during a quantum computation.

Raymond Laflamme has developed new quantum methods to protect quantum information to improve robust control over quantum systems. Another challenge in this context is finding practical methods for characterizing the impact of error sources and validating the realization of a quantum advantage with quantum computers. Joseph Emerson pioneered the development of scalable and robust methods for the practical characterization of error rates in prototype quantum computers; these methods have now been broadly adopted by the world-leading experimental labs developing quantum computers. Emerson's more recent work has extended the scope and robustness of these protocols to capture more detailed features of the errors, enabling better selection amongst quantum error correction strategies. Some of the protocols have been implemented in the lab by the group of Jonathan Baugh and Laflamme. Emerson also demonstrated that a key feature of quantum mechanics, known as quantum contextuality, is a critical resource for the experimental realization of a quantum complexity advantage with quantum computers. Future work in this area includes developing a comprehensive set of tools for characterizing, optimizing and validating the performance of the prototype quantum computers that are now emerging from today's leading experimental labs.

Quantum **cryptology**

One of the key applications of quantum information is the ability to establish a method of secure communication that is guaranteed by physical properties rather than the assumed hardness of certain computational problems. This ability stems from uniquely quantum phenomena such as entanglement, the no-cloning theorem, Heisenberg's Uncertainty Principle, and measurement-disturbance relations. Collectively, protocols which achieve secure communication are referred to as quantum key distribution (QKD), which is a form of quantum cryptology.

IQC faculty have been actively involved in advancing this area both theoretically and experimentally. Thomas Jennewein and Laflamme have led efforts to build a satellite QKD system. Norbert Lutkenhaus has made important contributions to developing a theoretical framework for QKD that accounts for the physical constraints of real-world devices.

Future work in this area will focus on continued development of a theoretical framework for establishing the security of QKD in real-world systems and their practical implementation.

Optical quantum information processing

Quantum optics describes the aspects of light that cannot be understood using classical physics as described by Maxwell's famous equations. Some of these quantum features include the particle, or photon, nature of light and entanglement. Quantum bits can be encoded into the polarization states of single photons, or more complex degrees of freedom like the energy, or angular momentum.

Optical systems are central to quantum information science as they are nearly ideal carriers of quantum states over large distances. They have been used to distribute quantum information over 140km for quantum cryptography and fundamental tests of nature by a team including Jennewein. They play a crucial role quantum computing and quantum sensors as well. For example, in the breakthrough scheme of linear optics quantum computing developed by Laflamme and coworkers, scalable quantum computing could be achieved using single photons, linear optical elements, and measurement.

Finding new methods for controlling the properties of light and developing and implementing novel quantum communication protocols are central goals in this area. For example, Jennewein and Kevin Resch have developed a new source of entangled triplets of photons. Lutkenhaus will develop practical quantum communication protocols based on optical systems. Resch will explore nonlinear optical interaction between single or entangled photons and shaped laser pulses for engineering quantum states of light. Michal Bajscy is developing techniques for pairs of photons to strongly interact using atoms in hollow core optical fibres for all-optical quantum logic gates and quantum memories; Bajscy will also develop optical frequency conversion of single photons from microwave to optical frequencies enabling long distance quantum communication between superconducting quantum systems. Jennewein will develop the technology to perform quantum communication between a ground station and a low-earth orbit satellite.

Nanophotonics

The behaviour of light can be significantly modified when it is confined or generated from small structures. The field of nanophotonics aims to design and build such structures for controlling the properties of light and enhancing light-matter interactions. Many of the tools housed in the Quantum NanoFab facility are essential for growing these systems.

Artificial atoms called quantum dots act like single emitters of light, which can be used to generate just one photon at a time. Nitrogen-vacancy (NV) centres in diamond also act like single atoms held fixed in space embedded into the diamond lattice with rich spin physics based on the electrons in the centre and the surrounding nuclei. Michael Reimer has developed bright and efficient single-photon sources based on quantum dots grown inside tapered semiconductor nanowires. David Cory has developed theoretical techniques for understanding the interaction of spins and many body interactions with optical cavities. Reimer will extend his nanowire platform to generating entangled photon pairs for quantum communication and use waveguide methods for developing highly efficient single-photon

counting detectors. Cory will build sensitive chemical sensors with optical readout using the properties of diamond NV centres.

Superconducting quantum **systems**

Electronic circuits, when cooled to very low temperature, can exhibit quantum behaviour analogous to optical photons and atoms. These systems are fabricated as opposed to naturally occurring, and can thus be engineered with several important parameters widely tunable through the geometry and layout of the electrical components.

Superconducting qubits have seen dramatic improvements in the coherence times over several orders of magnitude in the past decade and are now being connected into complex multi-qubit quantum systems with high-fidelity control over the qubit interactions. IQC faculty Adrian Lupascu, Matteo Mariantoni, and Chris Wilson have developed superconducting quantum systems in their labs.

Lupascu and Wilson have engineered the interaction between superconducting qubits and an electromagnetic field to enter a new regime of light-matter interaction in which the interaction frequency is larger than the natural frequency of the qubit. Mariantoni has developed a 3D superconducting qubit wiring technique called a Quantum Socket to enable the complex electrical control over superconducting circuits. Lupascu and Wilson will focus on simulation of effects combining physics of quantum mechanics and relativity, such as the Unruh and Casimir effects, in superconducting systems. Mariantoni will push the state-of-the-art in quantum error correction in these systems. Lupascu will use superconducting qubits as the platform for studying a model of quantum computation known as quantum annealing.

Atomic quantum information **processing**

Atoms, the building blocks of matter, are naturally occurring quantum systems. Technological advances such as laser cooling and trapping have enabled the study of ultracold atoms and ions in highly controlled environments. For example, atoms can be stored in a variety of electrical and optical traps for diverse studies ranging from the physics of single atoms and ions to the collective properties of millions. This is a very clean system for studying so-called many-body physics and quantum phase transitions.

Crystal Senko has developed coherent control techniques in ion traps involving up to 18 ions. Rajibul Islam has measured entanglement using the Renyi entropy in atomic systems. Kyung Choi will build an experiment to couple highly excited atomic states, called Rydberg states, to high fidelity optical cavities to study the many-body physics with complex controllable interactions. Senko will experiment with long chains of coupled ions to study Haldane physics in a strongly interacting ionic crystal. Islam will develop quantum simulators of magnetic materials using trapped ions.

Spin quantum information processing

Spin refers to a special kind of angular momentum inherent to quantum systems, such as electrons and atomic nuclei. In some, so-called spin-1/2 particles, the spin is a natural two-level quantum system or qubit, one that can be controlled using magnetic fields. This is the basis for nuclear magnetic resonance (NMR) and electron spin resonance (ESR) quantum information processing.

Laflamme demonstrated coherent control over 12 spin qubits in a magnetic resonance experiment pushing the limits of complexity in quantum information processing. Cory developed methods for high resolution NMR imaging of materials and applied the techniques originally developed for NMR to other physical systems such as superconducting and NV centres. Cory and Emerson developed a theoretical model for the statistical fluctuations known as quantum spin noise. Raffi Budakian successfully applied NMR and force microscopy technique for single-spin detection in solids as well as NMR for nuclear spins with nanoscale resolution.

In the future, Budakian will improve the spin sensitivity and spatial resolution of his pioneering measurement techniques for determining structure of complex biomolecules and quantum sensing with single electron spins. Laflamme will implement ideas and concepts of quantum information processing using nuclear and electron spins to develop scalable methods to control quantum systems.

Neutron interferometry

Neutrons are the electrically neutral particles making up the nuclei of atoms, along with the positively charged protons. Neutrons can be produced from reactors which are relatively slow with a narrow range of velocities. These neutrons are ideally suited for interferometry, with a strong analogue to optical systems, with some fundamental differences related to the neutron's mass, relatively slow velocities, and sensitivity to magnetic fields.

Dmitry Pushin and Cory developed neutron interferometers exploiting quantum error correction techniques making them robust against vibrations. They also demonstrated control and detection of neutron orbital angular momentum states. Cory plans to develop the neutron interferometers with engineered neutron quantum states as a measurement tool characterize proximate-effect based quantum materials. Emerson, Pushin and Cory plan to probe the limits of the quantum coherence of neutrons with high-precision tests of multipath quantum interference.

Quantum materials

Developments in materials science is enabling for many technological fields. As just one example, materials with certain magnetic or optical properties allow for extremely high density storage of information. Recently new classes of materials have been discovered which have surprising quantum properties such as certain topological features or quasiparticles called Majorana or Weyl fermions. Some properties of these materials are

predicted to have applications in quantum information processing, such as topologically protected quantum error correction or certain quantum statistics which naturally implement quantum logic operations.

Guo-Xing Miao has shown that magnetic semiconductors can produce extremely large effect magnetic fields, far exceeding the fields from even the best superconducting external magnets. Budiakian discovered experimentally a new quantum state of matter called a half-quantum vortex in the superconductor strontium ruthenate; he is now working toward manipulating these states for applications in topological quantum computing. Miao has developed the capability to make some of the best quantum materials in the world and aims to develop the exotic materials required for quantum logic based on braiding.

Transformative Quantum Technologies

This seven-year program, led by David Cory, aims to develop and deploy impactful quantum devices. TQT is a \$144M initiative with \$76.3M from CFREF, \$33M from the University of Waterloo and \$35M in industry and other contributions. It represents the largest research grant ever received by the University of Waterloo.

The program has three components:

1. Undertake focused, team driven research on three grand challenges, essential steps toward building a quantum technology industry, where success will unlock the capabilities of future quantum technologies:
 - Demonstrate a **quantum computer** that is beyond the ability for a classical processor to simulate;
 - Develop and commercialize **quantum sensors** that have applications in navigation, materials, biochemistry, medicine and other fields;
 - Deploy useful, **long-distance quantum communication**/key distribution (QKD) in partnership with the University of Ottawa.
2. Enhance Waterloo's research infrastructure for quantum technologies. This includes substantial investments in shared fabrication and metrology tools. In addition, TQT will support new technical staff to enable the effective use of such tools. TQT will also coordinate with Quantum Valley partners, including Quantum Valley Investments and the newly established Quantum Valley Ideas Lab to support an eco-system for the realization, application and commercialization of quantum technologies.
3. Invest in exploring broader applications of quantum technologies. This includes establishing a Seed Grants program in quantum for researchers across the university, funded at a level of \$500,000/yr. TQT will also engage "early adopters" to seek new applications in medicine, health, environment, materials, etc. Quantum capabilities will also be expressed through industry workshops and related collaborative initiatives.

This program builds on IQC's global reputation, infrastructure and research community with a mission driven agenda to bring quantum technologies to market. It will strengthen and complement IQC in many ways, including adding six new faculty slots in quantum

information, providing access to startup funds and additional renovation costs. It offers an exciting research agenda, which will attract a large and diverse new body of researchers to the institute. The teams working on grand challenge projects will include many IQC researchers. The upgrades of the Quantum Nanofab and metrology tools and related staffing brings new capabilities to researchers. In addition, TQT support will allow greater access to specialized materials science and testing tools in the RAC complex. TQT will amplify the overall research activities in IQC and enable yet more connections both across campus and to a broad range of new applications.

ACHIEVEMENTS | RESULTS

The collective wealth of knowledge and research conducted at IQC has resulted in many published papers in prominent journals and has been internationally recognized. In this section, we detail a few of the scientific achievements of IQC researchers over the past five years.

Establishing Waterloo as a World-Class Centre for Research in Quantum Technologies and their Applications

IQC's researchers continue their aggressive pursuit of research excellence in quantum computing, quantum communication, quantum sensors and quantum materials. IQC members form a multidisciplinary community of researchers from the Faculties of Science, Mathematics and Engineering spanning seven different departments.

Over the past five years, IQC has solidified its role as a world-class centre for quantum information research by attracting leading researchers, postdoctoral fellows and graduate students; by conducting research at the highest level; by collaborating with fellow researchers from across the globe; and by continuing to garner research funding and awards.

Research Highlights

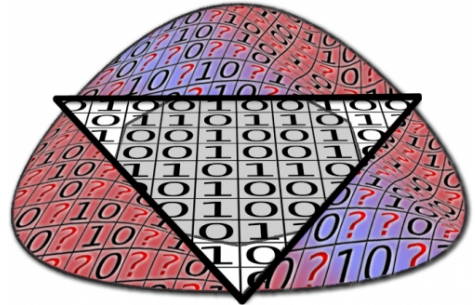
Contextuality supplies the 'magic' for quantum computation

Published in Nature, June 2014

<http://www.nature.com/nature/journal/v510/n7505/full/nature13460.html>

Researchers showed that a weird aspect of quantum theory called contextuality is a necessary resource to achieve the so-called magic required for universal quantum computation.

One major hurdle in harnessing the power of a universal quantum computer is finding practical ways to control fragile quantum states. Working towards this goal, IQC researchers Joseph Emerson, Mark Howard and Joel Wallman confirmed theoretically that contextuality is a necessary resource required for achieving the advantages of quantum computation.



Quantum devices are extremely difficult to build because they must operate in an environment that is noise-resistant. The term magic refers to a particular approach to building noise-resistant quantum computers known as magic-state distillation. So-called magic states act as a crucial, but difficult to achieve and maintain, extra ingredient that boosts the power of a quantum device to achieve the improved processing power of a universal quantum computer.

By identifying these magic states as contextual, researchers will be able to clarify the trade-offs involved in different approaches to building quantum devices. The results of the study may also help design new algorithms that exploit the special properties of these magic states more fully.

Contextuality was first recognized as a feature of quantum theory almost 50 years ago. The theory showed that it was impossible to explain measurements on quantum systems in the same way as classical systems. Contextuality means that quantum measurements cannot be thought of as simply revealing some pre-existing properties of the system under study. That's part of the weirdness of quantum mechanics.

Controlling neutron orbital angular momentum

Published in Nature, September 2015

<http://www.nature.com/nature/journal/v525/n7570/full/nature15265.html>

An experiment by a team of researchers led from IQC demonstrated, for the first time, that a wave property of neutrons, Orbital Angular Momentum (OAM), can be controlled. This newfound control means that researchers can now use neutron OAM beams to see inside materials that optical, x-ray or electron OAM beams can't penetrate. This control can help measure the magnetism, for example, in magnetic materials, as well as deeper probes of superconducting and chiral materials.

Neutrons are the probe of choice for many materials. Researchers use neutrons to learn more about material properties, such as crystalline structure or magnetic signature. Neutrons are massive, penetrating and neutral particles, and they also exhibit wavelike properties.

OAM is associated with the rotation of an object around a fixed axis. For example, the OAM of a planet around the sun is related to the distance of the planet to the sun and its speed. Control of OAM has already been shown using different methods for beams of optical light, x-rays and electrons.

It was at a talk about electron OAM where Research Assistant Professor Dmitry Pushin, a member of the Department of Physics at the University of Waterloo, and collaborator Charles Clark of the Joint Quantum Institute in Maryland conceived of the idea to control neutron OAM. Pushin then designed the experiment to prove it.

Pushin's experiment uses neutrons created by a nuclear reactor at the National Institute of Standards and Technology (NIST) and passes them through a Mach-Zehnder interferometer. Although there is never more than one neutron in the interferometer at any given time, the neutron can be thought of as a pulse of waves. The neutron waves meet a blade of silicon and break into sub-beams. One of those beams then hits a spiral phase plate which impresses a twist on the neutron beam, giving a different OAM to the waves taking that path than the waves taking the other path. The twist quantizes, or entangles, the path.

The sub-beams then strike a second silicon blade that directs the two beams to the same spot on the third blade. Before the two sub-beams merge and interfere with each other at the third blade, a phase flag fine-tunes the phase of the neutron sub-beams. Finally the interference pattern is recorded at the third blade in a two-dimensional detector to confirm that the extra OAM has been controllably imparted.

Ultrastrong coupling of a single artificial atom to an electromagnetic continuum in the nonperturbative regime

Published in Nature Physics, October 2016

<http://www.nature.com/nphys/journal/v13/n1/full/nphys3905.html>

Researchers recorded an interaction between light and matter 10 times larger than previously seen. The strength of the interaction between photons and a qubit was so large that it opens the door to a realm of physics and applications unattainable until now.

The ultrastrong coupling between photons and qubits may lead to the exploration of new physics related to biological processes, exotic materials such as high-temperature superconductors, and even relativistic physics.

To conduct the experiment, the researchers fabricated aluminum circuits in the University of Waterloo's Quantum NanoFab, and then cooled them in dilution refrigerators to a temperature as low

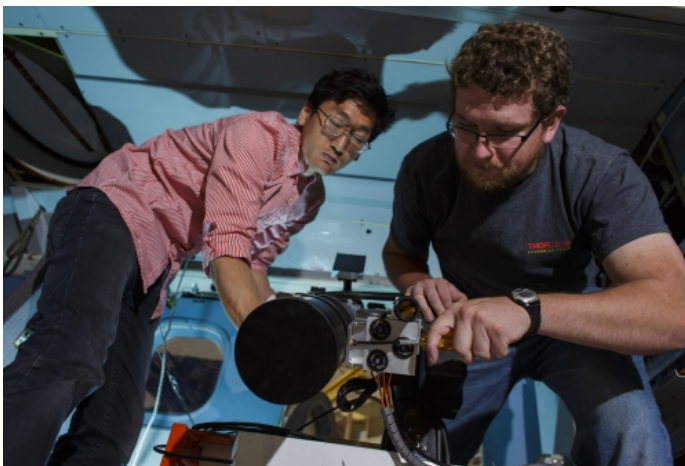


as one per cent of a degree above absolute zero. The circuits become superconducting at these cold temperatures, meaning that they can carry a current without resistance or losing energy. These aluminum circuits, known as superconducting qubits, obey the laws of quantum mechanics and can behave as artificial atoms.

To control the quantum state of a superconducting circuit, the researchers sent photons using microwave pulses into the superconducting circuit and applied a small magnetic field through a coil inside the dilution refrigerator. By measuring the photon transmission, the researchers could define the resonance of the qubit, indicated by the reflection of the photons off the qubit. Usually, the qubit resonance is centered around a very narrow range of frequencies.

Airborne demonstration of quantum key distribution

October 2016 - The results and technical details to be published in a peer-reviewed scientific journal



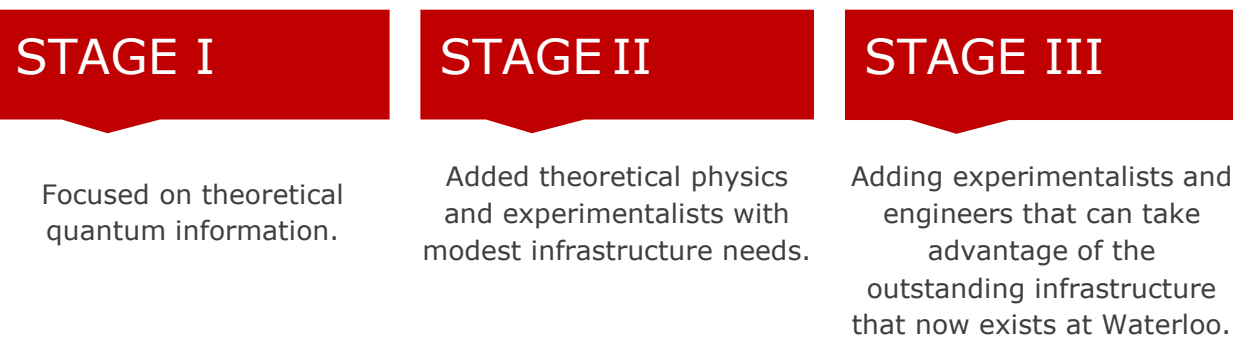
A team, led by IQC faculty member Thomas Jennewein, has successfully demonstrated quantum key distribution (QKD) between a transmitter on the ground and a receiver payload onboard an airplane. While researchers in Germany and China have previously conducted QKD experiments with quantum transmitters flown on an aircraft and a tethered low-altitude balloon, Jennewein's team is the first to demonstrate a QKD link with an airborne quantum receiver.

For this experiment, the ground-based transmitter infrastructure at Smiths Falls-Montague Airport sent photons to the quantum receiver passing by in the air. The airborne system was designed and built under the leadership of Jennewein and his team, in collaboration with industry partners and the Canadian Space Agency (CSA) while the ground station system was designed and built by the team with support from the Canadian Innovation Fund and the Ontario Research Fund

Several groups around the world are studying how to transmit photons over global distances. Jennewein has been strategically involved in shaping and advancing long-distance and satellite-based quantum communications technologies for over a decade. These most recent airborne experiments performed by the IQC team demonstrate the viability of the Canadian satellite mission concept Quantum Encryption and Science Satellite (QEYSSat) and the payload prototype.

Faculty Hiring and New Faculty Members

IQC is committed to bringing the best researchers in the world in quantum information to the Faculties of Mathematics, Science, and Engineering at the University of Waterloo. The faculty hiring has been guided by a growth plan:



In the first phase, growth was related to Waterloo's traditional expertise in mathematics, cryptography, and computer science and focused on theorists in quantum information science. In the second phase, IQC began also hiring experimentalists whose infrastructure requirements were relatively light, comprising the areas of optical- and spin-based quantum information processing.

Now, in the third phase, IQC is continuing to hire theorists and light experimentalists, but is adding experimentalists and engineers that can take advantage of the infrastructure available in the Mike and Ophelia Lazaridis Quantum-Nano Centre and Research Advancement Centre Buildings. These facilities include the Quantum NanoFab, a state of the art fabrication facility for building quantum devices and the Quantum Valley Investments' Quiet Labs, a pristine environment with strict isolation specifications from vibration and electromagnetic fields for ultrasensitive experiments.

One area in which IQC is actively searching for faculty is in theoretical physics, specifically those working on theory related to actual physics experiments (as opposed to more abstract and idealized models). Such new hires will complement the efforts of Joseph Emerson and Norbert Lutkenhaus, helping to build stronger bridges between theory and experiment as well as help understand the results of experiment and guide future work through detailed theoretical understanding of the physical systems in the experimental labs.

Commitment to Equity

In an effort to foster a safe, equitable and inclusive community, in 2015 IQC established a dedicated Equity & Inclusivity Committee, with representatives from faculty, students and staff. The committee developed Equity Guidelines for IQC, the first institute to do so on campus, with guidance from the University of Waterloo's Equity Office, the Special Advisor to the President on Women's and Gender Issues, Associate Provost Resources and Conflict Management and Human Rights Office.

The IQC Equity Committee is guided by the following strategies:

- Create a working environment that respects, promotes and celebrates diversity;
- Work to achieve better representation of designated populations in each of IQC faculty, staff, postdocs, students;
- Ensure that every member of the community has access to the training and resources they need to contribute to this environment;
- Leverage the special structure and resources of IQC to support equity goals;
- Communicate, communicate, communicate!

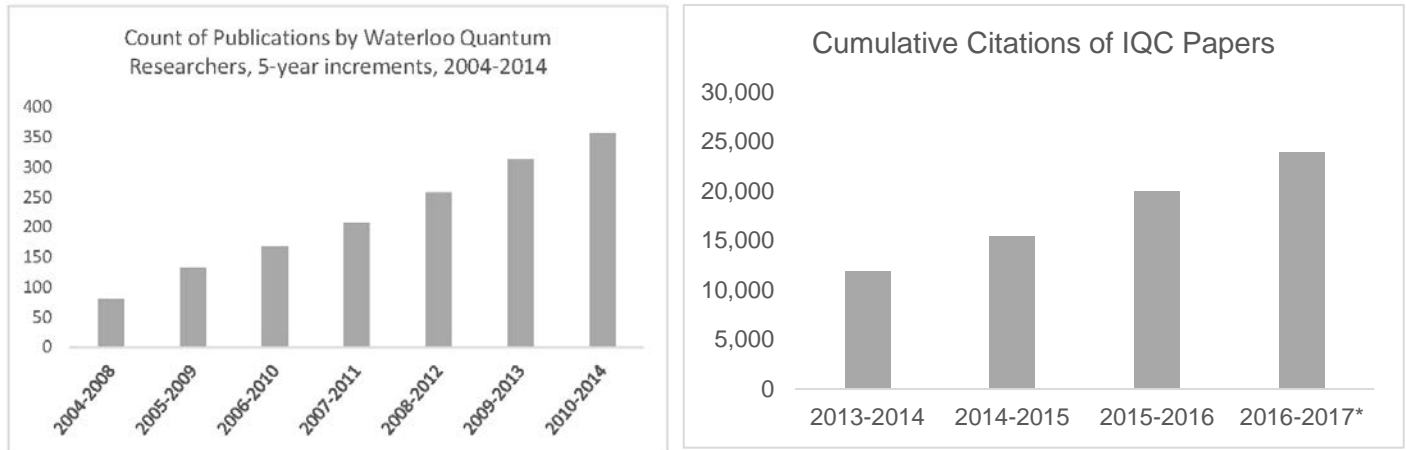
To date, IQC has included equity and diversity in its practices and procedures:

- Invited the American Physical Society (APS) to conduct an equity consultation which included interviews with IQC faculty, postdocs, students and staff;
- Developed and distributed *IQC Guidelines for Equity and Inclusion* which are also included in all onboarding for new members;
- Ensured equitable hiring practices training for all IQC members;
- Sponsored activities of the FemPhys student group;
- Participated in training in the University of Waterloo's Space Maker program (specific to LGBTQ+) for IQC members;
- Added a question on the IQC Exit Survey for students and postdoctoral fellows addressing inclusivity;
- Currently developing a Code of Conduct for IQC and/or IQC conferences;
- Addressing accessibility issues within the Lazaridis Centre building;
- Holding a women-only OpEd writing session;
- Hosting the Women in Physics Canada conference July 26-28, 2017 in partnership with the Department of Physics and Astronomy.

IQC will continue its commitment to equity as it grows ensuring a safe and inclusive environment for all members.

Publications and Citations by IQC Researchers

Papers published by IQC researchers are one indication of research output. Since the beginning of the fiscal 2012-2013 fiscal year, IQC researchers collectively published approximately 668 papers. This is 148 more papers than in the previous five years and equates to an average of 144 publications per year (or 29 every quarter).



Source: Web of Science from University of Waterloo Research Metrics Report 2016.

*2016-2017 reflects a partial year

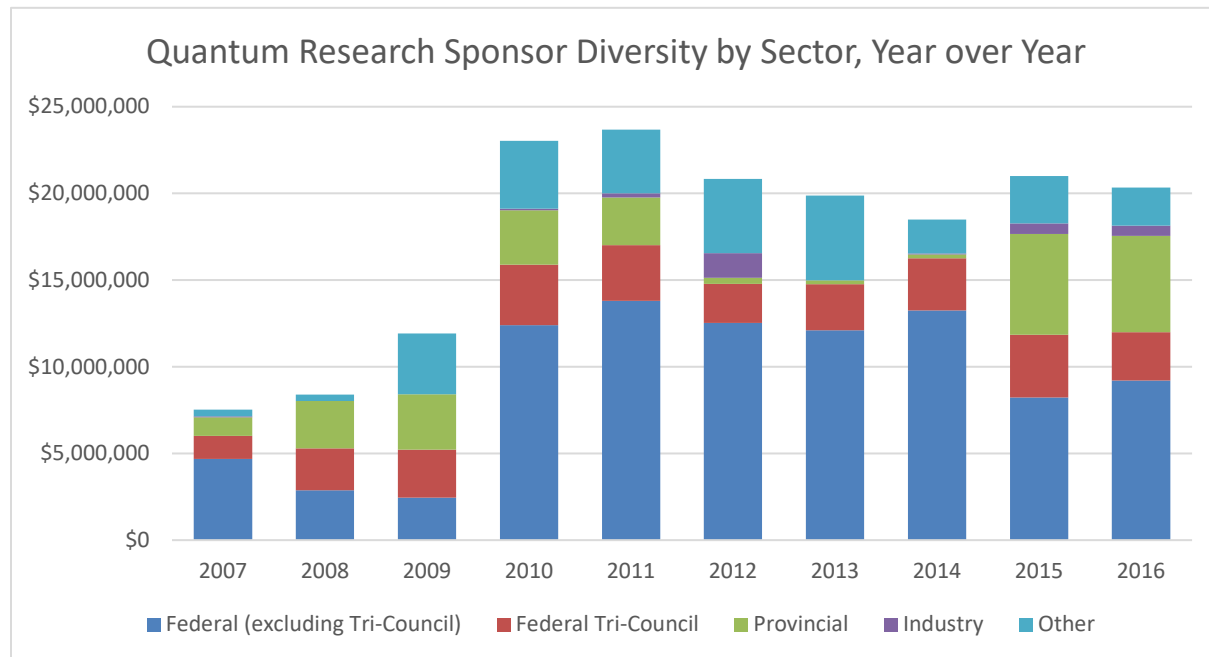
Highlighted Publications

Publication	2012-13	2013-14	2014-15	2015-16	2016-17*
Nature	1		2	1	3
Nature Photonics		3	2	1	2
Nature Physics	2	3		2	
Nature Communications	1	1	5	3	
Physical Review Letters	14	14	16	17	42
Science	1	1	3		4
FOCS	1				3
Journal of Mathematical Physics	6	4	4	6	1

A full list of current IQC publications can be found in Appendix D.

Research funding

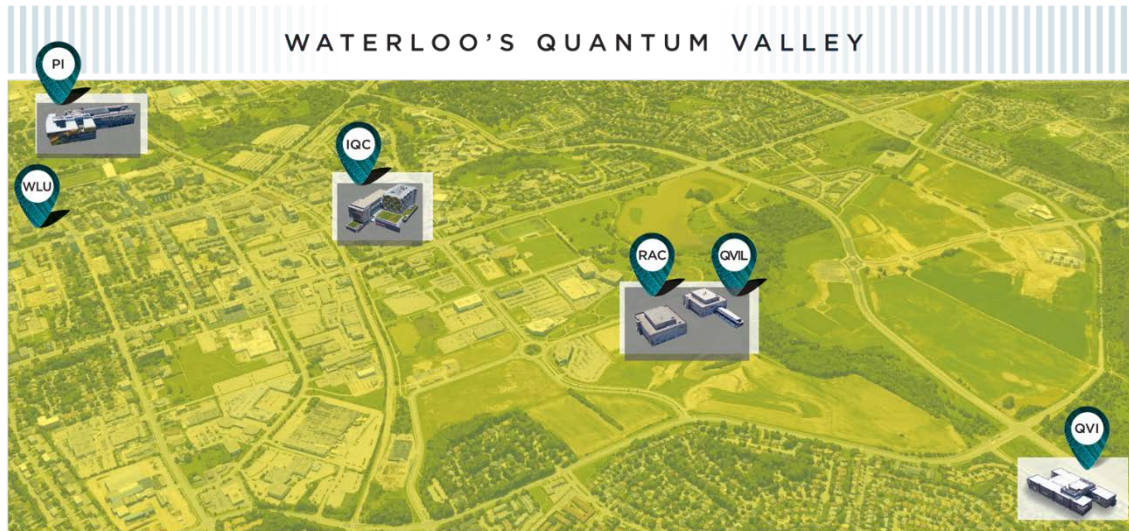
IQC researchers have been collectively awarded over \$100 million in research grants since 2012. These funds include research chair awards, funding from the Province of Ontario, the Government of Canada, the Canada Foundation for Innovation (CFI), industry partners and others.



Collaborations

Within the University of Waterloo: Quantum information science and the Institute for Quantum Computing are discussed prominently in the University of Waterloo's 2013-2018 Strategic Plan, which aims to build on the university's strong reputation as a highly innovative university. IQC is identified as a focused objective of the Transformational Research theme, whose principal goal is to increase the worldwide impact and recognition of University of Waterloo research.

Within the Quantum Valley: IQC sits within the Quantum Valley ecosystem, with partners including the following:



- **Perimeter Institute for Theoretical Physics.** A leading centre for scientific research, training and educational outreach in foundational theoretical physics. Founded in 1999, its mission is to advance our understanding of the universe at the most fundamental level, stimulating the breakthroughs that could transform our future. Perimeter also trains the next generation of physicists through innovative programs, and shares an appreciation for science with students, teachers and the general public.
- **Quantum Valley Ideas Lab.** A dedicated application focused research lab that will help address the gap between foundational research done in academic research labs and commercialization. The Ideas Lab will connect with industries to identify strategic opportunities for new quantum technologies with practical applications based on existing foundational physics principles.
- **Lazaridis Institute for the Management of Technology Enterprises.** An institute for developing training and research programs, which will produce exceptional tech-savvy business managers and leaders that Canadian technology companies need to grow and scale globally.
- **Quantum Valley Investment Fund.** A quantum technology investment fund established in 2013 by Mike Lazaridis and Doug Fregin with a commitment of \$100 million in investment capital. QVI has developed as a quantum technology commercialization incubator with the necessary components to enable and accelerate the commercialization of new transformative quantum technologies in the Quantum Valley.

Over 250 researchers work within 1km of IQC to advance the science, technology and commercial impact of quantum information.

Within Canada: IQC partners with peer Canadian institutions and organizations in pursuit of quantum information science and technology.

Raymond Laflamme, has been integral in bringing together quantum researchers from across Canada as the Program Director of the CIFAR Quantum Information Science program. The CIFAR program brings together 35 leading researchers from a multidisciplinary perspective to explore fundamental questions in the field, harness the power of quantum mechanics, and create quantum technologies. Several members of IQC participate in the Quantum Information Science program of the Canadian Institute for Advanced Research (CIFAR): Raymond Laflamme is the program's director; David Cory serves as a program advisor; and Raffi Budakian, Richard Cleve, Joseph Emerson, Thomas Jennewein, Debbie Leung, Michele Mosca, Ashwin Nayak, and John Watrous are program members.

CIFAR
CANADIAN
INSTITUTE
FOR
ADVANCED
RESEARCH

ICRA
INSTITUT
CANADIEN
DE
RECHERCHES
AVANCÉES

International Partnerships: IQC has signed seven international agreements to facilitate collaborative research projects, joint research projects, joint research and the pursuit of common scientific interests:

- Centre for Quantum Technologies (Singapore)
- Delft University of Technology (Netherlands)
- Korea Institute of Science and Technology (Korea)
- Raman Research Institute (India)
- Technion Israel Institute of Technology (Israel)
- Tsinghua University (China)
- University of Science and Technology (China)



Patents and Spinoffs

As the field of quantum information research advances, commercializable technologies are emerging from IQC labs. IQC faculty hold over 50 patents and startup companies are being created to bring quantum technologies out of the labs and into the marketplace. The following companies have emerged from IQC research:

- HighQ
- Neutron Optics
- Universal Quantum Devices
- Qspin
- evolutionQ
- QuantumLaf Inc.
- Quantum Benchmarking Inc.

Note: In the past, researchers were not required to report on patents or commercialization activities. With this in mind, the number of patents and or licenses may actually be higher.

Commercial opportunities from quantum research are growing and attracting the attention of the private sector. Mike Lazaridis and Doug Fregin have created the Quantum Valley Investment fund to support commercialization efforts in quantum information research. This \$100 million fund will invest in breakthroughs in quantum information science that have the potential to lead to technologies and applications with commercial potential. IQC is also in regular contact with other potential investors and with leading companies including IBM, Microsoft and Fujitsu. These firms have considerable interest in our discoveries, people, and even location in Canada as a potential site for their own work.

The critical mass of research and commercialization opportunities happening at IQC will also leverage a wider, stronger network of funding and support from the innovation ecosystem in the Waterloo Region. From Quantum Valley Investments to the Accelerator Centre to the Communitech Hub, IQC researchers have a network of support unmatched anywhere in the world. IQC is uniquely positioned to leverage these relationships, support structures and funding opportunities.

Faculty Awards

IQC faculty members continue to set a high standard for excellence in quantum information research. This is evidenced in part by the many awards and acknowledgements garnered by the members at IQC. The following chart lists awards presented to faculty over the past five years.

Faculty Member	Awards Earned from 2012-Present
Raffi Budakian	WIN Endowed Chair in Superconductivity (2014)
Kyung Soo Choi	Early Research Award (2015-2016)
David Cory	Fellowship of the Royal Society of Canada (2015-2016) Fellow, American Physical Society (2015-2016)

Faculty Member	Awards Earned from 2012-Present
Raymond Laflamme	CAP-CRM Prize in Theoretical and Mathematical Physics, 2017 Canada Research Chair in Quantum Information (2002-present) Queen Elizabeth II Jubilee Medal, 2013 Honorary Degree, Université de Sherbrooke, 2012
Debbie Leung	University Research Chair, University of Waterloo (2015)
Matteo Mariantoni	Sloan Research Fellow (2013) Early Researcher Award (2013-2014)
Michele Mosca	University Research Chair, University of Waterloo (2012-2013) Queen Elizabeth II Diamond Jubilee Medal (2013-2014)
Ashwin Nayak	Queen Elizabeth II Diamond Jubilee Scholarship (2014-2015)
Kevin Resch	E.W.R. Steacie Fellowship, NSERC (2012-2013) Canada Research Chair in Optical Quantum Technologies (2013)
John Watrous	NSERC Discovery Accelerator Supplement (2014-2017) Outstanding Performance Award, University of Waterloo (2015-2016)
Christopher Wilson	Early Researcher Award (2013-2014)

Facilities for Research and Training

IQC is home to 51,832 square feet of lab space for training and research which span three buildings on campus and in the David Johnston Research and Technology Park..

Mike and Ophelia Lazaridis Quantum-Nano Centre

In September of 2102, IQC expanded into its new headquarters – the Mike and Ophelia Lazaridis Quantum-Nano Centre. This 285,500 square foot building, located on the main campus of the University of Waterloo, provides purpose-built labs, fabrication facilities and collaborative work space for all IQC researchers.

The space was designed and built with three guiding principles:

- Functional at the highest of scientific standards;
- Encourages interaction and collaboration between researchers;
- Will attract top scientists to Waterloo.



Equipped with controls for vibration, temperature, humidity and electromagnetic radiation, high level research can be conducted in the Lazaridis Centre Its many meeting rooms,

classrooms and 220-seat convertible auditorium enables lectures and events of various sizes and its six-story open atrium and lounge spaces create opportunities for members to interact daily.

Lazaridis Centre Laboratories

As of December 2016, there are 14 operational research labs in the Lazaridis Centre, with an additional four research labs currently being designed for experiments by three of IQC's more recently recruited faculty members: Rajibul Islam, Michael Reimer and Crystal Senko. In addition, there are four services labs (operational or in a design phase) which include an electronics shop, a chemical preparation lab, a staging lab and an educational outreach lab. Active research labs include:

- Quantum Photonics Laboratory
- Satellite Quantum Key Distribution Laboratory
- Integrated Quantum Optoelectronics Laboratory
- Quantum Verification Laboratory
- Laboratory for Digital Quantum Matter
- Quantum Optics and Quantum Information Group Laboratory
- Engineered Quantum Systems Laboratory
- Integrated Nano Electronics
- Ultracold Quantum Matter and Light

Quantum NanoFab Fabrication Facility

Officially opened in the fall of 2014, the Quantum NanoFab is an 8,000 square foot facility which includes a 6,750 square foot class-100 cleanroom with ISO 5 and ISO 6 certified process bays. The facility also includes a Sample Prep Lab for processing of non-standard materials as well as a Packaging & Device Assembly Lab for backend processing of fabricated devices.

The Quantum NanoFab toolset ranges from:

- Deposition equipment supporting ALD, PECVD, LPCVD and PVD technologies;
- Etch equipment supporting RIE, Ion milling, O₂ plasma and wet processing technologies;
- Lithography equipment including optical and electron-beam technologies;
- Characterization equipment including surface profiling, sheet resistance and thin film stress measurement, ellipsometry and microscopy;
- Packaging equipment including wafer dicing, cleaning (wet & H₂ plasma), die bonding, wire bonding and epoxy encapsulation.

In addition to serving external academic and industrial users, the Quantum NanoFab includes over 120 lab members under 32 Principal Investigators spanning eight departments under the Faculties of Engineering and Science at the University of Waterloo. The Quantum NanoFab Team aims to best serve and grow the facility's community of lab members by providing a rigorously controlled lab environment in which detailed Standard Operating Procedures are made available for each piece of available equipment. These SOP's are coupled with extensive safety training as well as comprehensive and mandatory hands-on equipment training for all new lab members. In an effort to maximize membership research

output, characterized and stable baseline processes as well as nanofabrication process support are available to all registered users.

Research Advancement Centres (RAC I & II)



Since 2008, IQC has occupied 10,000 square feet of a building north of campus in the David Johnson Research and Technology Park - the Research Advancement Centre I (RAC I).

In 2010, the adjacent RAC II building opened and each continues to house IQC laboratories and researcher offices.

RAC I

There are four active experimental labs currently housed in RAC I with additional labs and a 1,650 square foot cleanroom in the design and preparation phase. Below is a list of operational labs in RAC I:

- 10,000 sq ft
- 8 experimental labs and a 1,650 sq ft cleanroom facility
- Nuclear Magnetic Resonance Lab
- Electron Spin Resonance
- Coherent Spintronics Lab
- Quantum Photonics Laboratory
- Magnetic resonance force microscopy lab
- Quantum Photonic Devices Lab
- Cleanroom – certified class-1000

RAC II

The RAC II laboratories are centered around spin-based and hybrid approaches to quantum research, with emphasis on the development and engineering of sensitive and robust quantum sensors, actuators and transducers, with the long-term goal of engineering practical quantum devices. Operational research lab spaces currently include:

- Nuclear magnetic resonance lab
- Electron spin resonance lab
- Diamond-based optically detected magnetic resonance lab
- Electrical quantum transport lab
- Low temperature physics lab
- Quiet lab suite for optical, low temperature and MRFM experiments
- Ultrahigh vacuum cluster deposition system
- Material growth lab.

RAC II also contains a collection of research support facilities, including:

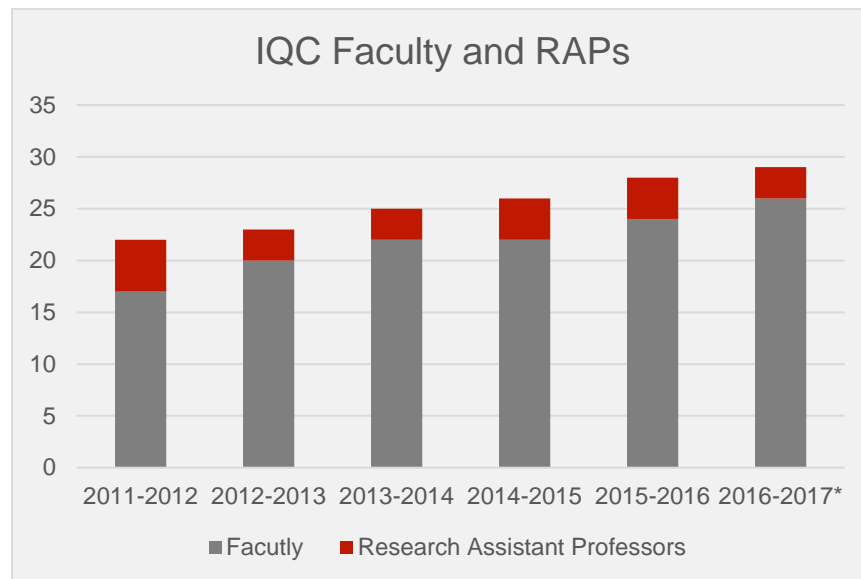
- RF probe building
- Wire bonding
- Atomic force and scanning tunneling microscopy
- Diamond turning
- Electronics
- Chemistry
- Machine shop
- X-ray crystallography.

Becoming a Magnet for Highly Qualified Personnel in the Field of Quantum Information

An important component of IQC’s mandate is to build and advance the field of quantum information research. To achieve this goal, IQC continues to attract leading researchers, postdoctoral fellows and graduate students to Waterloo. Additionally, IQC’s visitor program welcomes researchers from around the world to Waterloo to enhance our scientific community and provide unique opportunities for students to learn from the global institutions.

New Faculty Members

All regular IQC faculty members are appointed to IQC by the Executive Committee, based on the recommendation of the Executive Director, and hold appointments in departments at the University of Waterloo. Regular membership is normally for a five-year, renewable period.



IQC is now home to 28 full-time faculty members. Since 2012, IQC has welcomed 14 new members, four who have joined in the past year alone. At steady-state, IQC’s membership will reach 39 faculty (including 6 new positions allocated through the Transformative Quantum Technologies program). A full list of current faculty can be found in Appendix E.



Michal Bajcsy

Assistant Professor
Electrical & Computer
Engineering
2014

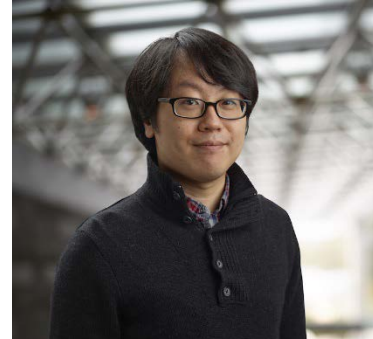
PhD in Applied Physics
from Harvard University
Postdoctoral training in
the Nanoscale and
Quantum Photonics Lab at
Stanford University
Focuses on the
development of scalable
photonic devices and
quantum optics
experimental platforms
based on quantum
coupled to nanophotonic
structures



Raffi Budakian

Professor,
Nanotechnology Chair in
Superconductivity
Physics and Astronomy
2014

Bachelor's, Master's and
PhD in Physics University
of California, Los Angeles
Winner of World
Technology Award in 2005
for work in the detection
and manipulation of
electron spins
Explores the application of
tools for ultra-sensitive
detection of electron and
nuclear spins



Kyung Soo Choi

Assistant Professor,
Physics and Astronomy
2014

PhD in Physics,
Postdoctoral Fellowship,
and Institute for Quantum
Information and Matter
Visiting Scientist at the
California Institute of
Technology
Senior Scientist at Korea
Institute of Science and
Technology 2011-2014
Focuses on building exotic
quantum systems with
strongly interacting atoms
and light



Kazi Rajibul Islam
 Assistant Professor
 Physics and Astronomy
 2016

PhD thesis recognized by the University of Maryland's Distinguished Dissertation Award
 Postdoctoral research at both Harvard University at the Center for Ultracold Atoms and MIT
 Addresses fundamental physics questions, concentrating on encoding and manipulating quantum information in a quantum many-body system using trapped ions



Na Young Kim
 Associate Professor
 Electrical and Computer Engineering
 2016

Graduate and postgraduate research in the Department of Applied Physics at Stanford University
 Senior Optical Engineer at Apple Inc. working on the development of small display products
 Aims to build large-scale quantum processors based on novel materials and advanced technologies



Matteo Mariani
 Assistant Professor
 Physics and Astronomy
 2016

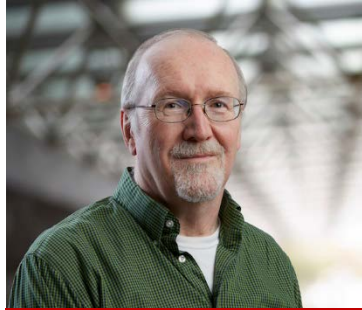
PhD from both the Walther-Meissner-Institute for Low Temperature Research and the Technical University of Munich
 Awarded the Elings Prize Fellowship in Science of the California NanoSystem Institute at the University of California, Santa Barbara
 Leads the Laboratory for Digital Quantum Matter



Guo-Xing Miao

Assistant Professor
Electrical and Computer
Engineering
2011

PhD from Brown University in 2006
Postdoctoral associate and research scientist at the Francis Bitter Magnet Laboratory at the Massachusetts Institute of Technology
Constructs spintronic devices with improved performances and scalability



Vern Paulsen

Professor
Mathematics
2016

PhD in Mathematics from the University of Michigan-Ann Arbor
Has written four graduate level texts in mathematics, published over 100 research articles, and won several teaching awards
Has been involved in Quantum Information Technology (QIT) programmes at Sweden's Mittag-Leffler Institute and Cambridge's Isaac Newton Institute



Michael Reimer

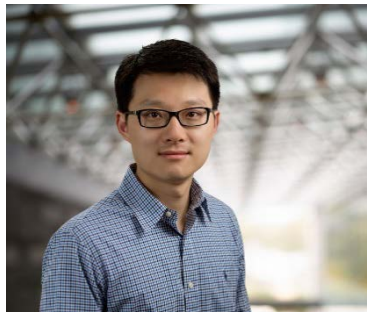
Assistant Professor
Electrical and Computer
Engineering
2016

BSc University of Waterloo, PhD in Physics at the University of Ottawa/National Research Council of Canada
Postdoctoral researcher at Technical University of Delft from 2009-2014
Focuses on the development of quantum photonic devices and optical approaches needed to advance quantum information science and technologies



Crystal Senko
 Assistant Professor
 Physics and Astronomy
 2016

PhD at the University of Maryland
 Postdoctoral Fellow at the Center for Ultracold Atoms, Harvard University
 Focuses on using trapped ions for quantum simulations and quantum computing applications, as well as encoding logical units of information using qudits



Adam Wei Tsen
 Assistant Professor
 Chemistry
 2016

PhD in Applied Physics at Cornell University
 Postdoctoral associate in the Department of Physics at Columbia University where he studied atomically thin quantum materials and incorporated them in nanoscale electronic devices
 Explores atomically thin quantum materials at IQC and develops novel quantum devices based on their exotic properties



Christopher Wilson
 Associate Professor
 Chemistry
 2012

PhD in Physics from Yale University
 Yale W.M. Keck Postdoctoral Fellow researching quantum computation and information processing
 Assistant Professor, then Associate Professor Chalmers University of Technology
 He continues his work on quantum information, microwave quantum optics and nonlinear dynamics



Jon Yard
 Associate Professor
 Combinatorics & Optimization
 2016

Earned his doctorate at Stanford University
 Held postdoctoral positions at McGill University, Caltech and Los Alamos National Laboratory
 At IQC, Yard tackles complex mathematical problems and looks for new solutions to existing problems by combining approaches from mathematics, physics, engineering and computer science

New Research Assistant Professors

In addition to the thirteen new faculty members, IQC also recruited two additional Research Assistant Professors since 2012.

Eduardo Martin-Martinez

Research Assistant
Professor
2014-2016

PhD in Theoretical Physics at Universidad Complutense de Madrid (UCM), Spain. Postdoctoral fellowship at the Institute for Quantum Computing at the University of Waterloo. Awarded Banting Postdoctoral Fellowship. Associate postdoctoral researcher at Perimeter Institute.

In 2014, named a Research Assistant Professor at the Institute for Quantum Computing, cross-appointed to the Perimeter Institute. Awarded the John Charles Polanyi Prize for Physics. In July 2016, appointed Assistant Professor in the department of Applied Mathematics at the University of Waterloo, an IQC Associate and a Perimeter Institute Affiliate.

William Slofstra

Research Assistant
Professor
2015

PhD in Mathematics from the University of California, Berkeley in 2011. Research Associate at the University of British Columbia. Krener Assistant Professor at the University of California, Davis. His research interests have focused on algebra, specifically in Lie theory/representation theory, Schubert calculus and connected areas, as well as non-local games.

Postdoctoral Fellows

Recruiting postdoctoral fellows to work at IQC is a continuous priority. IQC has successfully recruited 62 fellows from across Canada, the United States and the world. Below is a sample of notable institutions from which IQC postdoctoral fellows were recruited.

Canada	USA	International
University of Toronto	California Institute of Technology	Hong Kong University of Science and Technology, China
McGill University	Columbia University	Kyoto University
Carleton University	Harvard University	National University of Singapore
University of Waterloo	Massachusetts Institute of Technology	Tsinghua University, China
	Pennsylvania State University	University of Strathclyde, UK
	Princeton University	University of Stuttgart, Germany
	University of Southern California	University of Sydney

At the time of this report, there are 36 postdoctoral fellows at IQC. Of the alumni who have moved on from IQC, approximately 44% have stayed in academia, with 12% and 3% moving to industry and government respectively. Below are profiles on select postdoctoral alum.

Profiles: Outstanding Postdoctoral Fellows



Urbasi Sinha

Former IQC postdoctoral fellow Urbasi Sinha's research focused mainly on quantum optics-based tools used to perform fundamental tests of quantum mechanics. During her time at IQC, Sinha developed a holistic approach towards her research that she finds useful in her current role as Associate Professor at the Raman Research Institute in India. "At IQC I learned how to accept success and failure with equal gusto and carry on enthusiastically with results both big and small," says Sinha.

Currently, a major aspect of her research involves manufacturing and employing single photons and entangled photons produced by spontaneous parametric down conversion towards experiments in quantum information and computing. One of her experimental projects explores the use of multiple slits as possible qudits and investigating higher dimensional quantum correlations through studies of entanglement-based phenomena.



Anne Broadbent

Technological advances will see the need for a deeper theoretical understanding of quantum information at all levels, predicts Anne Broadbent, Assistant Professor and University Research Chair in Quantum Information Processing at the University of Ottawa. Broadbent was a postdoctoral fellow at IQC until 2013. She held an NSERC postdoctoral fellowship and was also a CIFAR Global Scholar. Her research focused on quantum cryptography and developing methods for delegating private quantum computations and quantum one-time programs.

Now leading her own research group at the University of Ottawa, Broadbent continues to push the limits of our understanding of how quantum information provides advantages in all aspects of cryptography. She has also further developed techniques for outsourcing quantum computations in terms of quantum homomorphic encryption, as well as verifying remote quantum computations.

**Nathan Wiebe**

Nathan Wiebe, currently an Associate Researcher in the Quantum Architectures and Computation group at Microsoft Research, finished his postdoctoral fellowship at IQC in 2013. Since then he has continued his research on quantum simulation algorithms and the foundations of quantum thermodynamics, and ventured into quantum machine learning algorithms and quantum circuit synthesis.

Wiebe credits his time at IQC for the opportunity to build connections with world-renowned researchers who exposed him to new ideas, an experience that has contributed to his chosen career path in industry research. The IQC Graduate Student Association invited Wiebe back to IQC in October to share his experience in industry research with current graduate students as part of the Quantum Industry Lecture Series. Looking ahead, Wiebe predicts the landscape and scope of quantum information research to continue changing as more industry partners invest in the field.

**Audrey Dot**

During her time as a Postdoctoral Fellow at IQC, Audrey Dot was using four-wave mixing in optical fibre to convert a single photon into a pair of photons. Dot, along with her supervisor Thomas Jennewein, PhD student Evan Meyer-Scott and colleagues at McGill University, Montreal, sent a single photon through the optical fibre with a strong pump beam to produce a pair of photons with increased efficiency compared to previous methods. Dot then brought her knowledge and research skills to the smart thermostat company Qivivo, where she worked on machine learning algorithms as a Physicist Engineer.

Now she is at the Alternative Energies and Atomic Energy Commission (CEA) in France, an industrial research centre. She is working on 3D time-resolved diffused optical tomographic reconstruction for medical applications, a process used to model organs like the heart in order to find problems such as tumours and occlusions quickly and without intrusion.

Scientific Visitors

IQC welcomes scientific visitors from around the world each year to enhance our research community, conduct collaborative research, and give research and public talks. Since 2012, IQC has hosted 698 visitors from 303 unique institutions in Canada, the United States and countries across the globe. Institutions include:

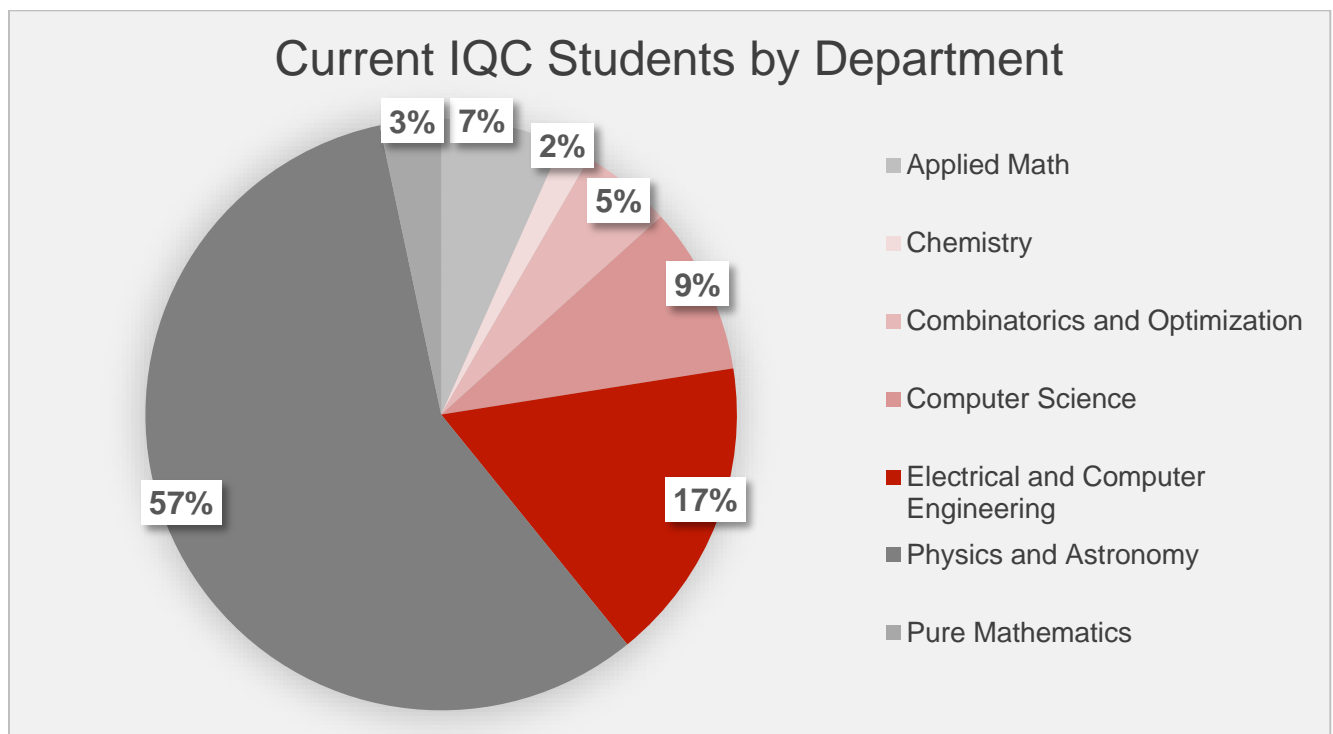
Australian National University, Australia	Massachusetts Institute of Technology, USA
Beijing University of Posts and Telecommunications, China	MIT-Harvard Center for Ultracold Atoms, USA
Brown University	Max Planck Institute for the Science of Light, Germany
California Institute of Technology (CALTECH), USA	National Institute of Standards and Technology (NIST), USA
Canadian Space Agency, Canada	National Research Council, Canada
Centre for Quantum Technologies, National University of Singapore, Singapore	National University of Defense Technology, China
Chalmers University of Technology, Sweden	National University of Singapore, Singapore
Columbia University, USA	Raman Research Institute, India
Delft University of Technology, The Netherlands	Simon Fraser University, Canada
Friedrich-Alexander University Erlangen-Nürnberg, Germany	Stanford University, USA
Gdańsk University of Technology, Poland	The Institute of Photonic Sciences, (ICFO), Spain
Harvard University, USA	The University of Edinburgh, Scotland, UK
Hong Kong University of Science and Technology, Hong Kong	The University of Queensland, Australia
IBM TJ Watson Research Center, USA	Tsinghua University, China
Israel Ministry of Defense, Directorate of Defense Research and Development, Israel	University of California - Los Angeles, USA
Joint Quantum Centre, Durham-Newcastle, UK	University of Cambridge, UK
Lockheed Martin, USA	University of Illinois at Urbana-Champaign, USA
Los Alamos National Laboratory, USA	University of Science and Technology of China, China
McGill University, Canada	University of Strathclyde, Scotland, UK
Microsoft Research, USA	University of Toronto, Canada
NASA Headquarters, USA	University of Vienna, Austria
	University of Warsaw, Poland
	Yale University, USA

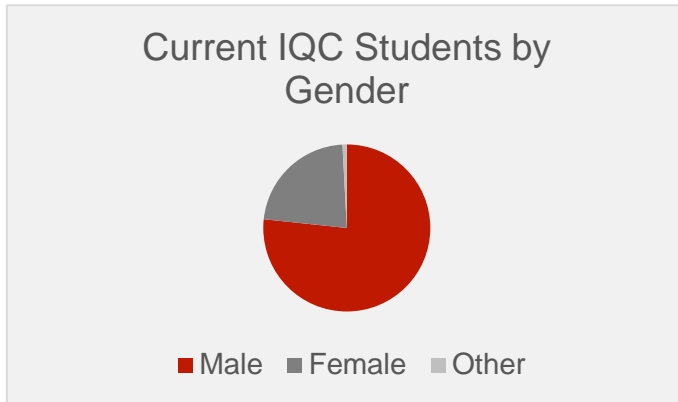
A full listing of visitors and their respective institutions can be found in Appendix F.

Collaborative Graduate Program

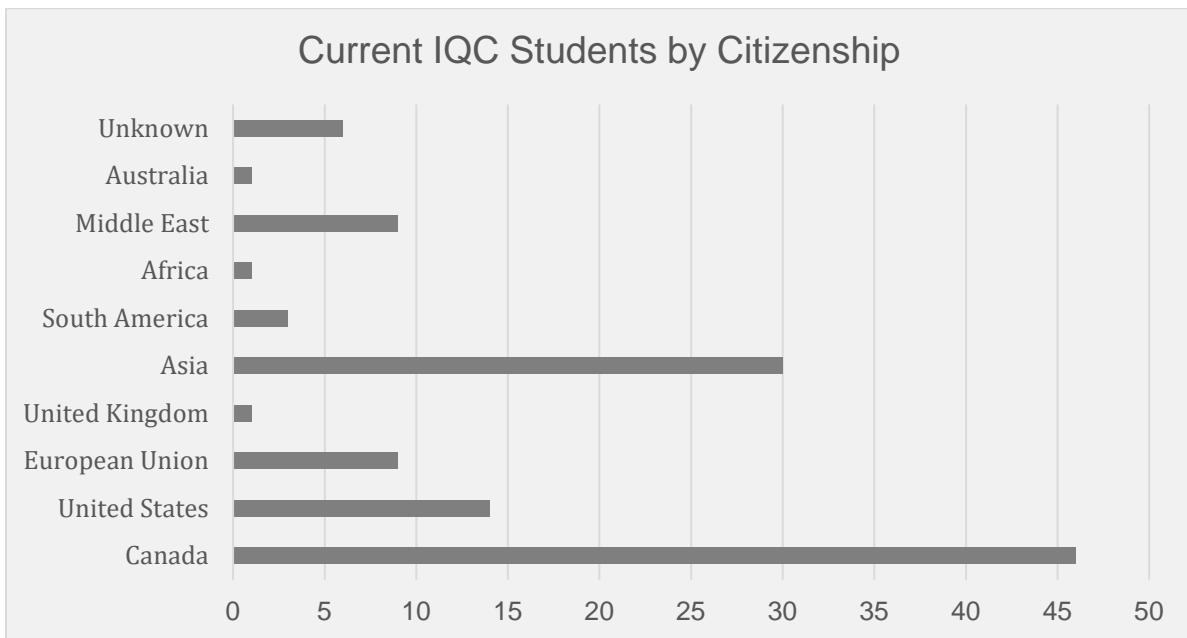
The Departments of Applied Mathematics, Chemistry, Combinatorics & Optimization, Electrical & Computer Engineering, Physics & Astronomy, and the School of Computer Science, in collaboration with IQC, offers a graduate program leading to MSc and PhD degrees with a focus on quantum information. Students enrolled in this program complete all of the requirements set by their home department or school, as well as additional requirements set by IQC.

As of December 31, 2016, IQC was home to 45 Master's and 75 PhD students. Of these students 59% are registered with the Faculty of Science, 24% with the Faculty of Mathematics and 17% with the Faculty of Engineering. A further departmental breakdown is shown in the chart below:





Demographically, the current student populations has 22% female representation and 77% male with 62% of students coming from outside of Canada.



In support of the collaborative quantum information graduate program, IQC offers a wide selection of graduate courses. These courses are typically held with or cross-listed with courses in the participating departments and schools as appropriate. Two core courses are required for all students in the collaborative program:

- Quantum Information Processing (offered every Fall term)
- Implementations of Quantum Information Processing (offered every Winter term)

Other regularly offered courses (which are most typically offered once every two years) include the following courses:

- Quantum Algorithms
- Open Quantum Systems
- Theory of Quantum Information

- Theory of Quantum Communication
- Nanoelectronics for Quantum Information Processing
- Quantum Electronics and Photonics
- Optical and Atomic Implementations
- Implementations of Quantum Communication
- Modern Quantum Optics and Nanophotonics
- Quantum Error Correction and Fault Tolerance
- Applied Quantum Cryptography
- Spin-Based Implementations

Several additional courses have run either once as a topics course or are offered on an irregular basis, including Design in Quantum Systems; Semidefinite Programming in Quantum Information; Examples of Quantum Devices; Recent Advances in Quantum Information; Quantum Complexity Theory; Haar Measure in Quantum Information Theory; Solid State Photonic Devices; Theory of Quantum Optics; Relativistic Quantum Information; Entanglement and Nonlocality; Introduction to Noise Processes; and Functional Analysis Methods for Quantum Information Technologies.

Finally, two special topics courses are offered each year

- Topics in Quantum Safe Cryptography
- Selected Advanced Topics in Quantum Information

Appendix G lists all quantum information courses offered by IQC in the last five years.

International opportunities for Students

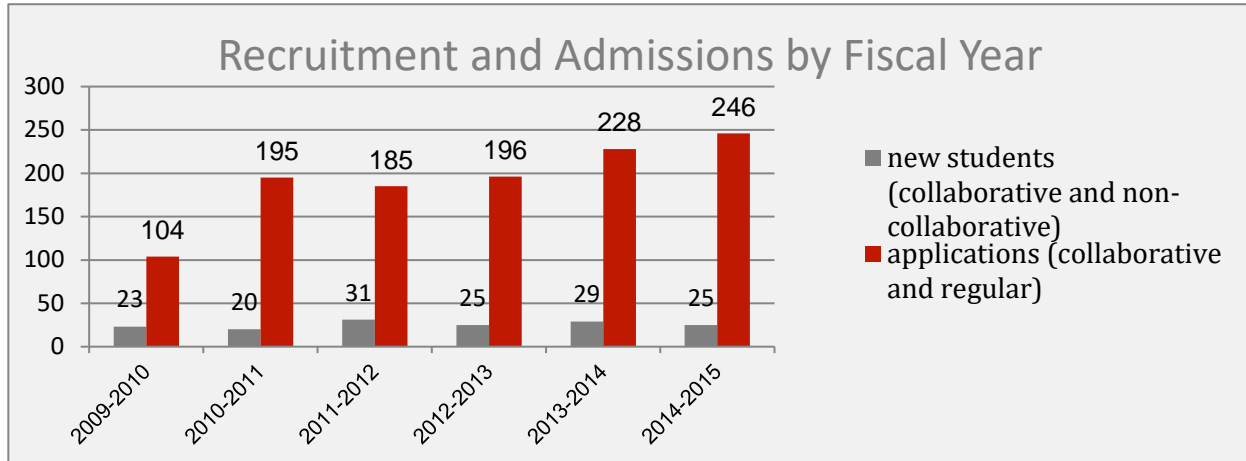
The University of Waterloo also supports exchange opportunities for IQC students, postdoctoral fellows, and researchers that promote the advancement of education and research in quantum information processing through student exchange agreements with the following institutions:

Universität Innsbruck (Austria)	University of Latvia (Latvia)
École Normale Supérieure de Lyon (France)	National University of Singapore (Singapore)
Université Paris Diderot (France)	University of Maryland (USA)
Friedrich-Alexander-Universität Erlangen-Nürnberg (Germany)	National Institute for Standards and Technology (USA)
Universität des Saarlandes (Germany)	Delft University of Technology (Netherlands)
RWTH Aachen University (Germany)	

Appendix H itemizes the recipients of the 146 awards IQC graduate students have received over the past five years.

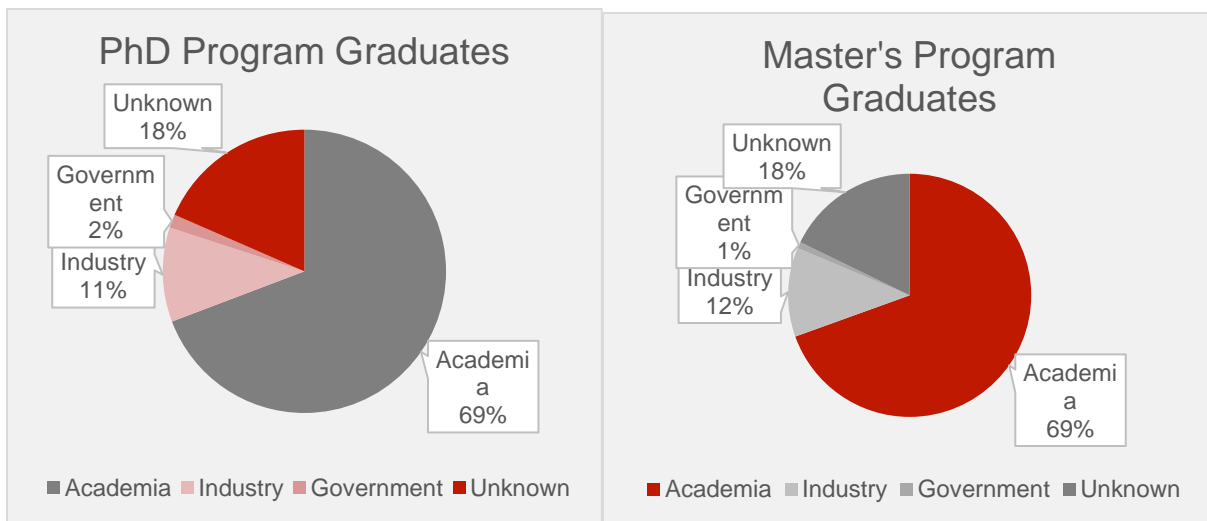
Applications to IQC

Applications to the collaborative graduate programs have continued to increase year over year. As the chart below captures, the growth in applications to programs – including to collaborative programs – has more than doubled since fiscal 2010 with IQC fielding 257 applications in fiscal 2016 alone. Note: Fiscal years are based on a May 1 to April 30 timeframe.



Student Alumni

In the fifteen years since IQC’s inception, 66 students successfully earned PhD degrees and 119 have earned Master’s degrees. Of these, 46 PhD and 58 Master’s degrees were granted since the beginning of the 2012-2013 fiscal year. These alum now have careers spanning academia, government and industry.



Profiles: Outstanding Student Alumni



**Kalista (Kelly)
Itakura**
Masters 2005
PhD 2010

During her time at IQC, former Masters of Mathematics student Kalista (Kelly) Itakura focused on creating a quantum algorithm for testing the commutativity of matrices under supervisor Ashwin Nayak. She earned her PhD in Computer Science, focusing on Artificial Intelligence (AI) and Information Retrieval at the University of Waterloo. After a postdoctoral fellowship researching AI at the Queensland University of Technology, Itakura moved to the National Institute of Informatics in Tokyo where she received a JSPS Grant-in-Aid for Challenging Exploratory Research for her project titled (in Japanese) "Using Big Data for Social Persuasion".

Itakura notes that her time at IQC helped her prepare for her current position as a risk manager at Scotiabank in Toronto, where she generates and oversees counterparty credit risk measures used by the trading desk. In the future, she hopes that quantum information science will allow for the creation of a practical quantum trading system so that she can start her own quantum AI trading company.



Gus Gutoski
Masters 2006
PhD 2009
PDF 2016

Gus Gutoski is using the skills he gained at IQC to develop quantum-safe security for conventional computing systems at ISARA, a Waterloo-based company founded in 2015. While earning his Master's and PhD degrees at IQC, Gutoski studied quantum computational complexity theory and the mathematical foundations of quantum information. Then, during his time as a postdoctoral fellow, he gradually shifted focus to quantum cryptography.

"At IQC, I acquired a level of academic maturity that made it easy to identify and transfer the relevant skills and knowledge I already possessed and to identify and acquire the new skills and knowledge necessary for quantum-resistant cryptography," he said. This foundation eased his transition to ISARA where he evaluates and improves cryptographic algorithms. He is excited to investigate his ideas about improving lattice-based signature schemes in the near future. In the long-term, he expects that the past two decades of rapid progress in the mathematic and computational aspects of quantum information science will continue.



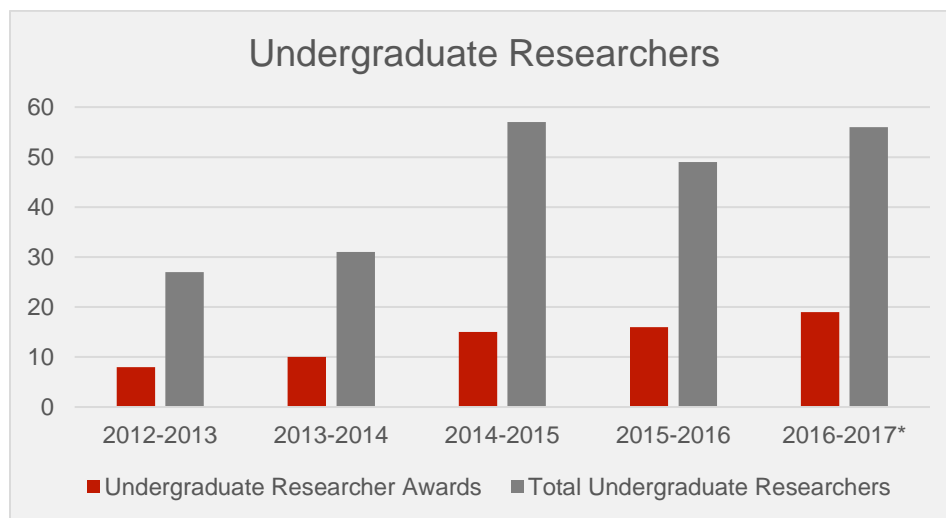
Douglas Stebila
Masters 2005
PhD 2010

After completing his PhD in 2009 with a focus on cryptographic key exchange protocols, IQC alumnus Douglas Stebila ventured down under to Brisbane, Australia for a postdoctoral fellowship at the Queensland University of Technology.

Stebila is now a Senior Lecturer at QUT investigating provable security of real-world cryptographic protocols – specifically looking at the security properties of protocols used in web browsers and other online communications. As quantum computing evolves and impacts classical cryptography, Stebila hopes to contribute to the development of new standards for cryptographic protocols.

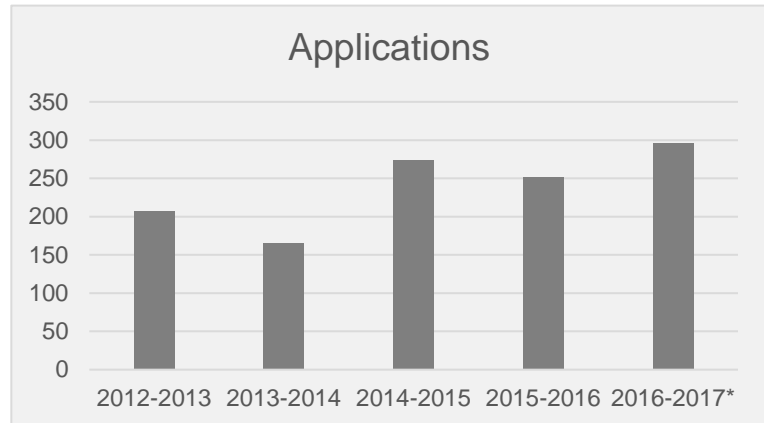
Undergraduate Researchers

IQC offers many opportunities to expose undergraduate students to research. Students can apply primarily in tandem with applications to the annual Undergraduate School for Experimental Quantum Processing (USEQIP) for a chance to stay for a research term following the program, or they can apply for a research position outright. The chart below reflects both the growth of USEQIP students who received Undergraduate Research Awards through the USEQIP program and undergraduate researchers who gain work opportunities at IQC through other channels, like co-operative employment positions.



Applications from undergraduate researchers also continue to climb. The chart reflects application growth from undergraduates around the world.

**2016-2017 reflects a partial year*



Conferences and Workshops

IQC is dedicated to creating an environment for researchers that fosters continued learning and collaboration. To that end, each year IQC is host to several conferences and workshops for researchers in the quantum information space. These sessions, which are often organized by IQC, but are at times organized by national or international partners, are not only essential to building the quantum community globally, but also serve as a recruitment tool.

	Date	Conference
2012-2013	Jun 11-16	12th Annual Canadian Summer School on Quantum Information
	Jun 18-22	9th Canadian Student Conference and 2nd AQuA Student Congress on Quantum
	Sept 6-9	Quantum Innovators
2013-2014	May 20-23	Quantum Foundation and Quantum Information Conference - Decoherence and Friends
	Jul 29-2	Quantum Key Distribution Summer School
	Aug 5-9	Qcrypt – 3rd International Conference on Quantum Cryptography
	Jan 17-20	Quantum Innovators
2014-2015	Sep 29-30	6th International Summer School on Post-Quantum Cryptography
	Oct 1-3	6th International Conference on Post-Quantum Cryptography
	Oct 6-8	Quantum Innovators
	Oct 6-7	ETSI 2nd Quantum-Safe Crypto Workshop
	Nov 23-26	Quantum Information Science Program Meeting
	Apr 13-14	CERC Summit

	Date	Conference
	Jun 8-11	Quantum Programming and Circuits Workop
	Jul 27-31	NanoMRI
2015- 2016	Aug 17-21	Qantum Key Distribution Summer School
	Oct 5-7	Quantum Innovators
	Sep 16-18	Waterloo Innovation Summit
	Dec 5-6	Teaching Quantum Technologies
2016- 2017*	Jun 21-24	Relativistic Quantum Information North (RQI-North) Conference
	Aug 16-17	Semi-Quantum Computing Workshop
	Sep 19-21	4th ETSI/IQC Workshop on Quantum-Safe Cryptography

**2016-2017 reflects a partial year.*

In this same timeframe, IQC also sponsored 60 conferences and workshops at partnering organizations across Canada and the world. A full list of these sponsorships can be found in Appendix I.

Establishing IQC a Prime Source of Insight, Analysis and Commentary on Quantum Information

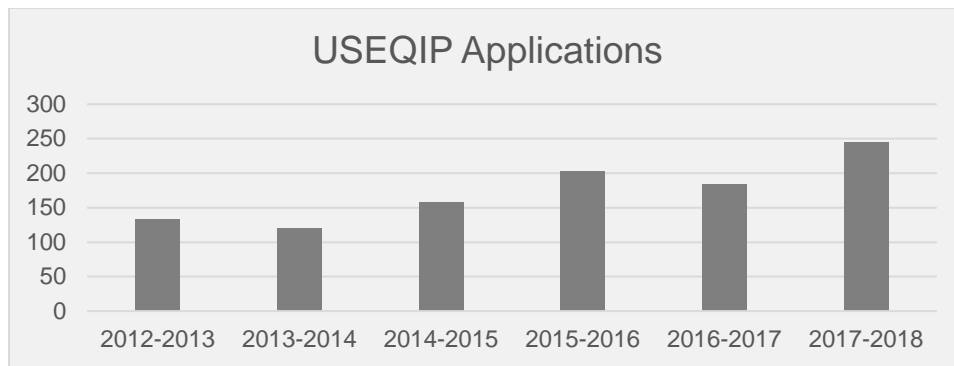
Part of establishing IQC as a primary source of insight on quantum information relies on disseminating knowledge and communicating the importance of quantum research to a variety of external stakeholders. Stakeholders to IQC include external or potential students, educators, government and industry stakeholders, the media and the general public. IQC works each year to ensure touchpoints with various stakeholders are met, from organizing and hosting workshops for young students and teachers to inviting government and industrial representatives for in-depth tours to planning and facilitating public outreach both face-to-face and through online channels.

Outreach - Schools and Workshops

Each year, IQC organizes and leads specialized schools and workshops for the world's most promising young students and educators. Some of these are recurring, allowing IQC to hone the content, improving year over year. While these are schools and workshops accomplish outreach goals for IQC, they also act as crucial recruiting tools for future students.

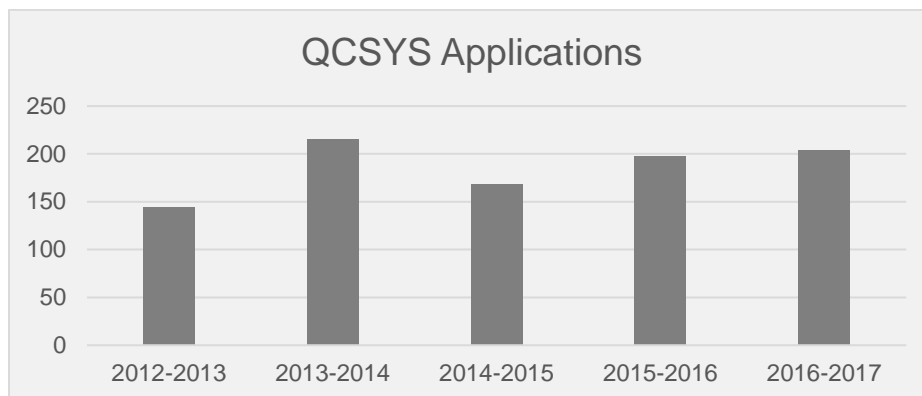
Undergraduate School on Experimental Quantum Information Processing (USEQIP)

USEQIP is a two-week program on the theoretical and experimental study of quantum information aimed primarily at students one year away from completing their undergraduate studies. The lectures and experiments are geared toward students in engineering, physics, chemistry, mathematics and computer science and serves IQC as an effective recruitment tool. With a limit of 25 participants, the past five years saw an average of 22 students per year. Interest in the program continues to grow with an increase of 115% more applications for the current year than for the program in the 2012-2013 fiscal.



Quantum Cryptography School for Young Students (QCSYS)

QCSYS is a unique, eight-day enrichment program for high school students offering a blend of lectures, hands-on experiments and group work focused on quantum cryptography. Each year, participants get a first-hand look into the physics and mathematics of quantum mechanics, cryptography and how they merge into quantum cryptography. Participants meet and collaborate with some of the most renowned researchers the field has to offer. With space for up to 45 students, an average of 43 participants come to IQC for QCSYS from around the world. There has been a 40% increase in applications since 2012-2013 program.



Quantum Key Distribution (QKD) Summer School

The International QKD Summer School is a five-day program focused on theoretical and experimental aspects of quantum communication with a focus on quantum cryptography. Established in 2008, QKD occurs every other year and was last held in 2015 and will run this coming summer. The School aims to provide a solid foundation in relevant approaches and techniques to enable graduate students and young postdoctoral fellows to perform their own independent research.

Schrödinger's Class

Schrödinger's Class (formerly called Teaching Quantum Technologies) is a free, three-day workshop for teachers of high school physics. Participants have the opportunity to attend lectures and engage in hands-on activities focused on the integration of quantum technology into the current teaching curriculum. Teachers leave the workshop with:

- The ability to teach quantum mechanics beyond the basics and discuss cutting-edge advances in the field
- Lesson plans and other affordable, ready-to-go activities to take back to their classrooms
- Discussion points about how quantum mechanics can transform society

After a successful pilot program in December of 2015 for 20 teachers, IQC invited 30 teachers in November of 2016 and intends to continue offering this workshop.

Public and Community Events

Outreach and events for members of the public are a priority for IQC because it is important for the general public to understand what quantum could mean for their future and how they fit in as stakeholders.

Each year, IQC organizes varied events to appeal to different public audiences. While hosting laboratory tours and talks to high school students are common for IQC and below are highlights from public events by fiscal year.

In the 2012-2013 year, IQC's outreach team interacted with over 11,000 members of the public face-to-face. A main highlight this year was the grand opening of the Mike and Ophelia Lazaridis Quantum-Nano Centre in September, which featured an appearance by Professor Stephen Hawking and attracted over 1200 guests. This was also the year that sparked a new relationship between IQC and the Kitchener-Waterloo Symphony (KWS). Raymond Laflamme and the KWS's Music Director came together and collaborated on a unique orchestral performance, Qubits and Quantum Symphony. Other events this year included outreach team members attending careers days, organizing a film screening, public lectures, attending the American Association for the Advancement of Science (AAAS) conference and a featured talk at TEDxWaterloo.

In the 2013 – 2014 year, IQC was invited to participate in BrainSTEM – a large public event presented by partners at the Perimeter Institute for Theoretical Physics (PI). In total for the year IQC reached over 29,000 members of the public, including those who attended BrainSTEM and also those who attended IQC's Doors Open event in the fall of 2013, kids science shows and three Quantum Frontiers Distinguished Lectures.

The following year, 2014-2015, saw 2,350 face-to-face interactions with the public. A key highlight was a public talk by IQC faculty member, Michele Mosca on cybersecurity.

In 2015-2016 IQC participated in sponsoring a group of graduate students to develop an exhibition on light and light-based technologies. This exhibition, LIGHT Illuminated, was installed for six months at THEMUSEUM in downtown Kitchener and garnered over 40,000 visits from members of the community. This exhibition, along with hosting three Quantum Frontiers Distinguished Lectures and a major Open House event, meant that IQC reached 42,063 people face to face that fiscal. The Open House event, which included a public talk by Raymond Laflamme, also included the public launch of IQC's Quantum Cats – a custom game application that introduces quantum concepts to kids. After the launch, over 6,000 people downloaded the application on their personal devices.

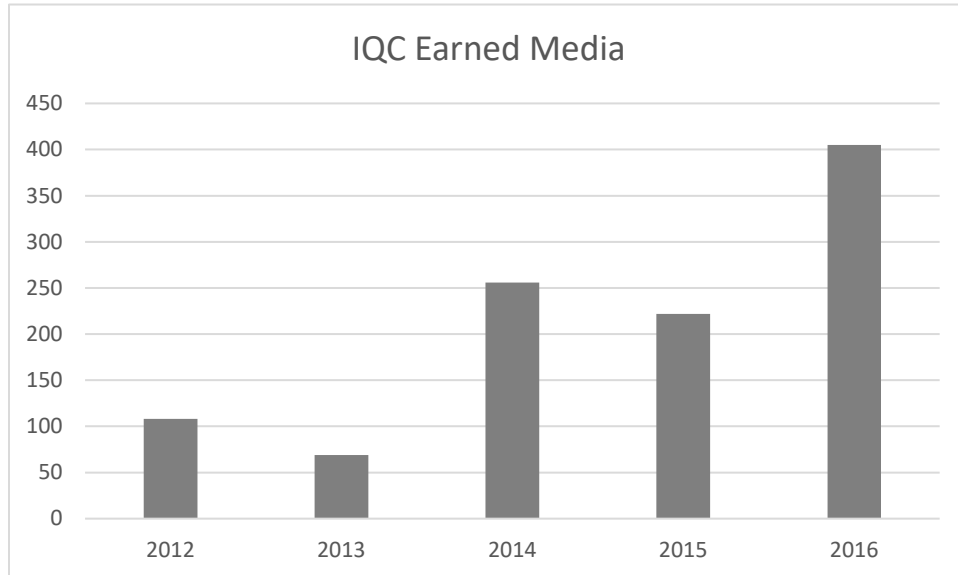
The 2016-2017 fiscal (which is currently in progress) saw the launch of IQC's QUANTUM: The Exhibition – a 4,000 square foot travelling exhibition on quantum information science and technology. The exhibition, which is fully interactive and bilingual launched this year at THEMUSEUM in downtown Kitchener (where 16,526 people saw it) and is currently on display at Science World in Vancouver. The exhibit is part of the Canada 150 celebrations and after Vancouver will travel to science centres in Saskatoon, Calgary, Halifax and Ottawa. In addition to the exhibition, IQC hosted two public lectures and its annual Open House Event, reaching a total of 18,572 people (with three months left in the year to go).

Communications and Marketing

IQC communications aims to keep current members, stakeholders, alumni and partners informed of research activities. IQC's dedicated communications and marketing team produce a number of print publications each year and utilize social media to reach a broad stakeholder audience and the general public. Publications include: IQC Annual Report, NewBit newsletter, Program brochures (QCSYS, USEQIP, URA, Collaborative Graduate Program, Schrödinger's Class).

Earned Media

Another core function of IQC’s communications team is to plan, develop and execute media releases for when newsworthy events, research and collaborations occur. Over the past five years, IQC has appeared in several prominent publications including The Wall Street Journal (US), The Washington Post (US), The Guardian (UK), Wired (US), Times of India, Globe and Mail, National Post, and CBC. Since 2013, IQC’s earned media has increased by over 400%.



Appendix J has a comprehensive list of earned media from the last five years.

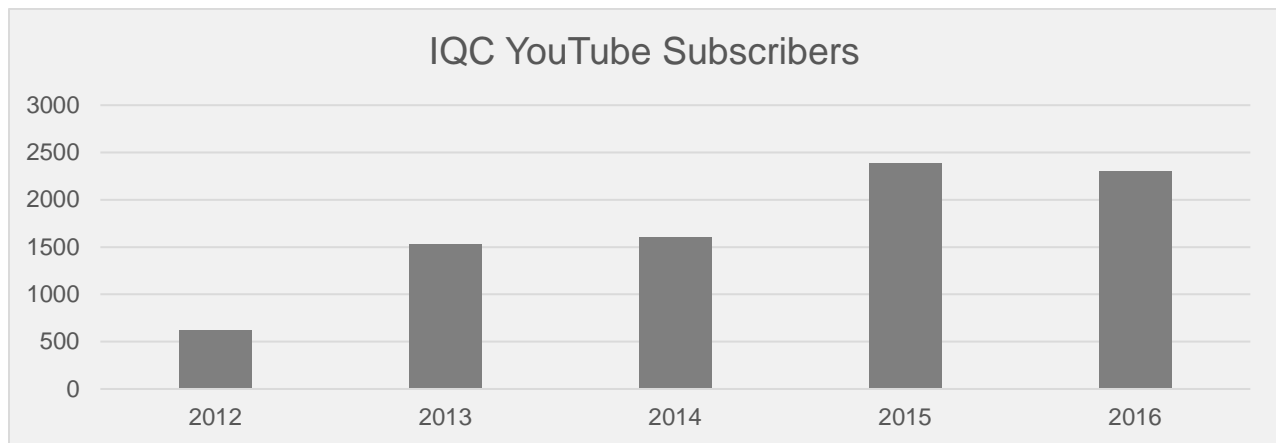
Website

IQC’s website continues to be a destination for researchers, government and those from the general public who have an interest in science. The Quantum Computing 101 page - designed to simply explain quantum information processing - is the number one visited page following the homepage, accounting for 10% of total traffic.

In the past four years, IQC’s website has hosted over 600,000 sessions and from users who have viewed over 1.5 million pages. These visitors are mostly Canadian (46%), but the United States (20%) and India (7%) also account for a material percentage of visitors. Each of these visitors averages approximately 2.4 pages per visit and stays for 1:45 on average indicating that visitors to the site are staying on the site and exploring different sections.

YouTube

Since May 2012, IQC has uploaded over 330 videos to its YouTube channel. These videos have accounted for almost 1 million total views and over 7.4 million minutes watched. Users often 'like' the videos, and have shared them with friends or colleagues close to 3,000 times. Viewers are 25 times more likely to like one of IQC's videos rather than dislike, which shows a positive viewership. During the period from May 2012 to December 2016 the YouTube channel gained 8,447 subscribers with over 2,300 of them coming in last year.



Twitter

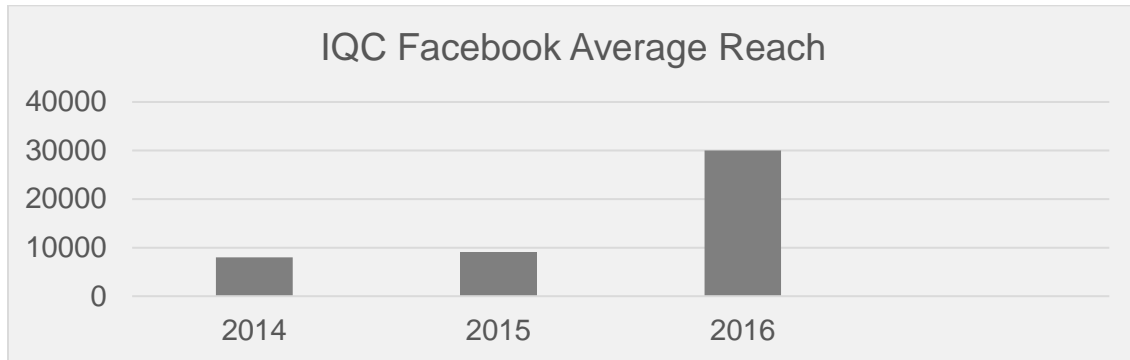
IQC's Twitter channel is often our most active social media channel. Over the past five years, IQC has seen a steady growth and now has well over 7,000 followers. It is the social platform that is pushing the most traffic to IQC's website. In October of 2014 a tweet about IQC's Quantum Innovators workshop garnered over 320,000 impressions.

The IQC Twitter audience is 75% male and they are interested in technology, tech news and science and 40% of them are professional/technical. Their locations are varied. The number of female Twitter followers has been increasing in the last year with the promotion of posts about women in science events and activities, particularly the University of Waterloo's HeforShe initiative.

Facebook

IQC continues to use Facebook to share research stories about the institute, promote upcoming events and support campus partners. Unlike Twitter which is used several times a day to keep users up to date on what's happening around the institute, IQC's Facebook page is nearly 4,000 likes. Daily posts are targeted to the audience with top engagement posts including #FridayFun where math, science or engineering related humour is used. This accounts for 26.5% of Facebook user reactions. There has also been an increase in female

followers based on more posts supporting campus programs and groups for women in science. IQC’s Facebook page is moving towards 4,000 likes and continues to reach and engage with more people every month with a total reach of over 30,000 each month.



Instagram

In September 2016 IQC launched an Instagram account. The majority of active users on Instagram are between 18 and 29 years old and fairly evenly distributed by gender. The decision to use Instagram came as a way to help this age group see themselves at IQC. Through campaigns such as #MeetIQC, #pictureyourselfhere and #whereinIQC, this account is meant to encourage engagement and focus on some of the state-of-the-art equipment available to researchers. Instagram followers has grown to 148 followers in the first four months.

FINANCIALS

INSTITUTE FOR QUANTUM COMPUTING
LONG RANGE FINANCIAL PLAN - CASH FLOW
for the 7 years ending March 31, 2023
(\$000's - last updated Dec 15, 2016)

	Actual F'16	F'17	F'18	F'19	F'20	F'21	F'22	F'23	Notes
Summary of Operating Expenditures	25,028	47,006	47,060	49,906	50,798	52,003	52,610	53,435	
Unfunded expenditures to be funded later	(1,641)	(4,500)							1
Resolution of past unfunded research 105 amounts	2,193	1,400	-	-	8,151	-	-	-	1
Total cash outflows	25,580	43,906	47,060	49,906	58,949	52,003	52,610	53,435	
Summary of Sources of Funds									
uWaterloo - all sources	4,697	5,512	5,481	5,762	5,932	6,482	6,667	6,827	2
Trust - interest income	3,594	3,500	-	-	-	-	-	-	
Endowments - interest income	386	400	400	400	400	400	400	400	
Federal government (2014 - 3 years, \$5m per)	5,000	5,000	-	-	-	-	-	-	3
Federal government (2017 - 5 years, \$5m per)	-	-	5,000	5,000	5,000	5,000	5,000	-	3
Province of Ontario (2014 - 5 years, \$5m per)	5,000	5,000	5,000	5,000	-	-	-	-	4
Province of Ontario (2019 - 5 years, \$5m per)	-	-	-	-	-	-	-	-	4
Research Grants - Existing IOF	445	600	820	850	900	639	-	-	5
Research Grants - Cory CERC	1,696	1,397	-	-	-	-	-	-	5
All other research grants and collected fees	6,970	7,803	8,200	8,700	9,300	9,900	10,500	11,200	
Additional grant and fundraising efforts	-	50	500	750	1,000	1,000	1,000	1,000	
TQT, net of IQC contributions	-	17,098	19,866	22,362	21,799	21,771	21,195	20,992	
Total Sources of Funds	27,788	46,360	45,267	48,824	44,331	45,192	44,762	40,419	
Anticipated cash needs / (surplus) from the trust	(2,208)	(2,453)	1,794	1,082	14,618	6,812	7,848	13,016	

Notes:

- 1) Expected timing of resolution of past excess spending in fund 105 research accounts
- 2) Includes faculty salaries, stipends, benefits, start-up commitments, research matching and IQC operating
- 3) Current agreement ends Mar 31/17; expected renewal of \$5m per year for 5 years - 80% probability
- 4) Current agreement ends Mar 31/19; renewal of \$5m per year for 5 years expected, but we have assumed none to be conservative
- 5) Used until balance runs out

INSTITUTE FOR QUANTUM COMPUTING
 LONG TERM FINANCIAL PLAN - EXPENDITURE SUMMARY
 for the 7 years ending March 31, 2023
 (\$000's - last updated Dec 15, 2016)

	Actual F'16	F'17	F'18	F'19	F'20	F'21	F'22	F'23
Uses of Funds								
Salaries & Benefits								
Faculty Salary and Stipends	4,121	4,847	5,406	5,795	6,338	6,928	7,483	7,876
Research Related	6,304	6,797	7,034	7,582	8,107	8,424	8,741	9,044
Technical support	668	1,013	1,054	1,096	1,140	1,185	1,233	1,282
External Relations	1,062	1,041	1,151	1,133	1,179	1,228	1,279	1,332
Management, Admin & Support	1,148	1,141	1,219	1,300	1,385	1,468	1,526	1,586
Total Salaries	13,303	14,838	15,863	16,906	18,149	19,233	20,261	21,120
Operating Expenses								
Research Related	2,841	2,752	2,935	2,700	2,770	2,890	3,015	3,135
External Relations	1,160	3,071	1,230	930	955	955	955	980
Admin & Support	425	450	460	470	480	490	500	505
Total Operations	4,426	6,273	4,625	4,100	4,205	4,335	4,470	4,620
Equipment & renovations	6,449	7,330	5,160	4,870	4,880	4,890	4,900	4,910
QNC Utilities	850	1,050	1,100	1,100	1,155	1,155	1,155	1,155
TQT	-	17,515	20,312	22,930	22,409	22,390	21,824	21,630
Total Spending	25,028	47,006	47,060	49,906	50,798	52,003	52,610	53,435

LETTERS OF SUPPORT

March 1, 2017

Professor Raymond Laflamme
Executive Director,
Institute for Quantum Computing
University of Waterloo
200 University Avenue West
Waterloo, Ontario
N2L 3G1

Dear Raymond:

Personally and on behalf of IQC's Board of Directors, I am writing to express my strongest possible support for the renewal of the Institute for Quantum Computing.

In 15 years, IQC has established itself as a globally leading centre for quantum information science research. IQC has successfully recruited top researchers from around the world who have chosen IQC as the place where they will make their contribution to the advancement of quantum information science. IQC is also one of handful of centres in the world where top researchers go to collaborate and to discuss and learn about the latest advances in the field.

IQC also continues to play a critical role as a core member of the Quantum Valley as we continue to take the necessary steps to establish Waterloo and Canada as a global leader in the Second Quantum Revolution – the new global industrial super-cycle based on the development and commercialization of new quantum technologies.

IQC is the result of a strong and longstanding public private partnership with the Government of Canada and the Province of Ontario who have been fundamental partners and investors in IQC since its inception. I want to acknowledge the \$76 million award to IQC as part of the federal government “Canada First Research Excellence Fund” last year. IQC has helped educate the Province and the Government of Canada on the importance of quantum information science with the result that both governments have established the development of quantum technologies and the commercialization of these technologies in Canada as a national priority.

IQC's efforts in this regard and those of its partners in the Quantum Valley are very much being noticed around the world. In a recent report issued by the UK government, IQC was identified as “**the largest centre for quantum information worldwide**”.

<http://uknqt.epsrc.ac.uk/files/ukquantumtechnologylandscape2016/>

In a second report issued by the UK National Science Advisor, the quantum technology effort of IQC, the Quantum Valley and Canada is ranked as 5th in the world overall. Given the size of the other countries in the ranking in terms of both population and GDP, this is something that we can all be proud of.

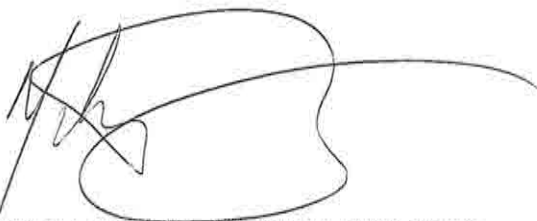
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/564946/gs-16-18-quantum-technologies-report.pdf

These things don't just happen. When we observe the progress that IQC has made, it is easy to forget that only 15 years ago, IQC was nothing more than an idea. Ray, IQC has been very fortunate to have the type of leadership that you and your colleagues have demonstrated. I can only marvel at your efforts and your success over the past 15 years in a broad number of key areas - including recruitment, establishment of state of the art research facilities, large scale fundraising with both government and private donors - just to name a few. IQC's progress would simply not be possible without your vision and efforts and those of your colleagues.

There is no doubt that the Second Quantum Revolution is upon us and the momentum around the world is accelerating quickly. This revolution will change how we view and manipulate matter and energy, manufacture new materials, vastly improve simulation and measurement, computation and communication, data storage and data security, medical diagnostics and medicine and enable advances that would be impossible with even the best classical technologies.

IQC is very much positioned to advance the principles of quantum physics toward breakthroughs that will be the basis for new transformative quantum technologies. IQC will also continue to shape the Quantum Valley ecosystem as we build the components necessary to establish this Region and Canada as a global centre for the development and commercialization of new quantum technologies.

I am very proud of what the Institute for Quantum Computing has achieved. I strongly support the renewal of the IQC as a Senate-sanctioned institute. The past fifteen years of IQC has been tremendously successful, and the future promises to be even more exciting.



Mike Lazaridis, OC, OOnt, FRS, FRSC
Chair, Board of Directors
Institute for Quantum Computing
University of Waterloo

February 6, 2017

Prof. Kevin Resch, Acting Director
Institute for Quantum Computing
University of Waterloo

Re: 5-year renewal of the Institute for Quantum Computing

Dear Kevin:

I write in strong support of the 5-year renewal of the Institute for Quantum Computing. IQC was founded to bring together researchers from a broad range of disciplines to work on common goals of harnessing the quantum properties of light and matter in a broad range of areas from secure communications to computing and sensing. The mandate of IQC was to recruit, in collaboration with the faculties of Engineering, Mathematics and Science, researchers of the highest international calibre working in various areas of quantum information science and technology. I have been very pleased to see that, over the past five years, IQC was able to attract six outstanding faculty members who have found a home in the Faculty of Science, in the departments of Chemistry and Physics & Astronomy: Raffi Budakian, Kyung Soo Choi, Kazi Rajibul Islam, Matteo Mariantoni, Crystal Senko and Adam Wei Tsen.

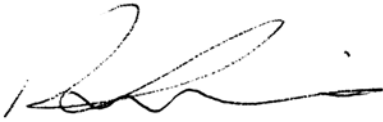
Over the past five years, IQC members have been remarkably productive and impactful, as evidenced by over 600 publications, including 33 in the *Nature* journals, 11 in *Science* and 78 in *Physical Review Letters*. Faculty of Science IQC members also received several prestigious external awards, including the renewal of a Tier 1 Canada Research Chair and a Queen Elizabeth II Diamond Jubilee Award to Raymond Laflamme, a E.W.R. Steacie Fellowship and Tier 2 Canada Research Chair to Kevin Resch, and a Sloan Research Fellowship to Matteo Mariantoni. Faculty of Science IQC members were also responsible for securing major funding for the institute as principal investigators, including \$25M from the Government of Ontario (Laflamme), \$15M from the Federal Ministry of Innovation, Science and Economic Development (Laflamme), \$750K from the Canadian Institute for Advanced Research (Laflamme), \$550K from FEDEV (Laflamme and Jennewein), and most recently \$76.3M from the Canada First Research Excellence Fund in support of Transformational Quantum Technologies (Cory).

IQC has made significant contributions to the academic excellence of UW through its teaching, research, outreach activities, internationalization and entrepreneurship. It is now recognized as one of the top institutes focused on quantum science and technologies worldwide, and is often highlighted by provincial and federal governments as the embodiment of innovation and entrepreneurship that is the UW brand. It is evident that IQC will lead the way of the



quantum revolution and the Faculty of Science is privileged to be an integral part of this magnificent enterprise. Hence, I am pleased to give my strongest possible endorsement for the renewal of IQC as a University Institute.

Sincerely,

A handwritten signature in black ink, appearing to read 'R. Lemieux', with a stylized flourish at the end.

Robert P. Lemieux
Dean of Science



February 15, 2017

Professor Raymond Laflamme
Executive Director
Institute for Quantum Computing
University of Waterloo

Dear Professor Laflamme,

I am delighted to write this letter in support of the renewal of the Institute for Quantum Computing (IQC) at the University of Waterloo. Math is proud to be a founding partner of IQC and we have enjoyed our strong relationship since the founding in 2002.

Faculty members of Math have been members of IQC from its inception. Currently, eight Math faculty are active members of IQC, including: Richard Cleve, Joseph Emerson, Debbie Leung, Michele Mosca, Ashwin Nayak, Vern Paulsen, John Watrous and Jon Yard. During their time at IQC, these faculty have published over 120 publications collectively, garnered numerous research grants and fellowships, and have participated in the collaborative graduate program in quantum information, including Ashwin Nayak and John Watrous having both served as graduate Program Director.

Math professors have held various prestigious chair positions including Debbie Leung who held a Canada Research Chair (Tier II 2005-2010); Michele Mosca, who currently holds a University Research Chair; and Richard Cleve, who holds the IQC Chair in Quantum Computing and is a Fellow of the Royal Society of Canada. Each of these researchers have established significant research agendas that accelerate the understanding of quantum science and have helped to establish the Faculty of Mathematics at Waterloo as a world-leading centre for education and research.

Additionally, IQC has also partnered with the Centre for Education in Math and Computing (CEMC) on various events, workshops, and an online course in quantum information for math teachers. This partnership reinforces Math's strategic goal in educational outreach and community engagement that increases mathematical and computing literacy nationally and globally.

IQC's commitment to research excellence and the advancement of knowledge and understanding in quantum science has attracted not only leading researchers, but also outstanding graduate students and post-doctoral fellows. Waterloo Math students make up 26% of the graduate students in the collaborative quantum information program and have garnered over 45 awards since 2012.



I strongly encourage renewed support and approval of the Institute for Quantum Computing and look forward to many more successes in the future.

Sincerely,

A handwritten signature in black ink that reads "Stephen Watt". The signature is written in a cursive style with a large, stylized initial "S" and "W".

Stephen Watt
Dean, Faculty of Mathematics
University of Waterloo

MEMORANDUM

To: George Dixon, Vice President University Research

From: Rick Culham, Acting Dean, Faculty of Engineering

cc: Kevin Resch, Acting Director, Institute for Quantum Computing

Date: January 27, 2017

Re: Renewal of Institute for Quantum Computing

On behalf of the Faculty of Engineering, I am pleased to extend my enthusiastic support for the renewal of the Institute for Quantum Computing (IQC).

Established in 2002, the University of Waterloo's IQC is an internationally recognized institute for research in quantum technologies and their applications. It has attracted world-class researchers in this field and has been instrumental to the university's recent success in receiving the Canada First Research Excellence Fund in quantum technologies.

With a multidisciplinary approach to research, IQC engages faculty members from a number academic units across the university, including the Department of Electrical and Computer Engineering (ECE) in the Faculty of Engineering. Since 2011, IQC and ECE have joined hands to hire five new faculty members, namely Professors Bajcsy, Kim, Miao, Reimer and Wilson. IQC has been instrumental in attracting these elite junior researches from around the globe and has provided world-class research support, including access to state-of-the-art labs and exceptional startup grants.

The above five faculty members regularly apply for external research grants, conduct cutting edge research and provide training to highly qualified personnel, in particular through the collaborative graduate program in quantum information that ECE is part of. The lack of a professional engineering license in some cases can place constraints on the choices of undergraduate courses that these faculty members teach due to accreditation concerns, most teach ECE courses at both undergraduate and graduate levels. All of these research and teaching activities make a positive impact towards ECE's academic mission. In 2014, Professor Wilson received an Early Researcher Award, contributing to ECE's reputation of excellence in research.



There have also been joint and reciprocal initiatives among a few other researchers of the Faculty of Engineering and members of IQC. For example, Professor Gong of ECE recently led a project sponsored by the Ontario Research Fund – Research Excellence for which Professors Mosca and Lütkenhaus of IQC were co-investigators. Currently, Professor Gong is a member of CryptoWorks21, which is an NSERC Collaborative Research and Training Experience Program in the area of cryptography led by Professor Mosca.

In closing, the Faculty of Engineering is very supportive of IQC's mandate and recommends its renewal for another five years.

A handwritten signature in black ink, appearing to be 'J. R. ...'.

February 23, 2017

Professor Ray Laflamme
Institute for Quantum Computing
University of Waterloo

Dear Ray:

I am writing in support of the Institute for Quantum Computing's request to renew its institute status at the University of Waterloo. IQC was founded with a vision to become a world-renowned center for quantum information and quantum technology development. Over the past 15 years the Department of Physics & Astronomy has been a key partner in the Institute's growth, from a "startup" on Columbia Street to the modern laboratory space located in the Mike and Ophelia Lazaridis Quantum-Nano Centre and at North Campus. The Department has grown to include eleven outstanding, full-time faculty members, and dozens of graduate students and postdoctoral fellows. Under your leadership, this bold vision has materialized as IQC has captured the world's attention as a premier institution for research and education in quantum phenomena.

On behalf of the Department of Physics and Astronomy, I am pleased to offer my full and unqualified support for the renewal of IQC's institute status. I look forward to working with you and our colleagues at IQC in the years to come.

With warm regards,



Brian R. McNamara
University Research Chair
Chair, Department of Physics and Astronomy



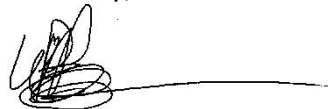
March 3, 2017

Prof. Kevin Resch, Acting Director
Institute for Quantum Computing
University of Waterloo

Dear Prof. Resch,

I offer this letter as evidence of the Department of Chemistry's continuing support of the mandate and efforts of the Institute for Quantum Computing. My Department was an early collaborator in the efforts to launch the Institute, and we have had a strong relationship with the Institute since its inception. We have partnered with IQC on three very important hires for the Department, including Prof. Jonathan Baugh, Prof. Wei Tsen, and of course the great impact of the appointment of Prof. David Cory as a CERC. Each of these additions to the Department have strengthened our profile, and they are outstanding colleagues that work well with the rest of the Department on many research areas. In addition, other Chemistry faculty have interacted with the work of IQC, including Prof. PN Roy (a Tier 1 CRC in Chemistry) and Prof. German Sciaini (a Tier 2 CRC in Chemistry). The enhanced research profile and environment made possible by our collaborations with IQC is of great benefit to the Department, and we plan to continue to support and play an active role in IQC for many years to come.

Sincerely,



William P. Power, Chair
Department of Chemistry
Phone: +1-519 888 4567, x33626
Mobile: +1-519 241 3216
wppower@uwaterloo.ca



Dr. Mark Giesbrecht
Email: cs-director@uwaterloo.ca
Phone: +1 519 888-4080

March 5, 2017

Dear Dr. Resch,

Over the course of the last decade, the Institute for Quantum Computing has been a source of significant benefit to the David R. Cheriton School of Computer Science. Our IQC-affiliated faculty have substantially improved our research quality and reputation, and the Computer Science graduate students brought in by IQC have included several of the strongest students we have trained. IQC also improves our experience by bringing a number of senior computer scientists to the campus as visitors and by maintaining the high level of prominence of computing research on our campus. For the past few years there have only been two IQC faculty members in the School, but both are now full professors who contribute in many ways to the School. Professor John Watrous is an outstanding researcher, who has done foundational work in quantum computational complexity. Watrous is also one of the School's finest instructors and has recently won a Faculty of Mathematics teaching award. He has also served as Associate Director of Undergraduate Studies as well as on the School hiring Committee and Tenure and Promotion Committee. Professor Richard Cleve is a Fellow of the Royal Society of Canada and among our School's most distinguished faculty. Prof. Cleve's work has received significant recognition. Cleve's graduate courses are widely appreciated and he has served in senior roles on our School committees, including the Tenure and Promotion and Annual Evaluation Committee.

IQC has brought excellent graduate students into the School, some of whom have won best-paper awards and outstanding teaching awards. Some of these students have moved on to excellent postdoctoral and faculty positions at leading institutions. Also, because of IQC, our School provides better training to graduate students in associated areas, such as algorithms and complexity, and machine learning. Courses in quantum computing are always popular with our graduate students. Another significant contribution of IQC has been in bringing a stream of impressive visitors to the university, including prominent computer scientists. Having these visitors at Waterloo is obviously of great benefit to our graduate students.

At the undergraduate level, the contribution of IQC to our programs is small, but CS 467, Introduction to Quantum Information Processing, is a very popular 400-level course. It is also a course that we can use to highlight the breadth of computer science courses available at Waterloo as we bring in the very best computer science undergraduates from around the world.

In summary, the Institute for Quantum Computing has made a major contribution to the success of the School over the past decade and we look forward to continuing our positive relationship with IQC.

Yours truly,

A handwritten signature in black ink, appearing to read 'Mark Giesbrecht', written in a cursive style.

Mark Giesbrecht
Professor and Director



Department of Applied Math,
University of Waterloo,
Waterloo, ON N2L 3G1,
9 February 2017

Kevin Resch
Associate Professor of Physics and Acting Director
Institute of Quantum Computing,
University of Waterloo

Dear Kevin,

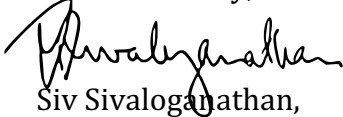
This is a letter to express my strong support for the renewal of the Institute for Quantum Computing (IQC) for a further five years.

The IQC has developed a strong international reputation, and has had a profound impact on academic units within the University. It has increased the profile of the University by attracting outstanding researchers and students. As a member of the Department Advisory Committee on Appointments, I have been involved in interviewing a number of candidates for IQC/Applied Math faculty positions, and have been repeatedly impressed by the intellectual acuity and excellence of all of them. As the IQC has grown and matured, the full breadth and significance of the research conducted by its faculty, has become more and more apparent.

The presence of the IQC has clearly had a positive impact on the Department of Applied Mathematics, and has helped attract outstanding faculty and first class students. Our department looks forward to the continued and enriching connections that we have enjoyed with IQC, thus far.

If I can be of any further assistance, please do not hesitate to contact me.

Yours sincerely,



Siv Sivaloganathan,
Professor and Chair,
Dept of Applied Mathematics



February 2, 2017

On behalf of the Pure Mathematics Department, I would like to affirm our continued support for the Institute for Quantum Computing.

The IQC is doing interesting, interdisciplinary research that brings together mathematicians of quite varied expertise, physicists, chemists and computer scientists. It also provides opportunities for students and postdoctoral fellows to be engaged in cutting edge research.

One faculty member in our department has a joint appointment with IQC. With the support he receives from IQC he has already made a significant impact on our department in just the two years that he has been here. He has been able to provide sophisticated training and substantial funding for five graduate students that he is supervising or co-supervising. He has contributed to the support of several postdoctoral fellows with whom he is working, and he brings visitors, both long and short-term, into the department on a regular basis. The graduate courses he has taught for both the Pure Mathematics department and IQC have attracted students from across the Mathematics Faculty and beyond. With his assistance, we are now exploring the possibility of creating new courses and/or modifying existing courses, for undergraduate students interested in the fundamental mathematical ideas that lie behind quantum computing problems and applications.

The IQC is a great asset to the University of Waterloo, both in terms of its important scientific contributions and its outstanding international reputation.



Kathryn Hare
Chair, Department of Pure Mathematics
University of Waterloo



Jochen Koenemann
Professor and Chair
Dept. of Combinatorics and Optimization
Faculty of Mathematics, University of Waterloo
Waterloo, ON N2L 3G1, Canada

Email: jochen@uwaterloo.ca
Phone: 519-888-4567 ext 35592

**UNIVERSITY OF
WATERLOO**

22nd February 2017

Dear Professor Resch,

I am supplying a letter in strong support of renewing the IQC's mandate on campus.

Cryptography as a subject of investigation in the C&O department began in the 1980's with Professors Ron Mullin and Scott Vanstone's interest in cryptographic problems related to their research in combinatorial design theory and finite fields. Later, industrial support for the establishment of two NSERC Industrial Chairs led to the formation of the Centre for Applied Cryptographic Research (CACR) in 1998.

The C&O department began recruiting Professor Michele Mosca, who was in the process of completing his Ph.D. in quantum algorithms at Oxford University. Quantum algorithms was a relatively new discipline, but was of strong cryptographic relevance because of its potential destructive applications (in particular, Shor's algorithm, discovered in 1994, was known to totally compromise the security of RSA and elliptic curve public-key cryptosystems). Funding at the University of Waterloo was tight in the late 1990's, but the department was successful in securing an Ontario Research and Development Challenge Fund (ORDCF) award. These funds enabled the hiring of Michele Mosca at St. Jerome's University. Professor Mosca was cross-listed to the C&O department, which used the funds from a MITACS grant to hire two postdoctoral fellows to work with Professor Mosca on quantum algorithms. Thus, a quantum algorithms research group was born at Waterloo.

Professor Mosca then met Mike Lazaridis, and started making ambitious plans for quantum computing research at Waterloo. Professor Ray Laflamme was recruited to Waterloo, and shortly thereafter Professor Ashwin Nayak joined the C&O department. The latter hiring was made possible because of the aforementioned ORDCF award that was used to pay the first two years of Professor Nayak's salary. The quantum computing group soon evolved into the Institute for Quantum Computing, which was formally established in 2002.

The C&O department was fortunate to hire several outstanding quantum algorithms faculty members. In addition to Professors Nayak and Mosca (who transferred to the C&O department in 2009), the department hired Professors Andris Ambainis, Debbie Leung, Andrew Childs, and Jon Yard. (Ambainis and Childs subsequently left to take positions at the University of Latvia and the University of Maryland.) Furthermore, Professor Richard Cleve from the School of Computer Science

is cross-listed to the C&O department.

The C&O department has been greatly enriched by the inter-disciplinary research activities that have emerged, both within the C&O department, and with faculty members in other department. For example, Professor Chris Godsil, an expert in algebraic combinatorics, is now the world's foremost expert in applying techniques from algebraic graph theory to tackle problems in quantum information theory including the existence of mutually unbiased bases, quantum colouring and homomorphisms, and quantum walks. Professor Levent Tuncel, an expert in optimization, and Professor Nayak used convex optimization methods to search for quantum-strong coin-flipping protocols. Professor David Jao, an expert in mathematical cryptography, has teamed with Professor Mosca to develop commercialize quantum-safe public-key cryptosystems. In 2012, Professor Mosca received an NSERC CREATE grant and developed CryptoWorks21, an inter-departmental supplementary training program to prepare graduate students and postdoctoral fellows to create quantum-safe cryptographic tools.

Sincerely,



Jochen Koenemann

February 21, 2017

To Whom it may concern,

It is with great pleasure that I write this letter in strong support for a renewed mandate for the University of Waterloo's Institute for Quantum Computing (IQC).

IQC was established at Waterloo in 2002; a primary objective was to draw an elite team of researchers and faculty together who could interconnect several facets of quantum computing from mathematics, science, and engineering – all 'under one roof'. In particular, there has been a unique emphasis on uniting theoretical and experimental worlds. The Quantum Nano Centre (QNC), where IQC is housed, is home to the world-class Quantum NanoFab facility. This facility enhances researchers' capacity to propel their work from concepts to working prototypes. As a result, IQC has been a strategic investment tool that has helped the Department of Electrical and Computer Engineering (ECE) attract five world-leading faculty members:

- Michal Bajcsy conducts research in nano-photonic structures. He completed his doctoral work at Harvard University and joined ECE in 2014.
- Na Young Kim joined ECE as an Associate Professor in 2016. She completed a PhD at Stanford University in 2006 and then spent several years working in leading industrial positions. Her work focuses on solid-state quantum devices.
- Guo-Xing Miao works in quantum materials. He obtained a PhD from Brown University and then spent five years at MIT. He joined our department as an Assistant Professor in 2012.
- Michael Reimer came back to Waterloo after many years as a postdoctoral fellow at TU Delft. He holds a PhD from the University of Ottawa. His work focuses on quantum optics.
- Chris Wilson, P.Eng., was previously a tenured faculty member at Chalmers University and joined ECE in 2012. An outstanding scholar with an international reputation, Prof. Wilson has made groundbreaking discoveries in superconducting single-electronics.

This past year alone, four of ECE's IQC faculty received prestigious Early Researcher Awards from the Province of Ontario – a stunning feat. Through IQC, they have had access to large start-up grants, allowing them to build on their established capabilities and accelerate their current research into new transformative directions. The Quantum NanoFab facility and other IQC experimental facilities have provided our ECE IQC faculty members with access to state-of-the-art, multi-million dollar research infrastructure that cannot be easily accessed anywhere else in the world. Revolutionary research and development can only emerge when resources and intellectual freedom are made available through the commitment and support of the institution.



ECE strongly endorses a renewed mandate for IQC. We look forward to more exciting, cutting-edge, globally competitive research in the years to come that will enhance our research capacity and enable us to strive for global leadership.

Best wishes for continued success!

A handwritten signature in blue ink that reads "Vincent Gaudet". The signature is written in a cursive style with a blue ink color.

Vincent Gaudet, Ph.D., P.Eng.
Professor and Chair

APPENDICES

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IQC Constitution

September 22, 2016

Article 1: Name

The name of this body shall be the *Institute for Quantum Computing*. In the remainder of this document it shall be referred to as *IQC* or *the Institute*.

Article 2: Vision and Mission

Vision: Harnessing quantum information will lead to transformative technologies and scientific advancements that will benefit society and become a new engine of economic development in the 21st century.

Mission: To develop and advance quantum information science and technology at the highest international level through the collaboration of computer scientists, engineers, mathematicians, and physical scientists.

Article 3: Categories of Membership

IQC's objectives depend on a respect for the diversity, rights, and dignity of all members of the Institute and a recognition of their contributions. All members of IQC are expected to adhere to the highest standards of collegiality and ethical conduct in support of these principles, to act in the best interests of the Institute and the University, and to strive to improve the Institute and the broader community in which we live and work.

3.1 Regular Members

Regular Members hold a faculty appointment in an academic department or school at the University of Waterloo and conduct research in the areas of quantum information science, technology, engineering, and/or mathematics. Regular Members are expected to demonstrate excellence in research, and tenured Regular Members are expected to be internationally recognized in their areas of research expertise.

Regular Members are appointed to IQC by the Executive Committee, based on the recommendation of the Executive Director. Candidates for Regular Membership must be vetted and voted upon by the Regular Members of the Institute. Appointment to IQC as a

Regular Member is normally for a 5 year renewable period. Regular Members are subject to the renewal procedures described in the IQC Faculty Renewal Procedures document.

Regular Members are expected to develop and maintain internationally recognized research programs of a very high calibre that reflect the research excellence of the Institute. Regular Members are also expected to contribute to the general objectives of IQC through teaching and training of highly qualified personnel (HQP), procuring individual and/or group research grants, and/or participating in service and governance activities within IQC, through service on committees within IQC and participation in IQC faculty meetings.

Regular Members will be evaluated regularly by a committee whose members are drawn from the Regular Membership of IQC and chaired by the Executive Director. This evaluation will be focused primarily on contributions to research, but may also recognize other contributions to IQC including teaching and service.

3.2 Research Faculty

3.2.1 Research Assistant Professors

Research Assistant Professors hold a definite-term faculty appointment in a department or school at the University of Waterloo and conduct research in quantum information science, technology, engineering, and/or mathematics, or research that directly supports one or more of these areas. Research Assistant Professors are expected to perform research of very high calibre.

Research Assistant Professors are appointed to IQC by the Executive Committee, based on the recommendation of the Executive Director. New Research Assistant Professors must be vetted and voted upon by the Regular Members of the Institute.

Research Assistant Professor appointments are ordinarily made for a fixed five-year term and are not renewable.

Each Research Assistant Professor must be supervised either by the Executive Director or by one or more Regular Members.

3.2.2 Research Associate Professors and Research Professors

Research Associate Professors and Research Professors hold a definite-term or contingent-upon-funding faculty appointment at the University of Waterloo and conduct research in quantum information science, technology, engineering, and/or mathematics, or research that directly supports one or more of these areas. Research Associate Professors and Research Professors may be appointed to a department, school, or faculty, or may be appointed directly to the Institute. Research Associate Professors and Research Professors are expected to perform internationally recognized research of very high calibre.

Research Associate Professors and Research Professors are appointed to IQC by the Executive Committee, based on the recommendation of the Executive Director. Renewable Research Associate Professor and Research Professor appointments are subject to review, normally at 5 year intervals. Research Associate Professor and Research Professor appointments and renewals are to be vetted and voted upon by the Regular Members of the Institute.

In extraordinary circumstances, Research Associate Professors and Research Professors may be appointed by the Executive Committee as *de facto* Regular Members of IQC, and in such cases are subject to the expectations, responsibilities, and procedures for Regular Members described above.

3.3 Staff Members

IQC Staff Members, including technical and administrative staff members, are University of Waterloo staff members appointed to a position or secondment within IQC. Staff Members may be supported through research funding held by IQC members or through internal IQC funding.

All Staff Member appointments to IQC require the approval of the Executive Director.

3.4 IQC Associates

IQC Associates are researchers, either internal or external to the University of Waterloo, that are engaged either full-time or part-time in research in quantum information science, technology, engineering, and/or mathematics. IQC Associates are expected to engage with IQC members regularly in ways that support the Institute's objectives.

Associate Members are appointed to IQC by the Executive Director, based on the recommendation of the Regular Members of the Institute. Associate Members are normally appointed for a 5 year period, which may be renewed upon mutual agreement.

There are two general categories of IQC Associate Members:

- Associate Members who hold a faculty appointment at the University of Waterloo, who typically devote a fraction of their research efforts to quantum information science and technology, and/or work in an area that supports or broadens the research efforts of IQC.
- Associate Members who are external to the University of Waterloo (and therefore are not eligible for regular membership within IQC), but who spend a fraction of their time at IQC and engage in research in quantum information science and technology.

Associate Members within both categories may be provided with appropriate resources by IQC, subject to the approval of the Executive Director.

3.5 IQC Affiliates

IQC Affiliates are researchers, either internal or external to the University of Waterloo, that are formally invited to collaborate with members of IQC and to participate in IQC activities and events.

IQC Affiliates are appointed as such to IQC by the Executive Director, based on the recommendation of the Regular Members of the Institute. IQC Affiliates are normally designated as such for up to 5 years, which may be renewable upon mutual agreement.

3.6 Postdoctoral Fellows

Postdoctoral Fellow Members of IQC are appointed to a department, school, or faculty at the University of Waterloo and conduct research in quantum information science, technology, engineering, and/or mathematics. Postdoctoral Fellow Members are expected to help advance the state of the art in quantum information science and technology by performing research of outstanding quality. This research is done under the supervision of one or more Regular or Associate Members.

3.7 Students

Student Members of IQC study and/or conduct research in quantum information science, technology, engineering, and/or mathematics and are registered as students in a department, school, or faculty at the University of Waterloo or at another university.

There are two ways in which a graduate student may become a member of IQC:

- If a student has a supervisor or co-supervisor that is a Regular Member or an Associate Member of IQC, then the student may become a Graduate Student Member of IQC, provided that the student and the student's supervisor (or supervisors) are in agreement.
- The Director of the Quantum Information Graduate Program may approve a student as a Graduate Student Member of IQC, provided that both the student and the student's supervisor (or supervisors) are in agreement.

Graduate Student Members are expected to engage in IQC activities (such as attendance at seminars and colloquia) when it is feasible and supportive of their studies to do so. Graduate Student Members working primarily in laboratories or assigned offices that are external to IQC are expected to be present at IQC on a regular basis, as agreed upon by the student's supervisor(s), co-supervisor(s), and the QI Graduate Program Director.

The Institute will provide support for Student Members when possible and appropriate, including access to IQC premises, facilities, and office space; IT and administrative support; and access to printing facilities. Graduate Student Members are also eligible to be considered for IQC student fellowships and awards.

Article 4: Governance

The principal aim of IQC's governance structure is to safeguard and facilitate the scholarly activities and academic freedom of its members, and to further the objectives of the Institute.

4.1 Executive Committee

The Executive Committee serves as the central governing body of IQC having primary executive authority over the Institute. The Executive Committee approves faculty member appointments to IQC, approves the budget of the Institute, and advises the Vice-President, University Research on the appointment of the Executive Director.

The membership of the Executive Committee is as follows:

- Vice-President, University Research of the University of Waterloo (chair)
- Associate Vice-President, University Research of the University of Waterloo
- Executive Director of IQC
- Managing Director of IQC (if this position is filled) (non-voting)
- At least three Regular Members (not including the Executive Director) that serve as representatives of all Regular Members of IQC
- The Chair of the IQC Board (non-voting)
- The Deans of Mathematics, Science, and Engineering

The Regular Members that serve as representative members on the Executive Committee will be elected by the Regular Members of the Institute, and will include at least one representative from each of the Faculties of Math, Science, and Engineering.

Meetings of the Executive Committee are open to all members of the university community, with *in camera* sessions held to discuss sensitive or private matters as determined by the committee chairperson. An agenda will be circulated in advance of each meeting to facilitate the collection of input by representatives on the committee from the Regular Members of IQC.

4.2 Executive Director

The Executive Director of IQC is a Regular Member who oversees the scholarly activities, strategic directions, and general governance of IQC. The Executive Director will seek the input and advice of regular faculty members on matters of high importance to the Institute.

The Executive Director is appointed by the Vice-President, University Research, on the recommendation of the Executive Committee. The Vice-President's selection for an Executive Director will be informed by an Executive Director Search Committee, chaired by the

Vice-President. The Executive Director Search Committee will include at least four Regular Members of IQC, including at least one representative from each of the Faculties of Math, Science, and Engineering, based on a nomination and voting process open to all Regular Members of IQC. In addition, the Vice-President's selection for an Executive Director will be vetted and voted upon by the Regular Members of the Institute.

The Executive Director's term is determined by the Vice-President, University Research, and is normally for a five-year period. The Executive Director's term may be extended or renewed with support from the Executive Committee and the Regular Members of IQC. Extensions and renewals of the Executive Director's term are to be vetted and voted upon by the Regular Members of the Institute.

The Executive Director may nominate one or more Associate Directors to help to oversee the academic and research activities of the Institute. Nominees for Associate Director positions are to be vetted and voted upon by the Regular Members of the Institute.

The Executive Director may appoint a Managing Director to help to manage and oversee the administrative activities of the Institute.

4.3 Scientific Advisory Committee

The IQC Scientific Advisory Committee consists of a group of eminent scholars, external to the University of Waterloo, who are acknowledged leaders in quantum information science and technology.

The role of the Scientific Advisory Committee is to assess the Institute's progress towards fulfilling its objectives and strategic goals, and to advise the Executive Director and Regular Members on strengths and weaknesses of the Institute. The Scientific Advisory Committee may also be asked to advise on the appointment and renewal of Regular Members.

The Scientific Advisory Committee normally meets once each year.

A. IQC Advisory Board Biographies

Mike Lazaridis (Board Chair)

Co-founder and Managing Partner, Quantum Valley Investments

Mike Lazaridis is Managing Partner and Co-Founder of Quantum Valley Investments (QVI), which he and Doug Fregin established in Waterloo. In March 2013, they launched QVI with \$100 million to provide financial and intellectual capital for the development and commercialization of quantum physics and quantum computing breakthroughs. In 1984, Mr. Lazaridis co-founded BlackBerry (formerly Research In Motion) with Mr. Fregin. They invented the BlackBerry device, created the smartphone industry, and built Canada's largest global tech business. Mr. Lazaridis served in various positions including Co-Chairman and Co-CEO (1984-2012) and Board Vice Chair and Chair of the Innovation Committee (2012-13).

Mr. Lazaridis is the Founder and Board Chair of Perimeter Institute, where he helps generate important private and public sector funding for the Institute. He also founded the Institute for Quantum Computing and the Quantum-Nano Centre, both at the University of Waterloo. He has donated more than \$170 million to Perimeter, and more than \$100 million to IQC.

Among his many honours, Mr. Lazaridis is a Fellow of both the Royal Societies of London and Canada and has been named to both the Order of Ontario and the Order of Canada. Mr. Lazaridis holds an honorary doctoral degree in Engineering from the University of Waterloo (where he formerly served as Chancellor), as well as a Doctor of Laws from McMaster University, the University of Windsor, and Laval University.

Peter E. Brown

Senior Practice Partner, Deloitte Canada

Peter E. Brown, CPA CA, ICD.D., is a Senior Practice Partner in Deloitte Canada. Peter has close to 30 years' experience in public accounting, serving clients in both the public and private sectors. He has gained significant international experience in assurance and advisory services and has extensive experience with business advisory services. Peter served as Managing Partner for Deloitte's Atlantic Practice until 2008 when Peter relocated to Toronto to assume the role of Managing Partner and National Leader for Private Company Services.

In 2011, Peter's responsibilities were expanded to include the entire middle market for Deloitte Canada. In 2013 Peter relinquished these responsibilities and was appointed to Deloitte Canada's Client Cabinet which is comprised of senior leaders with firm wide market responsibilities. Peter is the co-author of *The Power of The Best*, published in September 2012, the sequel to *Building the Best - Inside Canada's Best Managed Companies*.

Peter has been involved in United Way both in the Atlantic Region and Toronto, in Chambers of Commerce throughout Atlantic Canada, and is a member of the Advisory Board for the Sobey's School of Business. Peter is also involved in Habitat for Humanity and served as part of a Deloitte Humanitarian Team that travelled to Brazil in October of 2011 to build homes and meet with local business leaders. Peter is a graduate of St. Mary's University and is a member of the Canadian and Ontario Institutes of Chartered Accountants and a CPA

(Illinois). Peter is a graduate of the Directors Education Program offered by the Institute of Corporate Directors and Rotman School of Management.

Tom Brzustowski

RBC Professor, Telfer School of Management, University of Ottawa

An engineer, Tom Brzustowski graduated with a B.A.Sc. in Engineering Physics from the University of Toronto in 1958, and a Ph.D. in Aeronautical Engineering from Princeton in 1963. He was a professor in the Department of Mechanical Engineering at the University of Waterloo from 1962 to 1987, teaching and carrying out research in thermodynamics and combustion. He served as Chair of Mechanical Engineering from 1967 to 1970 and as Vice-President, Academic of the University from 1975 to 1987.

After that he served as deputy minister in the Government of Ontario from 1987 to 1995, first in the Ministry of Colleges and Universities, and later in the Premier's Council. He was appointed President of NSERC in October 1995, and reappointed in 2000. Tom Brzustowski holds honorary doctorates from several institutions, namely, Alberta, Concordia, école Polytechnique de Montréal, Guelph, McMaster, Ottawa, Royal Military College of Canada, Ryerson, and Waterloo, and received the Engineering Alumni Medal from the University of Toronto.

He is an Officer of the Order of Canada and a fellow of the Canadian Academy of Engineering and of the Royal Society of Canada.

Robert Crow

Managing Director/Executive in Residence, Institute for Quantum Computing

Robert E. (Bob) Crow is an experienced public policy and technology industry leader, currently serving as Managing Director/Executive in Residence at the Institute for Quantum Computing (IQC), University of Waterloo.

Bob's career includes lengthy service in the private, Non Governmental Organization (NGO), and university sectors as an executive, consultant and teacher. He is especially known as a strategic thinker and builder of organizational capacity in settings where technology and public policy intersect. A frequent speaker, Bob is an informed and articulate advocate for his organizations and their missions. Bob is the former Vice-President for Industry, Government and University Relations at Research In Motion Limited (RIM), where he built and led RIM's global programs in government relations, community relations, corporate responsibility, market intelligence and university research. Bob's teams supported RIM's rapid international expansion from 2001 – 2011 and were especially noted for their ability to create and defend access to foreign markets, often under challenging circumstances.

Prior to joining RIM in July 2001, Bob was Vice-President Policy at the Information Technology Association of Canada (ITAC) where he successfully positioned ITAC as a business association of credibility and influence in the Canadian policy milieu. Prior to this, he served from 1975 – 1998 at Ryerson University in Toronto as both professor of planning and senior administrator in a wide variety of roles including Information and Communication Technology strategy development, establishment of a technology centre, and leader of Ryerson's advancement activities.

Bob holds a bachelor's degree in engineering from Cornell University and master's degrees in planning and economics from the University of North Carolina at Chapel Hill and the University of Toronto, respectively. He also studied engineering and public policy at Carnegie Mellon University at the advanced graduate level.

George Dixon

Vice President, Chair, University Research, University of Waterloo

George Dixon is Vice-President, University Research and Professor of Biology at the University of Waterloo. Professor Dixon has received both the Award for Excellence in Research and the Distinguished Teaching Award from the university. He has over 25 years experience in aquatic toxicology and environmental risk assessment and management. He maintains an active research program, which is focused methods for environmental effects monitoring, methods of assessing the environmental risks associated with exposure of aquatic organisms to metal mixtures, and on the aquatic environmental effects of oil sands extraction in Alberta. He is Associate Editor of three scientific journals, including the Canadian Journal of Fisheries and Aquatic Sciences.

Robert Dunlop

Retired, Formerly Assistant Deputy Minister, Industry Canada

Robert recently retired from Industry Canada where he was the assistant deputy minister responsible for science and innovation. He held this position between 2009 and 2014, and before that he served at the assistant deputy minister level at Finance Canada where he co-managed the Economic Development and Corporate Finance Branch. Over his career he had responsibilities in a number of areas including program management, policy development and supporting ministers.

Robert is a native Montrealer where he studied economics and finance at McGill University. He now lives in Toronto.

Cosimo Fiorenza

VP and General Consul, Quantum Valley Investments

Cosimo Fiorenza is the Vice-President and General Counsel of the Quantum Valley Investments and the Quantum Valley Investment Fund. He is actively involved at several public and private non-profit and charitable institutions in addition to Institute for Quantum 133 Computing, including the Perimeter Institute, the Law Society of Upper Canada, the Centre for International Governance Innovation, and several private family foundations. Mr. Fiorenza holds a degree in Business Administration from Lakehead University and a law degree from the University of Ottawa.

David Fransen

Former Consul General Canadian Consulate in Los Angeles

David Fransen worked from 1985 to 1988 at the Privy Council Office, where he provided policy advice related to such developments as the Green Plan in 1990, the drafting of the Canadian Environmental Assessment Act and the Canadian Environmental Protection Act, and the creation of the Canadian Environmental Assessment Agency. He then became

Director of Economic Framework Policies in the Strategic Policy Branch of Industry Canada. In 1999, David became the Director General of the Centre for Healthy Human Development at Health Canada. He became Assistant Deputy Minister of the Industry Sector in 2003, where he was primarily responsible for providing policy advice and delivering programs related to some of Canada's key economic sectors. He became executive director of the Institute for Quantum Computing in 2006. He was most recently the Consul General, Canadian Consulate General in Los Angeles.

Peter Hackett

Professor, University of Alberta

Peter Hackett has been President and CEO of Alberta Ingenuity since October 2004. He is the former Vice-President Research at the National Research Council of Canada where he led NRC corporate strategies emphasizing emerging technologies, entrepreneurship and technology clusters. He was the lead NRC executive behind the creation and design of the National Institute for Nanotechnology at the University of Alberta. He is a member of the Institute Advisory Board Institute of Genetics, the Canadian Institute of Health Research, a board member of Genome Alberta and a founding member of the Alberta Advisory Committee on the Bio-economy. He was honoured recently by a Specially Elected Fellow of the Royal Society of Canada (RSC).

Raymond Laflamme (ex-officio)

Executive Director, Institute for Quantum Computing

Raymond Laflamme was born in Quebec City and did his undergraduate studies in Physics at Université Laval. He then moved to Cambridge, England, where he survived Part III of Mathematical Tripos before earning his PhD in the Department of Applied Mathematics and Theoretical Physics (DAMTP) under the direction of Stephen Hawking. Laflamme and Don Page are responsible for having changed Hawking's mind on the direction of time in a contracting Universe (as described in Hawking's best-seller "A Brief History of Time").

After his PhD, Laflamme became a Killam post-doctoral fellow at the University of British Columbia, where he met his future wife Janice Gregson. He moved back to Cambridge in 1990 as a Research Fellow at Peterhouse. He settled down for nine years at Los Alamos National Laboratory. He arrived as a postdoctoral fellow, then became an Oppenheimer Fellow in 1994. In 2001, he joined the Perimeter Institute for Theoretical Physics as a founding member. He founded the Institute for Quantum Computing and has been its Executive Director since 2002.

Mark Pecen

CEO, Approach Infinity Inc.

Mark Pecen serves as CEO of Approach Infinity, Inc., providing advisory services to firms requiring technology due diligence and management consulting in the areas of wireless communication and emerging technologies, rapidly growing technology companies and their venture capital funding partners. The firm comprises a network of senior executives and experts in the management of technology, innovation, research and development, marketing, sales, global standards, patents, technology entrepreneurship, and individuals

with specific technical disciplines such as information theory, radio frequency systems, wireless system protocols, cryptography and others.

Pecen retired as Sr. Vice President, Research and Advanced Technology and technology advisor to the CEO of BlackBerry, maker of wireless smart phones. He was responsible for the creation and management of BlackBerry's Advanced Technology Research Centre and a significant portion of BlackBerry's wireless patent portfolio. A past Distinguished Innovator and member of the Science Advisory Board at Motorola, Pecen also managed consultation work for clients in North America and Europe.

B. Scientific Advisory Committee Biographies

Chris Monroe, University of Maryland

Christopher Monroe is an experimental atomic, molecular and optical physicist. Monroe obtained his PhD at the University of Colorado in 1992. From 1992-2000, Monroe was a postdoc and staff physicist in the Ion Storage Group of David Wineland at the National Institute of Standards and Technology in Boulder, CO. In 2000, Monroe moved to the University of Michigan, where he introduced the use of single photons to couple quantum information between atomic ions. In 2006, he became Director of the FOCUS Center at the University of Michigan. In 2007, Monroe became the Bice Sechi-Zorn Professor of Physics at the University of Maryland and a Fellow of the new Joint Quantum Institute between Maryland and NIST. In 2007-2008, Monroe's group succeeded in producing quantum entanglement between two widely separated atoms and teleported quantum information between atoms separated by a large distance.

Harry Buhrman, Centrum voor Wiskunde en Informatica (CWI)

Harry Buhrman is head of the research group 'Algorithms and Complexity' at the Centrum Wiskunde & Informatica, which he joined in 1994. Since 2000 he also has a joint appointment as full professor of computer science at the University of Amsterdam. Buhrman's research focuses on quantum computing, algorithms, complexity theory, and computational biology. One of the highlights in the work of Buhrman is the article co-authored with Richard Cleve (University of Waterloo, Canada) 'Quantum Entanglement and Communication Complexity'. They demonstrated that with quantum entanglement certain communication tasks can be solved more efficiently. He also co-developed a general method to establish the limitations of quantum computers. He has written more than 100 scientific publications.

Sir Anthony Leggett, University of Illinois at Urbana-Champaign Anthony

J. Leggett, the John D. and Catherine T. MacArthur Professor and Center for Advanced Study Professor of Physics, has been a faculty member at Illinois since 1983. He was a co-winner of the 2003 Nobel Prize in Physics for pioneering work on superfluidity. He is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, the Russian Academy of Sciences (foreign member), and is a Fellow of the Royal Society (U.K.), the American Physical Society, and the American Institute of Physics. He is an Honorary Fellow of the Institute of Physics (U.K.). He was knighted (KBE) by Queen Elizabeth II in 2004 "for services to physics." He is also a Mike and Ophelia Lazaridis Distinguished Research Chair.

Umesh Vazirani, University of California

Umesh Vazirani is a professor in the Computer Science Division of the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley. Professor Vazirani is a Director of the Berkeley Quantum Information and Computation Center (BQIC). He received an NSF Presidential Young Investigator Award in 1987 and the Friedman Mathematics Prize in 1985. Professor Vazirani wrote the book, "An Introduction to Computational Learning Theory" with Michael Kearns and currently is at the forefront of research in the area of quantum computing.

Anton Zeilinger, University of Vienna

Anton Zeilinger is a professor of physics at the University of Vienna (previously Innsbruck). Professor Zeilinger is known for multiple experiments in the realm of quantum interferometry and the demonstration of quantum teleportation. His work influenced the experimental progress in a new sub-field of physics, quantum information theory. He has contributed to theoretical physics and the foundations of quantum mechanics — he has showed an amplification of the Einstein-Podolsky-Rosen paradox, where one considers three, instead of just two, entangled particles.

Wojciech Zurek, Los Alamos National Laboratory

Wojciech Hubert Zurek is a Laboratory Fellow at Los Alamos National Laboratory (LANL). He is a leading authority on a number of physics topics, including quantum theory, and particularly, decoherence. His work also has great potential benefit to the emerging field of quantum computing. He was educated in Krakow, Poland (M.Sc. 1974) and Austin, Texas (PhD 1979). He spent two years at Caltech as a Tolman Fellow, and began his appointment at LANL as a J. Oppenheimer Fellow. He was the leader of the Theoretical Astrophysics Group at LANL from 1991 until he was made a Laboratory Fellow in the Theory Division in 1996. Zurek is currently a foreign associate of the Cosmology Program of the Canadian Institute for Advanced Research.

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D. IQC Members (2017)

The following list reflects all IQC members as of December 31, 2016:

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Ibrahim Nsanzineza
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E. Scientific Visitors

Visitor	Visitor Affiliation
2012-2013	
Darryl Hoving	University of Toronto, Canada
Charles H. Bennett	IBM TJ Watson Research Center, USA
Mehul Kumar	Indian Institute of Technology Delhi, India
Mayank Mishra	Indian Institute of Science Education and Research, India
Dominic Berry	Macquarie University, Australia
Jop Briët	Centrum Wiskunde & Informatica (CWI)
Srijita Kundu	Chennai Mathematical Institute, India
Sam Bader	Massachusetts Institute of Technology, USA
Mark A. Eriksson	University of Wisconsin - Madison, USA
Keith R. Motes	Louisiana State University, USA
Taesik Nam	Pohang University of Science and Technology (POSTECH), South Korea

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Crystal Noel	Massachusetts Institute of Technology, USA
Michal Papaj	University of Warsaw, Poland
Seung Woo Shin	University of California - Berkeley, USA
Christophe Vulliot	Université de Rennes, France
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Daniel Gustaw	Nicolaus Copernicus University, Poland
Bill Coish	McGill University, Canada
Patrick Coles	Carnegie Mellon University, USA
Alexandre Blais	University of Sherbrooke, UK
Kelsey Johnsen	University of California - Berkeley, USA
Melanie Jensenworth	University of Washington, USA
Stefano Chesi	McGill University, Canada
Yingdan Wang	McGill University, Canada

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Dan Wayner	National Research Council, Canada
Chip Elliott	Raytheon-BBN Technologies, USA
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Matteo Mariantoni	University of California - Santa Barbara, USA
W. Michael Snow	Indiana University Bloomington, USA
RIM Security Research Group	Research in Motion, Canada
Jaques Pienaar	The University of Queensland, Australia
Thomas Brougham	University of Strathclyde, Scotland, UK
Robert Cameron	University of Strathclyde, Scotland, UK
Feiruo Shen	Tsinghua University, China
Louis Salvail	Université de Montréal, Canada
Pawel Dabkowski	Nicolaus Copernicus University, Poland
Audrey Dot	Joseph Fourier University, France
Barbara Terhal	RWTH Aachen University, Germany
Jacob Biamonte	ISI Foundation, Italy
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Francois Sfigakis	University of Cambridge, UK
Gaurav Bhole	The University of Queensland, St. Lucia
Juan Carlos Gracia Escartin	Universidad de Valladolid, Spain
Natsumi Komatsu	Rice University, USA
Bruno Huttner	ID Quantique, Switzerland
Dariusz Lasecki	Adam Mickiewicz University, Poland
Robert Johnson	Pennsylvania State University, USA
Jacob Marks	Yale University, USA
Zachary Pagel	Tufts University, USA
Dominique Pouliot	University of Illinois at Urbana-Champaign, USA
Ivana Rilak	University of Belgrade, Serbia
Jean Lapointe	National Research Council, Canada
Jason Herrmann	Harvard University, USA

Visitor	Visitor Affiliation
Matt Hodel	Massachusetts Institute of Technology, USA
Amir Karamlou	Massachusetts Institute of Technology, USA
Dennis Feng	University of California - Berkeley, USA
Noah Dylan Johnson	University of Wisconsin - Madison, USA
Michael Wolfe	University of Maryland, USA
Daniela Angulo Murcillo	National University of Columbia, Colombia
Milena Crnogorcevic	Middlebury College, USA
Peter D. Johnson	Dartmouth College, USA
Yiruo Lin	University of Illinois at Urbana-Champaign, USA
Crystal Senko	Harvard University, USA
Bhaskaran Muralidharan	Indian Institute of Technology Bombay, India
Mahrud Sayrafi	University of California - Berkeley, USA
Tzu-Chieh Wei	University of British Columbia, Canada
Karolina Sedziak	Nicolaus Copernicus University, Poland
Nina Bindel	Technische Universität Darmstadt, Germany
Serge-Olivier Paquette	Université de Montréal, Canada
Apoorva Patel	Indian Institute of Science, Centre for High Energy Physics Bangalore, India
Volkher Scholz	Ghent University, Belgium
Nachiket Sherlekar	University of Waterloo, Canada

Visitor	Visitor Affiliation
Valentina Bacetti	Macquarie University, Australia
Rebecca Lapointe	Université de Montréal, Canada
Robert Myers	Perimeter Institute, Canada
Tom Stace	The University of Queensland, Australia
Bowen Yang	Nankai University, China
Yu Zheng	Nankai University, China
Luis Garay	Universidad Complutense Madrid, Spain
Miriam Gauntlett	University of Cambridge, UK
Zidu Liu	University of Science and Technology of China, China
Dongsheng Wang	University of Calgary, Canada
Angela Karanjai	The University of Sydney, Australia
Jonathan Oppenheim	University College London, UK
Jess Riedel	Perimeter Institute, Canada
Yonuk Chong	Korea Research Institute of Standards and Science, South Korea
Michael Walter	Stanford University, USA
Lino Eugene	McGill University, Canada
Xiaobo Zhu	University of Science and Technology of China, China
Thomas Kauten	University of Innsbruck, Austria
Sophie Laplante	Université Paris Diderot, France
Carlos Perez Delgado	Singapore University of Technology and Design, Singapore
Marco Piani	University of Strathclyde, Scotland, UK

Visitor	Visitor Affiliation
Xionfeng Ma	Tsinghua University, China
Xiongfeng Ma	Tsinghua University, China
Stephanie Simmons	Simon Fraser University, Canada
Akihiro Mizutani	Osaka University, Graduate School, Japan
Urbasi Sinha	Raman Research Institute, India
Nai-Hui Chia	Pennsylvania State University, USA
Todd Pittman	University of Maryland, USA
Michael Bremner	University of Technology, Australia
Hugo Cable	University of Bristol, UK
Animesh Datta	The University of Warwick, UK
Rotem Liss	Technion – Israel Institute of Technology, Israel
Tal Mor	Technion – Israel Institute of Technology, Israel
Hengyan Wang	University of Science and Technology of China, China
Michael Lynch	Acadia University, Canada
Yoon-Seok Lee	Pusan National University, South Korea
Haining Pan	Nanjing University, China
Hugo Woerdeman	Drexel University, USA
Dmitry Pushin	National Institute for Science and Technology Centre for Neutron Research (NCNR), USA
Cheol-Joo Kim	Cornell University, USA
Hong Chiang	Chongqing University, China

Visitor	Visitor Affiliation
Atmn Patel	Kingsville District High School, Canada
Sacha Schwarz	University of Bern, Switzerland
Imran Khan	Max Planck Institute for the Science of Light, Germany
Lorenzo Procopio	University of Vienna, Austria
Joseph Choi	University of Rochester, USA
Rolf Horn	Quspin Technologies, Canada
Henry De Valence	Eindhoven University of Technology, The Netherlands
Andreas Fognini	Delft University of Technology, The Netherlands
Youn-Chang Jeong	Agency for Defense Development (ADD), South Korea
Yoon-Ho Kim	Pohang University of Science and Technology (POSTECH), South Korea
Heedeuk Shin	Pohang University of Science and Technology (POSTECH), South Korea
Christoph Marquardt	Max Planck Institute for the Science of Light, Germany
Shihai Sun	National University of Defence Technology, China
Laura Garcia-Alvarez	University of the Basque Country, Spain
K. Rajibul Islam	Massachusetts Institute of Technology, MIT-Harvard Center for Ultracold Atoms, USA
Martin Suchara	AT&T Labs Research, USA

Visitor	Visitor Affiliation
Mike Kobierski	McGill University, Canada
William Oliver	Massachusetts Institute of Technology, USA
Juan Bermejo Vega	Perimeter Institute, Canada
Douglas Stebila	McMaster University, Canada
Dapeng Yu	South University of Science and Technology of China, China
Manhong Yung	South University of Science and Technology of China, China
Charles W. Clark	National Institute of Standards and Technology (NIST), USA
Franco Wong	Massachusetts Institute of Technology, USA
Mark McArdle	eSentire, Canada
Jose Aumentado	National Institute of Standards and Technology (NIST), USA
Stephen K. Gray	Argonne National Laboratory, USA
Fereshteh Rajabi	University of Western Ontario, Canada
Karol Zyczkowski	Jagiellonian University, Poland

Visitor	Visitor Affiliation
Harry Buhrman	University of Amsterdam, The Netherlands
Tony Leggett	University of Illinois at Urbana- Champaign, USA
Christopher Monroe	University of Maryland, USA
Carlos Silva	Université de Montréal, Canada
Sara Hosseini	Australian National University, Australia
Xiaodong Ma	University of Science and Technology of China, China
Alexander Ling	Centre for Quantum Technologies, National University of Singapore, Singapore
Yidun Wan	Fudan University , China
Jorma Louko	The University of Nottingham, UK
Andrew Cameron	University of Prince Edward Island, Canada
Milena Grifoni	University of Regensburg, Germany
Christine Muschik	University of Innsbruck, Austria
Mathieu Lauriere	New York University Shanghai, China

F. Quantum Information Courses

	Winter Term	Spring Term	Fall Term
2012	QIC 750 - Implementations of Quantum Information Processing	QIC 890/891 - Selected Topics in Quantum Information	
	QIC 890 - Optical and Atomic Implementations		
	QIC 890 - Quantum Error Correction and Fault Tolerance		
	QIC 890 - Applied Quantum Cryptography		
	Sir Anthony Leggett Lecture Series 2012		
2013	QIC 750 - Implementation of Quantum Information Processing	PHYS 777 - Sir Anthony Leggett Lecture Series	QIC 710 - Quantum Information Processing
	QIC 890 - Implementation of Quantum Communication	QIC 890/891 - Selected Advanced Topics in Quantum Information	QIC 890 - Recent advances in quantum information
	QIC 885 - Quantum Electronics and Photonics	QIC 891 - Topics in Quantum-Safe Cryptography	QIC 891 - Examples of quantum devices
	QIC 845 - Open Quantum Systems		
	QIC 823 - Quantum Algorithms		
2014	QIC 750 - Implementation of Quantum Information Processing	Sir Anthony Leggett Lecture Series	QIC 710 - Quantum Information Processing
	QIC 885 - Quantum Electronics and Photonics	QIC 890/891 - Selected Advanced Topics in Quantum Information	QIC 890 - Spin-Based Implementations
	QIC 890 - Quantum Error Correction and Fault Tolerance	QIC 890 - Quantum Complexity Theory	QIC 890 - Haar Measure in Quantum Information Theory
	QIC 890 - Applied Quantum Cryptography	QIC 891 - Topics in Quantum-Safe Cryptography	QIC 890 - Modern Quantum Optics and Nanophotonics
	QIC 750 - Implementation of Quantum Information Processing	PHYS 777 - Sir Anthony Leggett Lecture Series	QIC 710 - Quantum Information Processing
2015	QIC 890 - Implementations of Quantum Communication	QIC 890/891 - Selected Advanced Topics in Quantum Information	QIC 820 - Theory of Quantum Information

	Winter Term	Spring Term	Fall Term
	QIC 885 - Quantum Electronics and Photonics	QIC 891 - Topics in Quantum Safe Cryptography	QIC 880 - Nanoelectronics for Quantum Information Processing
	QIC 845 - Open Quantum Systems	QIC 895 - Theory of Quantum Optics	QIC 890 - Solid State Photonic Devices
	QIC 823 - Quantum Algorithms	QIC 890 - Entanglement and Nonlocality	QIC 890 - Modern Quantum Optics and Nanophotonics
	QIC 750 - Implementation of Quantum Information Processing	QIC 890/891 - Selected Advanced Topic in Quantum Information	QIC 710 - Quantum Information Processing
	QIC 885 - Quantum Electronics and Photonics	QIC 890 - Quantum Error Correction and Fault Tolerance	QIC 890 - Qubits with Semiconductors and Spins
2016	QIC 890 - Applied Quantum Cryptography	QIC 890 - Introduction to Noise Processes	QIC 890 - Functional Analysis Methods for Quantum Information Technologies
	QIC 890 - Optical and Atomic Implementation	PHYS 777 - Sir Anthony Leggett Lecture Series	QIC 890 - Theory of Quantum Communication
	QIC 890 - Relativistic Quantum Information		QIC 890 - Solid-state Photonic Devices

G. Student Awards

Award	Student	Year Awarded
David R. Cheriton Graduate Scholarship	Alessandro Cosentino	2015
	Taylor Hornby	2017
	Li Liu	2013
	Vincent Russo	2013-2015
	Dhinakaran Vinayagamurthy	2017
Institute for Quantum Computing Entrance Award	Brandon Buonacorsi	2015
	Nayeli Azucena Rodriguez Briones	2016
IQC Achievement Award	Hillary Dawkins	2015
	Gregory Holloway	2014
	Michael Mazurek	2017
	Corey McRae	2015
	Shihan Sajeed	2017
IQC David Johnston Award for Scientific Outreach	Juan Miguel Arrazola	2015
	Carolyn Earnest	2016
	Aimee Gunther	2015
	Sarah Kaiser	2015
	Christopher Pugh	2014
IQC Entrance Award	Vadiraj Ananthapadmanabha Rao	2015
	Eduardo Barrera Ramirez	2015
	Arnaud Carignan-Dugas	2014
	Stephaney Daley	2017
	Hillary Dawkins	2015
	Olivia Di Matteo	2014
	Jennifer Fernick	2016
	Matthew Graydon	2012
	Holger Haas	2012
	Vinay Iyer	2015
	Hyeran Kong	2016
	Benjamin Lovitz	2016
	Clifford Plesha	2016
	Christopher Pugh	2012
	Daniel Puzzuoli	2015
	John Rinehart	2014
	Vincent Russo	2013
	Jeffrey Salvail	2015
	John Schanck	2014
	Guillaume Verdon-Akzam	2017
Dhinakaran Vinayagamurthy	2015	
Mike and Ophelia Lazaridis Fellowship	Sarah Kaiser	2012
	Shitikanth Kashyap	2012

Award	Student	Year Awarded
	Li Liu	2013
	Youn Seok Lee	2017
	Morgan Mastrovich	2017
	Nicholas Funai	2017
	Maria Kieferova	2015-2017
	Hammam Qassim	2015-2017
	Nayeli Rodriguez Briones	2017
	Sumit Sijher	2016-2017
	Yongchao Tang	2017
NSERC Alexander Graham Bell Canada Graduate Scholarship - Doctoral	Matthew Amy	2015
	Olivia Di Matteo	2016- 2017
	John Donohue	2014
	Matthew Graydon	2012-2015
	Jason LeGrow	2017
	Michael Mazurek	2016-2017
	Christopher Pugh	2014-2017
	Jason Pye	2016-2017
	Jeffrey Salvail	2015-2017
	Sean Walker	2016-2017
	Chunhao Wang	2015
	Kyle Willick	2014
NSERC Alexander Graham Bell Canada Graduate Scholarship - Masters	Stefanie Beale	2017
	Kristine Boone	2017
	Arnaud Carignan-Dugas	2014-2015
	Hillary Dawkins	2014
	Olivia Di Matteo	2014-2015
	Honghao Fu	2015
	Laura Henderson	2014
	Sumeet Khatri	2014
	David Layden	2015-2016
	Jason LeGrow	2016-2017
	Michael Mazurek	2013
	Christopher Pugh	2012-2013
	Jason Pye	2015-2016
	Sean Walker	2014-2015
NSERC Postgraduate Scholarship - Doctoral	Arnaud Carignan-Dugas	2017
	Aimee Gunther	2017
	Gregory Holloway	2015-2017
NSERC Vanier Canada Graduate Scholarship	Jean-Philippe Maclean	2015
	Kent Fisher	2012
	Tomas Jochym-O'Connor	2014
Ontario Graduate Scholarship	Eduardo Barrera Ramirez	2017
	Kristine Boone	2015-2017
	Hillary Dawkins	2015
	Jeremy Flannery	2017

Award	Student	Year Awarded
	Honghao Fu	2014
	Kaveh Gharavi	2014
	Matthew Graydon	2012-2016
	Aimee Gunther	2015
	Gregory Holloway	2014
	Taylor Hornby	2017
	Sumeet Khatri	2015
	David Layden	2016-2017
	Jason LeGrow	2015-2016
	Xingliang Lou	2015-2016
	Christian Mastromattei	2017-2017
	Michael Mazurek	2014-2016
	Christopher Pugh	2013-2017
	Daniel Puzzuoli	2016-2017
	Jason Pye	2014-2015
	Sean Walker	2015-2016
	Chunhao Wang	2014
	Joshua Young	2014-2017
	Kent Fisher	2015
President's Graduate Scholarship	Matthew Amy	2015
	Eduardo Barrera Ramirez	2017
	Stefanie Beale	2017
	Kristine Boone	2015-2017
	Arnaud Carignan-Dugas	2014-2017
	Christopher Chamberland	2017
	Hillary Dawkins	2014-2015
	Olivia Di Matteo	2014-2017
	John Donohue	2014
	Kent Fisher	2015
	Jeremy Flannery	2017
	Honghao Fu	2014
	Matthew Graydon	2012-2016
	Aimee Gunther	2015-2017
	Laura Henderson	2014
	Gregory Holloway	2014-2017
	Taylor Hornby	2017
	Sumeet Khatri	2014
	David Layden	2015-2017
	Jason LeGrow	2015-2017
	Xingliang Lou	2015-2016
	Christian Mastromattei	2016-2017
	Michael Mazurek	2013-2017
	Christopher Pugh	2012-2017
	Daniel Puzzuoli	2016-2017
	Jason Pye	2014-2017

Award	Student	Year Awarded
	Jeffrey Salvail	2015-2017
	Sean Walker	2014-2017
	Chunhao Wang	2014
	Kyle Willick	2014
	Joshua Young	2014-2017
Provost Doctoral Entrance Award for Women	Elena Anisimova	2012
	Paulina Corona Ugalde	2013
	Carolyn Earnest	2014
	Jennifer Fernick	2016
	Anqi Huang	2015-2016
	Maria Kieferova	2015
	Nayeli Rodriguez Briones	2016
	Aimee Gunther	2014
	Laura Henderson	2017
QEII-Graduate Scholarship in Science and Technology	Matthew Brown	2015
	Christopher Chamberland	2017

H. Sponsored Conferences

Year	Date	Name	Institution
2012-2013	Jun 11-13	Matching, Matroid, and Extensions: A Conference in Bill Cunningham's 65th Birthday	University of Toronto, Toronto, Canada
	Jun 25-28	Workshop on Relativistic Quantum Information	Perimeter Institute, Waterloo, Canada
	Aug 2-4	Women in Physics Canada	University of British Columbia
	Sep 10-14	QCRYPT 2012	
	Oct 25-29	Canadian Undergraduate Physics Conference	
	Nov 5-9	Post-Quantum Cryptography and Quantum Algorithms	
	Jan 15-21	16th Workshop on Quantum Information Processing	
	Mar 14-16	Conference in Honour of John Preskill's 60th Birthday	Caltech
2013-2014	May 13-17	Quantum Landscapes	Perimeter Institute, Waterloo, Canada
	May 21-13	8th Conference on Theory of Quantum Computation, Communication and Cryptography	University of Guelph
	May 23-26	Theory Canada 8	Bishop's University

Year	Date	Name	Institution
	May 27-30	Quantum Information and Complex Networks	Institute for Quantum Computing, Waterloo, Canada
	Jun 17-21	The Canadian Summer School on Quantum Information	University of Calgary, Canada
	Jun 24-28	The Canadian Quantum Information Student's Conference	University of Calgary, Canada
	Jun 26-28	Women in Physics Canada	Simon Fraser University, Vancouver, Canada
	Aug 15-18	Canadian -American-Mexican Graduate Student Physics Conference	Perimeter Institute, Waterloo, Canada
	Aug 26-29	Summer School on Quantum Information, Computing and Control	Imperial College London
	Sep 26-27	Quantum-Safe-Crypto Workshop	
	Sep 29-4	Quantum Simulation	Universidad del Pais Vasco
	Oct 17-20	Canadian Undergraduate Physics Conference	McMaster University, Hamilton, Canada
	Nov 28-30	7th Annual International Conference on Information Theoretic Security	NTU, Singapore
	Jan 14-20	Jeux de la Physique	Sherbrooke
	Feb 3-7	Quantum Information Processing	Barcelona
2014-2015	Jun 12-15	Theory Canada 9	Wilfrid Laurier University, Waterloo, Canada
	Jun 16-20	Canadian Association of Physicists Congress	Laurentian University, Sudbury, Canada
	Jun 16-20	The Canadian Summer School on Quantum Information	University of Guelph, Canada
	Jun 23-27	The Canadian Quantum Information Student's Conference	University of Guelph, Canada
	Jun 23-27	Algebraic Combinatorics: Special Graph Theory, Erdős-Ko-Rado Theorems and Quantum Information Theory	Institute for Quantum Computing, Waterloo, Canada
	Jul 14-16	Quantum LDPC Codes	Perimeter Institute, Waterloo, Canada

Year	Date	Name	Institution
	Aug 5-8	5th IUPAP International Conference on Women in Physics	Wilfrid Laurier University, Waterloo, Canada
	Sep 1-5	QCRYPT	Paris, France
	Oct 6-7	ETSI 2nd Quantum-Safe Crypto Workshop	Ottawa, Canada
	Oct 27-29	Quantum Optimization Workshop	Fields Institute, Toronto, Canada
	Oct 23-26	Canadian Undergraduate Physics Conference	Queen's University, Kingston, Canada
	Jan 9-11	Canadian Conference for Undergraduate Women in Physics	Laval University, Quebec City, Canada
	Jan 12-16	Conference on Quantum Information Processing	Sydney, Australia
	Feb 20-20	Science Expo	Ontario Science Centre, Toronto, Canada
	Feb 22-27	Quantum Simulation	Benasque, Spain
2015-2016	May 1-3	Canadian Undergraduate Technology Conference	Toronto
	Jun 11-14	Theory Canada 10	University of Calgary
	Jun 15-19	Canadian Association of Physicists Congress	University of Alberta
	Jun 16-19	Bilateral Waterloo-Bristol Nanotechnology Workshop	University of Waterloo
	Jul 3-10	Contextuality and Non-locality as Resources for Quantum Information	Naramata, Canada
	Jul 21- 2	71st Scottish Universities Summer School in Physics: Frontiers in Quantum Dynamics and Quantum Optics	University of Strathclyde
	Jul 30-1	Women in Physics Canada	University of Toronto
	Aug 10-14	Canadian Summer School on Quantum Information	Fields Institute, Toronto, Canada
	Aug 15-21	Quantum Marginals and Numerical Ranges Workshop	University of Guelph, Canada
	Sep 28-2	5th International Conference on Quantum Cryptography	Tokyo
	Oct 22-25	Canadian Undergraduate Physics Conference	Trent University
	Jan 8-10	Canadian Conference for Undergraduate Women in Physics	Dalhousie University, Halifax, Canada
	Jan 10-16	Quantum Information Processing	The Banff Centre
	Jan 15-17	Jeux de la Physique	University of Montreal
2016-2017*	Jun 6-11	Quantum Physics and Logic	University of Strathclyde

Year	Date	Name	Institution
	Jun 11-12	Information Theoretic Interpretations of Quantum Mechanics	University of Western Ontario
	Jun 19-24	International Symposium on Symbolic and Algebraic Computation	Wilfrid Laurier University, Waterloo, Canada
	Jul 27-29	Women in Physics Canada	University of Saskatchewan
	Aug 22-225	Workshop on Representation Theory in Quantum Information	University of Guelph, Canada
	Sep 12-16	6th International Conference on Quantum Cryptography	Washington D.C.
	Sep 19-21	Ultra-Strong Light Matter	University of the Basque Country
	Sep 27-29	Theory of Quantum Computation	University of Berlin

I. Earned Media

Publication	Date	Title
2012-2013		
Waterloo Stories	07-05-2012	Quantum on the cusp of transforming industry
Waterloo Stories	07-06-2012	Nobel winner extends IQC committment
Waterloo Stories	09-07-2012	Getting to quantum computing is as exciting as being there
Waterloo Stories	09-11-2012	One amazing building, two great institutes: The world is about to change
Waterloo Stories	09-17-2012	Quantum wolrd may hold key-keeping information secure
Waterloo Stories	09-20-2012	The Quantum Symphony: A Cultural Entanglement
Waterloo Stories	02-12-2013	On the frontiers of global information security
Waterloo Stories	02-12-2013	The quest for the quantum "holy grail"
Waterloo Stories	02-13-2013	Prestigious annual meeting in Boston has Waterloo connections
The Globe and Mail	03-19-2013	Mike Lazaridis's new quantum leap
Wall Street Journal	03-19-2013	BlackBerry Co-Founders Bankroll \$100 Million Quantum-Science Fund
Canadian Business	03-23-2013	Nothing has prepared you for what we are about to see'
Waterloo Stories	04-05-2013	Premier visits University of Waterloo during prosperity-focused tour
Waterloo Stories	04-19-2013	Quantum sounds could reveal shape of the universe
The Record	04-20-2013	The quest for Quantum Valley
The Record	04-23-2013	Investing in quantum is a no-brainer: Lazaridis
KW Metro News	04-23-2013	Trains, culture can help keep high-tech talent here, panel says
Daily Bulletin	04-24-2013	Midweek morsels
Wall Street Journal	04-24-2013	Waterloo Looks Beyond RIM as it Touts its Status as Innovation Hub
KW Metro News	04-24-2013	BlackBerry co-founder says quantum physics is key to tech advances
Techvibes	04-25-2013	Is There Any Canadian Entrepreneur More Innovative Than BlackBerry Founder Mike Lazaridis?
The Record	04-27-2013	Peering inside the quantum universe
CTV Provincewide	04-27-2013	Why they're spending big on the tiny world of quantum information
The Daily Galaxy	12-16-2012	Quantum Entanglement Leaps Beyond Einstein - "New States of Light"
R&D Mag	12-17-2012	Researchers demonstrate a new kind of quantum entanglement
	12-17-2012	

Publication	Date	Title
TGD	12-17-2012	Adding to Einstein's quantum world
Space Daily	12-18-2012	Extending Einstein
The Record	01-06-2013	The quest for computing's 'Holy Grail'
The Star	01-06-2013	Quantum computing the 'Holy Grail' for University of Waterloo scientists
Fast Company		RIM's Mike Lazaridis Takes A Quantum Leap Of Faith In Waterloo
The Globe and Mail	01-15-2013	Canadian Space Agency head leaving to focus on quantum physics
itbusiness.ca	01-16-2013	BlackBerry creator recruits Canada's top astronaut for quantum physics project
Daily Finance	01-21-2013	University of Waterloo Purchases Veeco MBE System for New Nano Research Center
Enhanced Online News	01-21-2013	University of Waterloo Purchases Veeco MBE System for New Nano Research Center
semiconductor Today	01-21-2013	Canada's University of Waterloo orders Veeco GEN10 MBE system
Asian Pacific Post	01-22-2013	A banner year for Canadian scientists
The Record	01-30-2013	BlackBerry Timeline
The Record	01-30-2013	RIM adopts BlackBerry as official company name
itbusiness.ca	02-05-2013	Venture capital firm eyes opportunities in Waterloo's Quantum Valley
Science Codex	02-15-2013	University of Waterloo researchers propose breakthrough architecture for quantum computers
R&D Mag	02-15-2013	Researchers propose breakthrough architecture for quantum computers
Morning Post Exchange	02-15-2013	Researchers propose breakthrough architecture for quantum computers
EurekAlert	02-15-2013	Quantum devices: Building an innovative future for Canada
Morning Post Exchange	02-15-2013	Waterloo shares advances in quantum research, food sustainability at AAAS annual meeting
News Track India	02-16-2013	Breakthrough architecture to revolutionize quantum computers
The Guardian	02-17-2013	BlackBerry's hometown waits in hope of a renaissance
HTIC	02-17-2013	BlackBerry's hometown waits in hope of a renaissance
Science Codex	02-17-2013	Quantum devices: Building an innovative future for Canada
Mobileblom	02-18-2013	BlackBerry Hometown Waterloo Shows Some Team Spirit As The Company Rears To Make A Comeback
Top News	02-18-2013	An Advanced Architecture for Scalable Quantum Computers

Publication	Date	Title
escience news	02-18-2013	University of Waterloo researchers propose breakthrough architecture for quantum computers
Tomshardware.com	02-19-2013	Researchers Suggest Scalable Quantum Computing Model
570 News	02-22-2013	Communitech to launch Intelligent Media Networks
CNW	02-27-2013	University of Waterloo professor receives E.W.R. Steacie Memorial Fellowship
phys.org	02-27-2013	University of Waterloo professor receives E.W.R. Steacie Memorial Fellowship
phys.org	02-28-2013	Space race under way to create quantum satellit
Science Daily	03-01-2013	Space race underway to create quantum satellite
Laboratory Equipment	03-01-2013	Space Race is on to Make Quantum Satellite
Science Codex	03-01-2013	Space Race is on to Make Quantum Satellite
Space Daily	03-04-2013	Space race under way to create quantum satellite
National Post	03-04-2013	Canadian researchers take a sneak peek at Schrödinger's Cat and a step toward a quantum computer
The Record	03-08-2013	NASA scientist encourages women to reach for the stars
Planet Save	03-10-2013	Researchers Propose New Quantum Computation Model – A Multi-Particle 'Quantum Walk
Globe & Mail	03-19-2013	Mike Lazaridis's new quantum leap
The Wall Street Journal	03-19-2013	BlackBerry Co-Founders Bankroll \$100 Million Quantum-Science Fund
CBC KW	03-20-2013	Blackberry co-founders start \$100M quantum tech fund
IT Pro	03-20-2013	Ex-BlackBerry chief sets up \$100m quantum science fund
AFP	03-20-2013	BlackBerry founders start quantum computing fund
The Record	03-20-2013	'A gift to future generations'
Metro	03-21-2013	BlackBerry wants to turn research into reality with \$100M fund
Dawn.com	03-21-2013	BlackBerry founders start quantum computing fund
iol scitech	03-22-2013	BB founders start quantum computing fund
The Record	03-23-2013	A valley full of promise
la Repubblica	03-23-2013	Lazaridis: "Voglio realizzare il Tricorder" Il papà del BlackBerry sogna Star Trek
Mondo Informazione	03-23-2013	Tricorder, dalla fantascienza alla realtà

Publication	Date	Title
IBJ.com	03-26-2013	ISO season: Cole Porter, Sandi Patty, Mario Vanzago
Current in Noblesville	03-26-2013	Indianapolis Symphony Orchestra unveils 2013-2014 season
Nuvo	03-26-2013	ISO announces 2013-2014 season
HuffPost Tech	03-26-2013	Biographical info on RIM co-founder Lazaridis
ValueWalk	03-28-2013	Research In Motion Ltd (BBRY) Co-Founder Retires, Won't Sell Shares
The Ledger	03-28-2013	Board Asks RIM Co-founder To Stay As CEO
The Record	03-28-2013	Lazaridis says BlackBerry board asked him to stay as CEO last year
The Record	03-29-2013	The adventure continues for BlackBerry co-founder Mike Lazaridis as he leaves the board
Myrtle Beach Online		Lazaridis bows out at BlackBerry
Macleans.ca	03-29-2013	Lazaridis says RIM board asked him to stay as CEO
The Record	04-02-2013	Today's editorial: Lazaridis' work has just begun
570 News	04-04-2013	Wynne to spend today in K-W
thespec.com	04-04-2013	Lazaridis named visionary of year by NY think-tank
The Record	04-04-2013	Premier Wynne to spend Friday in region
Morning Post Exchange	04-05-2013	ICF Names BlackBerry Founder and Vice Chairman Mike Lazaridis as 2013 Intelligent Community Visionary of the Year
Metro	04-05-2013	Premier Wynne heads to Kitchener-Waterloo region
The Record	04-05-2013	Local politicians want fair treatment on transit funding tools
The Record	04-06-2013	A taste of maple in Elmira
Ottawa Business Journal	04-09-2013	Lazaridis sees "great things" for Ottawa
The yee	04-16-2013	Citizen Scientists: Friendly Future for DIY Tech
Morning Post Exchange	04-16-2013	HELLENIC HERITAGE FOUNDATION LIFETIME ACHIEVEMENT AWARD HONOURING MIKE LAZARIDIS.
The Record	04-23-2013	Investing in quantum is a no-brainer: Lazaridis
TechVibes	04-25-2013	Is There Any Canadian Entrepreneur More Innovative Than Mike Lazaridis?
2013-2014		
AZoM.com	01-22-2014	Oxford Instruments Omicron NanoScience Complete Commissioning of Deposition and Analysis Cluster Tool
Waterloo Chronicle	01-22-2014	Mission to Mars
Science Codex	01-31-2014	NSA pursues quantum technology
Physics World	February	NSA keys into quantum computing
BNN	02-10-2014	
Waterloo Stories	02-10-2014	Meeting global challenges

Publication	Date	Title
Huff Post Business	02-11-2014	Big-Brain Hunting: The Key to Supercluster Success
Globe & Mail	02-11-2014	The 10 key priorities of Flaherty's federal budget
National Post	02-11-2014	John Ivison: Flaherty has done more than anyone to make life more affordable for Canada's most vulnerable citizens
The Record	02-11-2014	Local group aiming to mine open data gets \$3-million in federal budget
Morningstar	02-11-2014	U15 Group of Canadian Research Universities Applauds the Government of Canada for Investing in Research Excellence
Exchange Morning Post	02-12-2014	Federal budget supports quantum research at Waterloo
University Affairs	02-12-2014	Federal budget strengthens university research with new funding
Globe & Mail	02-12-2014	Is the budget good for science? Depends on what you research
YouTube - Budget Debate	02-13-2014	Harold Albrecht, MP Kitchener-Conestoga: The Road to Balance
uWaterloo Daily Bulletin	02-13-2014	Federal budget supports Waterloo Research
@uwaterloo - your alumni newsletter	02-13-2014	Waterloo alumnus makes first cut for Mars One mission
Photonics Spectra	02-14-2014	Quantum Communications Finds any Paths to Comercialization
Waterloo Stories	02-17-2014	Leading the quantum revolution
uWaterloo Daily Bulletin	02-18-2014	Laflamme to address Canadian Club of Ottawa
Waterloo Stories	02-18-2014	Physics prof awarded prestigious Sloan Research Fellowship
uWaterloo Daily Bulletin	02-20-2014	Physics prof awarded Sloan Fellowship
uw Imprint	02-21-2014	Federal government allocates \$15 million towards IQC research
The Record	02-24-2014	Outwater taking the right direction
National Post	02-26-2014	Amit Chakma: Making Canada an innovation powerhouse
Business Insider	03-07-2014	You've Never Heard Of Quantum Encryption, But It's The Technology That 'Keeps Our Digital World Running Smoothly'
Business Insider Australia	03-08-2014	You've Never Heard Of Quantum Encryption, But It's The Technology That 'Keeps Our Digital World Running Smoothly'
Business Insider	03-10-2014	Quantum Encryption Is On The Verge Of Solving The '100-Year Problem' In Data Security
Seattle Post Intelligencer	03-10-2014	Quantum Encryption Is On The Verge Of Solving The '100-Year Problem' In Data Security

Publication	Date	Title
IT World Canada	03-12-2014	Waterloo researchers team on quantum-based security
Scientific Computing	03-12-2014	Quantum Physics Secures New Cryptography Scheme
uWaterloo Alumni newsletter	03-13-2014	Physics prof awarded prestigious Sloan Research Fellowship
New Electronics	03-14-2014	Quantum based random oblivious transfer could enable trusted communication
Tech Generation Daily (TG Daily)	03-14-2014	Quantum physics secures new cryptography scheme
Wired	03-17-2014	How Google Can Repel the Attack of the NSA Quantum Computer
Waterloo News	03-18-2014	Waterloo, Technion partner to advance research, commercialization
Waterloo Stories	03-18-2014	Waterloo, Technion partner to advance research, commercialization
Lab Product News	03-18-2014	New partnership to advance research, commercialization
Jerusalem Post	03-19-2014	Technion inks cooperation deal with Canada's University of Waterloo
Daily Bulletin	03-19-2014	Waterloo, Technion sign partnership agreement
Space Daily	03-19-2014	Quantum physics secures new cryptography scheme
IT World Canada	03-19-2014	UWaterloo, Israel's Technion partner
Electronic Products and Technology	03-20-2014	Waterloo, Technion partner to advance research, nanotechnology
Phys Org	03-20-2014	Pseudogap theory puts physicists closer to high temperature superconductors
Business Standard	03-21-2014	World's first room-temperature superconductor comes closer to reality
Digital Journal	03-23-2014	Experiment Opens the Door to Multi-Party Quantum Communication
Photonics Online	03-23-2014	Experiment Opens The Door To Multi-Party Quantum Communication
The Register	03-24-2014	EXPOSED: bizarre quantum sibling LOVE TRIANGLE
International Science Times	03-24-2014	Scientists Demonstrate Three-Way Quantum Communication: What's Faster Than The Speed Of Light?
Science World Report	03-25-2014	Experiment Opens the Door to Multi-Party Quantum Communication
Liberty Voice	03-25-2014	Multi-Party Quantum Communication Possible
Asian Scientist	03-27-2014	Quantum Cryptography Protocol To Beef Up Cybersecurity
CBC News Toronto	03-27-2014	cost of flying with your baby is supposed to be one of the more pleasant aspects of what can be a stressful time

Publication	Date	Title
overclockersclub.com	03-27-2014	Multi-Party Quantum Communication May be Coming
TVTechnology	03-27-2014	Experiment Raises Possibility of Multiparty Quantum Communication
PlanetSave	03-28-2014	Quantum Entanglement Experiment Proves 'Non-Locality' For First Time, Will Permit Multi-Party Quantum Communication
uWaterloo Daily Bulletin	03-31-2014	Waterloo, Harvard physicists' eureka moment
The Record	04-04-2014	\$3.5M for communications, market hijinks studies
Frankfurter Allgemeine Wissen	04-05-2014	Drei Photonen treiben seltsamen Spuk
Waterloo Chronicle	04-08-2014	IQC displays quantum cryptography
"@uwaterloo - your alumni newsletter"	04-10-2014	Quantum talk: Moving from the possibility of two people to a network of people
CIFAR Knowledge Circle	April	Towards three-party quantum communication
Quartz	04-15-2014	Why nobody can tell whether the world's biggest quantum computer is a quantum computer
Innovators Magazine	Spring 2014	Institute for Quantum Computing - Theoretical & Experimental Quantum Information Research
Harvard Gazette	04-17-2014	MRI, on a molecular scale
Nanotechnology Now	04-21-2014	University of Waterloo Visits China to Strengthen Bonds With Research Partners
Sing Tao newspaper	04-22-2014	(in Chinese)
Nuvo	04-23-2014	Quantum theory and classical music
Waterloo Chronicle	05-30-2014	Another affirmation
2014-2015		
@uwaterloo - your alumni newsletter	January 2015	Quantum physics breakthrough: Scientists solve 100-year-old puzzle
Student Science	10-Mar-15	How to pick up messages after they're gone
Phys.org	02-03-2015	Light, meet matter: Single-photon quantum memory in diamond optical phonons at room temperature
Daily Bulletin	03-05-2015	Grad makes one-way Mars trip's shortlist
Exchange Morning Post	03-10-2015	How to be cyber-safe in a quantum world
Nature.com	03-12-2014	Physics: Quantum computer quest
.@uwaterloo alumni newsletter	03-12-2015	Embracing the Spirit of Experimentation
Waterloo Region Record	03-12-2015	Online risks in a quantum world
Canadian Jewish News	03-13-2015	Hamilton native wants to live on Mars
Quartz India	03-19-2015	These ten guys aced the IIT entrance exam. Here's what they're doing after graduation
Phys.org	03-23-2015	Quantum correlation can imply causation
newswise	03-23-2015	Quantum Cause and Effect
e-science news	03-23-2015	Quantum correlation can imply causation
Perimeter website	03-23-2015	Quantum Cause and Effect

Publication	Date	Title
Photonics Online	03-23-2015	Quantum Correlation Can Imply Causation
Exchange Morning Post	03-24-2015	Quantum correlation can imply causation
Exchange Morning Post	03-27-2015	A global index of wellbeing one goal of new Canadian Queen Elizabeth II Diamond Jubilee Scholarships
Simcoe.com	03-27-2015	Oro-Medonte teen goes asteroid hunting
infodimanche.com	03-29-2015	Conférence sur les technologies de l'information quantique
physicsworld.com	03-30-2015	Entangled photons cast a new light on cause and effect
Phys.org	03-31-2015	Photon 'afterglow' could transmit information without transmitting energy
EIT ICT Labs	04-01-2015	It's got easier to don't understand Quantum Mechanics
Digital Journal	05-01-2014	Ontario Budget Supports Quantum Research at Waterloo
Waterloo Stories	05-01-2014	Ontario Budget Supports Quantum Research at Waterloo
CIFAR	05-01-2014	Global Scholars launch projects on women in science, quantum mechanics by the stars
Imprint	05-01-2014	Budget supports Quantum Computing but offers no surprises for post-secondary students
SPIE.	05-01-2014	Progress toward a quantum communication satellite
Daily Bulletin	05-02-2014	Budget supports quantum research at Waterloo
Morning Post Exchange	05-02-2014	Ontario budget supports quantum research at Waterloo
uWaterloo Research News	05-02-2014	\$25 million allotted to Waterloo's IQC over five years
Speaking up for Canadian Science	05-02-2015	Shine on you crazy (quantum) diamond
Physics	05-02-2015	Synopsis: Quantum Diamond Shines On
Machine Intelligence Research Institute	05-07-2014	Harry Buhrman on quantum algorithms and cryptography
Canada's Technology Triangle	05-08-2014	Ontario Budget Supports Quantum Research at Waterloo
Daily Bulletin	05-08-2014	Campus summer camps, collected
cognitive-computing	05-11-2014	The origins of Quantum Teleportation - Charles Bennett
Daily Bulletin	05-12-2014	Town Hall today and other notes
YourIs.com	05-15-2014	Andris Ambainis - The road to quantum computing
CBC	05-22-2014	EBay hack underscores need for a more secure internet
Daily Bulletin	05-23-2014	Crow named interim VP University Relations
Daily Bulletin	05-26-2014	Monday's notes
Blog	05-26-2014	Summer 2014

Publication	Date	Title
Daily Bulletin	05-28-2014	Outstanding Performance winners named
Re\$earch Money	05-29-2014	People
Daily Bulletin	06-02-2014	Quantum satellite one step closer to launch
EurekAlert!	06-11-2014	Contextuality puts the 'magic' in quantum computing
Nature	06-11-2014	Quantum computing: Powered by magic
Waterloo Stories	06-11-2014	Waterloo researchers find "magic" ingredient for quantum computing
Perimeter website	06-11-2014	Researchers find "magic" ingredient for quantum computing
CrazyChucks.com News	06-11-2014	Study finds weird magic ingredient for quantum computing
Phys.org	06-11-2014	Study finds weird magic ingredient for quantum computing
Jersey Tribune	06-11-2014	Researchers find weird magic ingredient for quantum computing
Science Daily	06-11-2014	Weird 'magic' ingredient for quantum computing: Contextuality
Science Codex	06-11-2014	Researchers find weird magic ingredient for quantum computing
Science Newsline	06-11-2014	Researchers Find Weird Magic Ingredient for Quantum Computing
NanoWerk	06-11-2014	Contextuality puts the 'magic' in quantum computing
Before It's News	06-12-2014	Contextuality puts the 'MAGIC' in quantum computing, researchers say
RedOrbit	06-12-2014	Quantum Contextuality Needed To Achieve "Magic" Required For Universal Quantum Computation
e! Science news	06-12-2014	Researchers find weird magic ingredient for quantum computing
Science Newsline	06-12-2014	Contextuality Puts the 'Magic' in Quantum Computing
NVONews	06-12-2014	Magic ingredient for quantum computing means magic-state distillation
HNGN	06-12-2014	Quantum Computing's 'Weird Magical Ingredient' Revealed
Google News	06-12-2014	Quantum Computing's 'Weird Magical Ingredient' Revealed
Free Republic	06-12-2014	Quantum Computing's 'Weird Magical Ingredient' Revealed
Quantum Computing Frontiers - G+	06-12-2014	Contextuality the missing ingredient for universal quantum computing
SciTechDaily	06-12-2014	Researchers Discover "Magic" Ingredient for Quantum Computing
Technology.org	06-12-2014	Study finds weird magic ingredient for quantum computing

Publication	Date	Title
The Reference Frame	06-13-2014	Quantum contextuality is just another fancy word for Bohr's complementarity
The Register	06-13-2014	Boffins discover 'practical requirements' of 'realistic' QUANTUM COMPUTER
Canada Journal	06-13-2014	Scientists Find Weird Magic Ingredient for Quantum Computing
Nature World News	06-13-2014	Contextuality Essential in Making Quantum Computers a Reality, Researchers Say
boson.ws	06-13-2014	Quantum computing has a magic word – contextuality – Tech Times
Tech Times	06-13-2014	Quantum computing has a magic word – contextuality – Tech Times
Newslicious	06-13-2014	Scientists Find Weird Magic Ingredient for Quantum Computing - Canada News
WasOut	06-13-2014	Quantum Contextuality Needed To Achieve “Magic” Required For Universal
DesignLance	06-13-2014	Quantum computing has a magic word – contextuality – Tech Times
popbuzz.me	06-13-2014	Quantum Weirdness a Key Ingredient for Building Quantum Computer - Scientific Computing
Datacentre Management.org	06-13-2014	Quantum computing has a sorcery word – contextuality
Electronic Products and News	06-15-2014	Researchers find weird magic ingredient for quantum computing
Phys.org	06-16-2014	Best of Last Week
Space Mart	06-16-2014	Researchers find weird magic ingredient for quantum computing
One Page News	06-16-2014	Researchers find weird magic ingredient for quantum computing
Daily Bulletin	06-19-2014	Reading the tea leaves after the election
National Post	06-19-2014	Cutting-edge, Canadian-made quantum computer on wave of the future, but new tests say it is too slow
Daily Bulletin	06-23-2014	Conference honours work of math professor
Globe & Mail ROB	06-26-2014	The Interview: Mike Lazaridis on Canada's next computing revolution
Azonano	07-01-2014	Speakers Announced for Oxford Instruments Seminar at IOP in Beijing
FrogHeart	07-02-2014	Bringing the Nanoworld Together Workshop in Beijing, China, Sept. 24 – 25, 2014
Science Codex	07-03-2014	From pencil marks to quantum computers
Semiconductor Today	07-04-2014	Oxford Instruments' Nanotechnology Seminar at China's Institute of Semiconductors to start with 2D materials sessions
Debra's blog	07-04-2014	Quantum Computer Science: An Introduction book

Publication	Date	Title
Engineering.com	07-07-2014	From pencil marks to quantum computers
Joint Quantum institute	07-07-2014	JQI publications in 2014 Google Scholar Metrics
Space Daily	07-09-2014	From pencil marks to quantum computers
William Shatner's Weird or What	07-13-2014	Potential for human teleportation
Daily Bulletin	07-15-2014	NSERC funding for researchers on the brink
Morning Post Exchange	07-15-2014	Ontario budget supports quantum research at Waterloo
Scribd.	07-16-2014	Contextuality Supplies the Magic for Quantum Computation
Morning Post Exchange	07-17-2014	Funding announcement to accelerate scientific discovery at the University of Waterloo
Math News	07-17-2014	NSERC Discovery Grants announcement
Daily Bulletin	07-18-2014	Summer camps, the Waterloo Way
The Commercial Space Blog	07-23-2014	Space Activities at the University of Waterloo
Daily Bulletin	07-25-2014	Celebrating Canada, breakthrough research; remembering Andrei Anghel
Canadian Space Society - The Gazette Weekly	07-28-2014	Space at Waterloo, past and future
Daily Bulletin	08-05-2014	Women in Physics Conference this Week
Newswatch	08-10-2014	Raymond in Weird or What re-run
Daily Bulletin	08-11-2014	Students get their crypto fix at summer school
Waterloo News	08-27-2014	Major awards will help fund transformational research at Waterloo
physicsworld.com	09-01-2014	Fine-tuning quantum features to develop future technologies
TechNewsWorld	09-05-2014	Google Ratchets Up Quantum Computing Efforts
Tech Cheat Sheet	09-06-2014	What Is a Quantum Computer, and Why Is Google Building One?
Machines Like Us	09-07-2014	What Is a Quantum Computer, and Why Is Google Building One?
Great Local News: Boston	09-07-2014	Google Ratchets Up Quantum Computing Efforts
New Scientist	09-11-2014	Quantum control: How weird do you want it?
Phys.org	09-14-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Photonics Online	09-14-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Space Daily	09-14-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Science Daily	09-14-2014	Three's a charm: NIST detectors reveal entangled photon triplets
ECN	09-15-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Sci Guru	09-15-2014	Three's a charm: NIST detectors reveal entangled photon triplets

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Columbus Business First	09-16-2014	Battelle aims for business use of quantum-computing encryption for cybersecurity
Before It's News	09-16-2014	Three's a charm: NIST detectors reveal entangled photon triplets
live science	09-16-2014	Entangled 'Photon Triplets' Could Speed Up Telecommunication
RedOrbit	09-16-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Techly	09-17-2014	The Quantum of Cryptography: Australia's Role in New Unbreakable Encryption
Popular Science	09-17-2014	Spooky Action In Threes: Physicists Entangle Three Particles Of Light
TG Techno	09-18-2014	Three's a charm: NIST detectors reveal entangled photon triplets
Copernical	09-18-2014	NIST detectors reveal entangled photon triplets
it business	09-18-2014	Waterloo's IQC working on sensors with single molecule precision
Daily Bulletin	09-22-2014	Waterloo welcomes Korean delegations
Yahoo! News	09-22-2014	Entangled 'Photon Triplets' Could Speed Up Telecommunication
Morning Post Exchange	09-23-2014	Waterloo strengthens ties to South Korean research powerhouses
Daily Bulletin	09-24-2014	Agreements strengthen connections with Korea
Phys.org	09-24-2014	Are weak values quantum? Don't bet on it
MIT Technology Review	09-26-2014	First Quantum Logic Operation For An Integrated Photonic Chip
Gordon & Betty Moore Foundation	09-28-2014	The Gordon and Betty Moore Foundation selects awardees for \$34.2M in grants to stimulate experimental research in the physics of quantum materials
EDN Europe	10-01-2014	A leap into quantum computing
PRNewswire	10-03-2014	Qubitekk To Present New Keyless Authentication Method Using Quantum Cryptography At IQC/ETSI Workshop, October 6-7, 2014
GuardTime	10-05-2014	Matt Johnson to present at the ETSI/IQC Quantum-Safe Crypto Workshop in Ottawa Canada on 6-7 October
Market Wired	10-06-2014	Industry Minister Discusses the Harper Government's Commitment to a Connected, Digital Canada with i-CANADA Alliance
Market Wired	10-06-2014	Cybersecurity Experts Gather in Ottawa to Discuss Quantum-Safe Standards
Exchange Morning Post	10-07-2014	Cybersecurity Experts Gather in Ottawa to Discuss Quantum-Safe Standards
AZO Nano	10-08-2014	2D Plenary Sessions Attracted Enormous Interest at Beijing Nanotechnology Seminar

Publication	Date	Title
IT World Canada	10-08-2014	Things bad in IT security now? It could get worse
Epoch Times	10-08-2014	New Encryption Methods Need to Be Developed Urgently, Say Experts
RCI	10-08-2014	The future is coming: Quantum computing cybersecurity conference
Daily Bulletin	10-09-2014	Honorands announced for fall convocation
physicsworld.com	10-09-2014	Are 'weak values' quantum after all?
MIT Technology Review	10-10-2014	Microsoft's Quantum Mechanics
Enterra Insights Blog	10-14-2014	Closing In on Quantum Computing
Wired	10-16-2014	Closing In On Quantum Computing
Sys-Con Media	10-17-2014	Minister of State Holder Delivers Address on Seizing Canada's Moment in Science, Technology and Innovation
Waterloo Region Record Technology Spotlight	11-03-2014	Imagining a quantum future; Waterloo researchers ready share the dream of quantum computing
CBC	11-04-2014	10 influential people who went to the University of Waterloo
Exchange Morning Post	11-05-2014	University of Waterloo president on official visit to South Korea
The Telegraph	11-07-2014	China builds computer network impenetrable to hackers
RT	11-09-2014	Quantum leap forward: China to launch world's longest, 'hack-proof' network by 2016
Help Net Security	11-10-2014	China is building a quantum encryption network between Beijing and Shanghai
Waterloo Region Record	11-13-2014	Quantum Valley Investments moves into former BlackBerry building
Our Windsor.ca	11-13-2014	Quantum Valley Investments moves into former BlackBerry building
physicsworld.com	11-13-2014	Secure quantum communications go the distance
Waterloo Region Record	11-17-2014	Local researchers win physics, chemistry prizes
Waterloo Stories	11-17-2014	Two Waterloo researchers win prestigious Polanyi prizes
Morning Post Exchange	11-18-2014	Two Waterloo researchers awarded Polanyi Prizes honouring Nobel winner
Physics World	11-19-2014	We need to talk about quantum mechanics
Daily Bulletin	11-19-2014	Professors win Polanyi Prizes
CBC Kitchener Radio	11-19-2014	
Science Blog	13-02-2015	Correlations of quantum particles help in distinguishing physical processes
R&D magazine	13-02-2015	Correlations of quantum particles help in distinguishing physical processes
Phys.org	13-02-2015	Correlations of quantum particles help in distinguishing physical processes

Publication	Date	Title
uWaterloo Stories	13-02-2015	Waterloo invention advances quantum computing research
Daily Bulletin	14-01-2015	The quest for the first quantum computer
EurekAlert!	14-02-2015	Quantum research past, present and future for discussion at AAAS
Innovation.ca	15-02-2015	Paving the way to Canada's next big industry - the quantum information frontier
CIFAR	15-12-2014	CIFAR hosts prominent Chinese scientists at QIS meeting
domain-b.com	16-01-2015	Quantum physics just got less complicated
CBC News	16-02-2015	Mars One: 6 Canadians make short list for 1-way trip to Mars
CTV News	16-02-2015	Waterloo grad among 100 finalists in project to colonize Mars
Exchange Magazine	16-12-2014	Persons of Influence - Ray Laflamme (p.29)
Waterloo Region Record	17-02-2015	UW grad shortlisted for one-way Mars mission
uWaterloo Stories	17-02-2015	Waterloo grad shortlisted for one-way trip to Mars
University Affairs	18-02-2015	Waterloo shines a light on Canadian innovation at AAAS
www.SEOFactorFiction	18-02-2015	From molecular biology to quantum computing - Charles H. Bennett
National Post	19-01-2015	Waterloo Region open for business
skeptiko	19-12-2014	Researchers show wave/particle duality is an aspect of the uncertainty principle
International Business Times	19-12-2014	Quantum physics just got less complicated with 'Rosetta Stone' breakthrough
RedOrbit	19-12-2014	Quantum physics is less complicated than we thought
Free Republic	19-12-2014	Quantum physics just got less complicated
Democratic Underground.com	19-12-2014	Quantum physics just got less complicated
Waterloo Stories	19-12-2014	Quantum physics breakthrough: Scientists solve 100-year-old puzzle
Phys.org	19-12-2014	Quantum physics just got less complicated
EurekAlert!	19-12-2014	Quantum physics just got less complicated
Science Daily	19-12-2014	Quantum physics just got less complicated: Wave-particle duality and quantum uncertainty are same
Laboratory equipment	19-12-2014	Find Simplifies Quantum Physics
opli	19-12-2014	Quantum physics just got less complicated
Innovations Report	19-12-2014	Quantum physics just got less complicated
NanoWerk	19-12-2014	Quantum physics just got less complicated
(e) Science News	19-12-2014	Quantum physics just got less complicated
Science Codex	19-12-2014	Quantum physics just got less complicated
From Quarks to Quasars	19-12-2014	Particle-Wave Duality and the Quantum Uncertainty Principle United

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Function Space	19-12-2014	Quantum physics just got less complicated
Physics-Astronomy	19-12-2014	Quantum physics just got less complicated
World Science	20-12-2014	Quantum physics may have just gotten simpler
AmericanGreen ERBB Tranzbyte	20-12-2014	Particle-Wave Duality and the Quantum Uncertainty Principle United
Celiba3D Studip	20-12-2014	Wave-particle duality is the uncertainty principle in disguise
Globe & Mail ROB	21-01-2015	Canada leads the race to create Quantum Valley
Science 2.0	21-12-2014	Particle Duality' and Quantum Uncertainty - Two Sides of the Same Mystery?
West Texas News	21-12-2014	Quantum physics is simpler than previously thought: Study
CBC News	22-01-2015	Politics - Orders of the Day
Canada's Technology Triangle	22-01-2015	Canada leads the race to create Quantum Valley
New Scientist	22-01-2015	Weird cosmic echoes may offer new glimpse of big bang
Market Wired	22-01-2015	Minister Ed Holder and MP Peter Braid Announce Support of Quantum Research at Waterloo
Waterloo Region Record	22-01-2015	Federal investment touted during Institute for Quantum Computing visit
IT World Canada	22-01-2015	Federal government invests \$15M in quantum computing
570 News	22-01-2015	U-W's Institute for Quantum Computing expected to receive "significant" funding
Government of Canada	22-01-2015	Harper Government announces major investment in quantum research at University of Waterloo
CTV	22-01-2015	Institute of Quantum Computing gets \$15 million from federal government
News.nom.co	22-01-2015	NEWS: HARPER GOVERNMENT ANNOUNCES MAJOR INVESTMENT IN QUANTUM RESEARCH AT UNIVERSITY OF WATERLOO
disinformation	22-12-2014	Quantum Physics Just Got Less Complicated: Wave-Particle Duality and Quantum Uncertainty Are Same Thing
engadget	22-12-2014	Quantum physics theory is easier to understand than you think
Exchange Morning Post	22-12-2014	Quantum physics just got less complicated
Phys.org	22-12-2014	Best of Last Week – Quantum physics got less complicated, the pseudogap and ibuprofen as an anti-aging drug
Scientific Computing	22-12-2014	Puzzle Solved: Two Quantum Mysteries Merge into One
CBC News	23-01-2015	What is quantum computing and why should you care?

Publication	Date	Title
Huffington Post	24-12-2014	Quantum Physics Just Got A Tiny Bit Easier To Understand, As Two Oddities Merge Into One
Computerworld	25-02-2015	Emerging enterprise techs to watch
Waterloo Chronicle	25-02-2015	Another step closer to Mars
Daily Bulletin	26-01-2015	Government confirms support for IQC
Re\$earch Money	26-01-2015	News Briefs > Fed's \$15-million investment in IQC reannounced
Academica Group	26-01-2015	uWaterloo's Institute for Quantum Computing receives \$15 M from feds
Electronic Products & Technology	27-01-2015	Feds announce support of quantum research at Waterloo
Lab Product News	28-01-2015	Quantum research institute aims to change our world
Re\$earch Money	28-11-2014	NRC seeking partners for recently launched quantum photonics research program
Science 2.0	28-12-2014	Computing And Uncertainty: Quantum Leaps And Bounds In 2014
The Conversation	28-12-2014	Computing And Uncertainty: Quantum Leaps And Bounds In 2014
Full-Time Whistle	29-12-2014	Computing, uncertainty quantum leaps and bounds of 2014
Waterloo Region Record	30-01-2015	Quantum Carshare set to magically materialize on Sunday
World Economic Forum	30-12-2014	Why 2014 was the year of quantum mechanics
Nextbigfuture	31-01-2015	Dwave Systems will be commercially releasing a new 1152 qubit quantum annealing system in March 2015
Computerworld	31-12-2014	Strangest things about quantum physics may stem from overconfidence
@uwaterloo - your alumni newsletter	February	Canada leads in the race to create Quantum Valley
"@Waterloo" - alumni newsletter	July	Waterloo researchers find "magic" ingredient for quantum computing
Exchange Magazine	June	Waterloo Researchers Finding Innovative Solutions to Global Challenges
Optics & Photonics News	October	Canadian Photonics: The Foundation for a Quantum Leap
Discover	October	Preparing for the Quantum Storm
CERC Newsletter	September	Cory invited to speak at Commonwealth Science Conference
Inside the Perimeter	Spring 2014	Mike Lazaridis made Royal Society Fellow
REACH (CIFAR)	Spring 2014	How to build a quantum computer
La Ciencia de la Mula Francis		La contextualidad y el secreto del poder de los ordenadores cuánticos
2015-2016		
The CTT Triangle	Aug-15	Quantum encryption
IBM	Dec-15	A quantum of possibilities

Publication	Date	Title
University of Cambridge Research	01-21-2016	Artificial intelligence and rise of the machines: Cambridge Science Festival 2016science-festival-2016#sthash.M4QvvsrS.009gtFCr.dpuf
The Register	01-25-2016	MIT boffin: Big data won't compute? Try these handy quantum algorithms
CIO	01-25-2016	When big data gets too big, this machine-learning algorithm may be the answer
Cambridge Network	01-26-2016	Artificial intelligence and rise of the machines: Cambridge Science Festival 2016
TechCentral.ie	01-27-2016	Machine learning algorithm tackles even bigger data
Bitcoin News Channel	01-29-2016	Quantum Computing and the Future of Bitcoin Cryptography - Part 1
Foreignaffairs.co.nz	02-05-2016	Could a quantum approach help with big data?
Science and Technology Research News	02-08-2016	Contemplating a Quantum Future
Waterloo News	02-09-2016	\$5.2 million awarded to five Canada Research Chairs at Waterloo
CBCNews	02-09-2016	9 professors in Waterloo and Guelph named Canada Research Chairs
Ontario Canada	02-09-2016	What every investor needs to know about quantum computing
Goli Tube	02-09-2016	Explained: Quantum Computing
Exchange Magazine	02-10-2016	\$5.2 million awarded to five Canada Research Chairs at Waterloo
Daily Bulletin	02-11-2016	\$5.2 million awarded to new Canada Research Chairs
Phys.Org	02-19-2016	Researchers demonstrate 'quantum surrealism'
CIFAR.ca	02-19-2016	Researchers demonstrate 'quantum surrealism'
Entrevestor	02-19-2016	Pioneers in Quantum Computing
Nanotechnology Now	02-20-2016	Researchers demonstrate 'quantum surrealism'
New Universe Daily	02-22-2016	Researchers Demonstrate New Interpretation of Quantum Mechanics
Morning Ticker	02-22-2016	Breakthrough: Scientists describe the weird world of quantum surrealism
International Business Times	02-22-2016	Quantum Weirdness Gives Way to Intuitive Behavior In New Experiment
NorthernLife.ca	03-07-2016	Local filmmaker wins writing competition
EDN Network	03-07-2016	Inside a quantum computing lab
CIFAR Ideas Exchange	03-10-2016	CIFAR fellows among new Canada Research Chairs
The Signal	03-15-2016	Innovation 150 looks to inspire youth for Canada's 150th anniversary
Nova Scotia Chronicle Herald	03-15-2016	Federal cash targeted for Canada's 150th birthday
CTV Atlantic	03-15-2016	Canada's a year away from marking...
CBC Halifax	03-15-2016	Melanie Joly...

Publication	Date	Title
CBC Halifax	03-15-2016	Heritage Minister Mélanie Joly says investing in arts will help grow the economy
Perimeter	03-15-2016	Perimeter heads nationwide partnership to ignite innovation for Canada's 150th year
OttawaFestivals.ca	03-15-2016	A promising future thanks to youth and innovation
Newswire	03-15-2016	Nationwide partnership ignites the innovator in all of us for Canada's 150th year
Metro	03-15-2016	Federal heritage minister in Halifax to announce funding for Canada's 150th anniversary
Daily Bulletin	03-17-2016	Institute for Quantum Computing joins Innovation150
Toronto Star	03-20-2016	Stratford Festival reports third surplus in a row
Cambridge Network	03-21-2016	Cambridge Science Festival 2016: artificial intelligence stole the show
Waterloo Chronicle	03-23-2016	Celebrating the sensational
EET Asia	03-23-2016	Postcards from a quantum computing lab
CBC News - Kitchener-Waterloo	03-24-2016	Salary list spreads 'sunshine' on top university, college earners
Invest in Ontario	03-24-2016	Perimeter Institute's Neil Turok recognized for championing fundamental science
Phys.Org	03-30-2016	Quantum computing with single photons getting closer to reality
Opli	03-30-2016	Advancing quantum technologies one chip at a time
HNGN	03-30-2016	Quantum Computing Breakthrough Brings Single Photon Sources Within Reach
Waterloo Stories	03-31-2016	Ontario's Lieutenant Governor tours University of Waterloo
Daily Bulletin	04-01-2015	Diamond Jubilee awards for researchers
	04-09-2015	Media Advisory: Canada Excellence Research Chair Meeting at the University of Waterloo
@uwaterloo alumni newsletter	04-09-2015	Diamond Jubilee awards for researchers
ETSI	04-13-2015	Event - 3rd ETSI/IQC Workshop on Quantum-Safe Cryptography
Daily Bulletin	04-14-2015	CERC meeting focuses on new members
Daily Bulletin	04-16-2015	Research sessions, outreach events conclude CERC meeting
Morning Exchange	04-23-2015	Inaugural Board of Directors chosen for new Waterloo Region Economic Development Corporation (WREDC)
CBC.ca	04-24-2015	Mike Lazaridis gives \$20M to Wilfrid Laurier University for management institute
	04-24-2015	K-W Symphony and Institute for Quantum Computing take show to Ottawa

Publication	Date	Title
CBCNews	04-27-2015	New management school at Wilfrid Laurier to focus on global business
570 News	04-27-2015	Donation to U-W to aid research in treating lung disease & quantum computing
Technion	04-27-2015	Donation funds expansion of research between leading innovation universities
Morning Exchange	04-27-2015	Donation funds expansion of research between leading innovation universities
EurekAlert!	04-27-2015	Donation funds expansion of research between leading innovation universities
	04-27-2015	Donation funds expansion of research between leading innovation universities
Wall Street Journal	04-29-2015	IBM Brings Quantum Computing a Step Closer
techy type	04-29-2015	IBM Brings Quantum Computing a Step Closer
MIT Technology Review	04-29-2015	IBM Shows Off a Quantum Computing Chip
PCWorld	04-29-2015	IBM claims advance in effort to build reliable, large-scale quantum computer
Kelowna Now	04-29-2015	Kelowna Student Chosen Out of Hundreds to Attend Unique Program
Technology Spectator	04-30-2015	IBM pushes quantum computing a step closer
Physics4Me	04-30-2015	IBM Shows Off a Quantum Computing Chip
newsmaine	04-30-2015	IBM Researchers create Prototype Circuit that could become Basis of Quantum Computers
Demanjo	04-30-2015	IBM advances bring quantum computing closer to reality
Apt 613	05-01-2015	So music meets up with quantum mechanics in a bar . . .
Israelseen.com	05-03-2015	Philanthropy funds medical research
The Daily Courier	05-03-2015	Grade 11 student headed to Quantum Cryptography school
The Canadian Jewish News	05-04-2015	Donation supports Waterloo-Technion research projects - See more at: http://www.cjnews.com/?q=node/139314#sthash.PZe69ftJ.dpuf
Castanet.net	05-04-2015	Local 'Imitation Game'
Herd Magazine	05-05-2015	A Rumour of Androids- When Quantum meets Music
Nanotechnology Now	05-06-2015	New JEOL E-Beam Lithography System to Enhance Quantum NanoFab Capabilities
Solid State Technology	05-07-2015	New JEOL e-beam lithography system to enhance Quantum NanoFab capabilities
Globe & Mail	05-11-2015	Social media campaign aims to raise profile of Canadian research
Frogheart (BLOG)	05-11-2015	Research2Reality: a science media engagement experience dedicated to Canadian science
Daily Bulletin	05-12-2015	Research2Reality: a science media engagement experience dedicated to Canadian science

Publication	Date	Title
EurekAlert!	05-12-2015	Researchers theoretically demonstrate detection of spin of atoms at room temperature
Lab Product News	05-15-2015	Discovery could pave way to new approaches to medical diagnostics
Chemeurope.com	05-15-2015	Researchers theoretically demonstrate detection of spin of atoms at room temperature
PR Web	05-18-2015	Innovations Airs New Episode on Monday, May 25, 2015 Via Discovery Channel
Innovations with Ed Begley, Jr.	05-18-2015	Innovations Airs New Episode on Monday, May 25, 2015 Via Discovery Channel
7th space interactive	05-18-2015	DMG Productions explores the latest technological breakthroughs in science and technology
PR Web	05-19-2015	Operational Note: King and Queen of the Netherlands to Visit Waterloo
Digital Journal	05-19-2015	Operational Note: King and Queen of the Netherlands to Visit Waterloo
CBCNews	05-19-2015	King and Queen of the Netherlands to visit Waterloo Region May 28
Female First	05-20-2015	King Willem-Alexander and Queen Maxima to visit Canada
Everythingzoomer.com	05-20-2015	King Willem-Alexander and Queen Maxima to visit Canada
Brampton Guardian	05-20-2015	Dutch king and queen to visit Waterloo Region
Wikian Theological Foundation	05-20-2015	Photons in curved space-time
Phys.Org	05-21-2015	Researchers theoretically demonstrate detection of spin of atoms at room temperature
TV Eyes.com	05-25-2015	Transcript
Record	05-25-2015	A Dutch treat awaits the region
National Post	05-25-2015	5 things to watch; the Dutch Royals in Canada
Daily Bulletin	05-25-2015	Monday's notes
Waterloo Homepage	05-26-2015	Waterloo historian reflects on the liberation of the Netherlands
Waterloo Homepage	05-26-2015	Liberating the Netherlands: The story behind a Canadian soldier killed in battle
The Globe and Mail	05-26-2015	Education partnership on the agenda during Dutch mission to Canada
Daily Bulletin	05-26-2015	Preparations and protocols for tomorrow's royal visit
CBCNews	05-26-2015	Dutch royals kick off Canadian visit with YYT stop
Xinhua News	05-27-2015	Dutch royals visit Canada to mark 70th anniversary of WWII liberation
Hello! Canada	05-27-2015	King Willem-Alexander and Queen Máxima touch down in Canada
Critical Mention	05-27-2015	

Publication	Date	Title
Waterloo Homepage	05-28-2015	Dutch royal couple charms crowds at the University of Waterloo
Record	05-28-2015	Dutch visit to University of Waterloo commemorates Canada-Netherlands bond
570 News	05-28-2015	PHOTOS: Dutch Royalty visit Waterloo Region
Hello! Daily Magazine	05-28-2015	Queen Máxima of the Netherlands dazzles in ruby tiara during Canadian tour
CTV News	05-28-2015	Waterloo hosts royals
CTV Kitchener	05-28-2015	Waterloo hosts royals
Waterloo Homepage	05-28-2015	Dutch royals visit, witness new research and education partnership between leading universities
	05-28-2015	Dutch royals visit, witness new research and education partnership between leading universities
Waterloo Homepage	05-28-2015	Quantum researcher awarded Dutch liberation scholarship
Global News	05-29-2015	King Willem-Alexander, Queen Maxima of the Netherlands visit Toronto today
Canada AM	05-29-2015	
University Affairs	05-29-2015	New Dutch scholarships a thank you to Canada
Morning Exchange	05-29-2015	Dutch royals visit, witness new research and education partnership between leading universities
CPA Magazine	06-02-2015	Quantum valley
TEREPAC	06-03-2015	Terepac Corporation Teams with IQC and evolutionQ
Financial Review	06-03-2015	Terepac Corporation Teams with IQC and evolutionQ
CNW	06-03-2015	Terepac Corporation Teams with IQC and evolutionQ
Record	06-04-2105	Quantum partnership focuses on cybersecurity
Cyber Security Caucus	06-05-2015	Quantum partnership focuses on cybersecurity
	06-18-2015	Twenty-six University of Waterloo researchers receive prestigious research awards
Daily Trust	06-21-2015	A glance at quantum computing
Maclean's	06-26-2015	Canada's science performance, down the memory hole
Frogheart (BLOG)	06-27-2015	D-Wave passes 1000-qubit barrier
Stratford Beacon Herald	06-28-2015	Canadian physicist Raymond Laflamme discusses harnessing the power of curiosity at Stratford Festival
Forbes	06-29-2015	What's The Point Of Science Without 'Eureka!' Moments?
Epoch Times	06-30-2015	4 Common Misconceptions About Quantum Physics

Publication	Date	Title
Globe and Mail	06-30-2015	Theoretical Physics is a low-cost, high-yield investment
@uwaterloo alumni newsletter	07-09-2015	Canadian physicist Raymond Laflamme discusses harnessing the power of curiosity at Stratford Festival
Communitech News	07-14-2015	Politics Plug-in: Advice for young companies from GR veteran Bob Crow
Inside Halton.com	07-24-2015	Oakville teen studied with select group of brilliant students
North Shore News	07-26-2015	Teen masters physics, one particle at a time
Waterloo Homepage	07-27-2015	Nanotech experts hope to take detailed pictures of molecules
Daily Bulletin	07-27-2015	Scientists gather for NanoMRI conference this week
Bloomberg News	07-30-2015	Alibaba Secures Data Centers With Quantum Research Lab
Waterloo Homepage	08-04-2015	Internet security: Creating cryptographic tools for the quantum age
Le Monde	08-04-2015	70 ans après Hiroshima : « Une cyberattaque quantique aurait un effet dévastateur sur nos vies »
Daily Bulletin	08-17-2015	Monday's notes
Motherboard	09-01-2015	Countdown to the Crypto-Apocalypse
New Scientist	09-02-2015	Can we get energy from nothing?
uWaterloo	09-08-2015	Four Waterloo professors named Royal Society of Canada fellows
Quanta Magazine	09-08-2015	A Tricky Path to Quantum-Safe Encryption
The Record	09-08-2015	Laurier names business school for Mike Lazaridis
The Globe and Mail	09-08-2015	Wilfrid Laurier University names business school for Mike Lazaridis
Laurier	09-08-2015	Laurier names School of Business & Economics after visionary technology entrepreneur Mike Lazaridis
Laurier	09-08-2015	Announcing the Lazaridis School of Business & Economics
Nature	09-08-2015	Online security braces for quantum revolution
Scientific American	09-08-2015	Cryptographers Brace for Quantum Revolution
Daily Exchange	09-09-2015	Four Waterloo professors named Royal Society of Canada fellows
CTV Kitchener	09-09-2015	Economy, security top issues for Harper at Kitchener stop
Wired	09-19-2015	The Tricky Encryption That Could Stump Quantum Computers
Cambridge Times	09-22-2015	Eliminating barriers to job creation in Kitchener South-Hespeler
Musical Toronto	09-22-2015	Music Director Edwin Outwater Says Goodbye to the Kitchener-Waterloo Symphony

Publication	Date	Title
Phys.Org	09-23-2015	Twisting neutrons: Orbital angular momentum of neutron waves can be controlled
EurekAlert!	09-23-2015	Twisting neutrons - JQI
University of Waterloo News	09-24-2015	A twist for control of orbital angular momentum of neutron waves
EurekAlert!	09-24-2015	A twist for control of orbital angular momentum of neutron waves - Waterloo
(e) Science News	09-24-2015	A twist for control of orbital angular momentum of neutron waves
State of Innovation	09-24-2015	The 2015 Thomson Reuters Citation Laureates
Globe & Mail	09-24-2015	University of Ottawa prof named as possible Nobel Prize winner
Space Dailly	09-25-2015	Twisting neutrons
Quantum Computing Technology Australia	09-25-2015	Opportunity to Combine Quantum Control of Neutrons with The Study and Engineering of Quantum Materials
cantech letter	09-25-2015	Ottawa physicist tipped to win Nobel for enabling selfie-taking molecules
University of Waterloo News	10-05-2015	New Quantum Cats game launches to build better understanding of quantum concepts
softpedia	10-05-2015	Quantum Cats Is a Fun Way to Learn Quantum Science
Phys.Org	10-05-2015	New Quantum Cats game launches to build better understanding of quantum concepts
EurekAlert!	10-05-2015	New Quantum Cats game launches for better understanding of quantum concepts
Daily Bulletin	10-05-2015	2,345 Quantum Cats were herded on Saturday
Maclean's	10-07-2015	Talking points: On Nobel prizing and future driving
Maclean's	10-08-2015	Talking points: On Nobel prizing and future driving
Daily Bulletin	10-08-2015	Recapping Reunion 2015
NewStatesman	10-08-2015	Code breaking's quantum leap – you have been warned
CIFAR News & Ideas	10-09-2015	CIFAR Researchers appointed to the Royal Society of Canada and RSC College
CBC Hamilton	10-13-2015	Mars colonizer more hopeful about mission with discovery of water
Imprint	10-13-2015	Angry Birds and quantum science converge at IQC
Industry tap into news	10-14-2015	
physicsworld.com	10-16-2015	Quantum Cats, physicists and stamp collecting, extraterrestrial building work
Press Release Point	10-20-2015	Yale Quantum Institute to launch
phycis4thecool.com	10-20-2015	Schrö
Globe & Mail	10-22-2015	How Canada can nurture growth through tech and innovation

Publication	Date	Title
Motherboard	10-24-2015	Quantum Encryption Is No Match for a Scorching Laser Beam, Researchers Find
Yale News	10-28-2015	Introducing the Yale Quantum Institute and the start of the 'Second Information Age'
The Cord	10-28-2015	Glowing response to new exhibit
AZO Optics	10-31-2015	Light Illuminated' Exhibit Invites Visitors to Explore Role of Light in our Daily Lives
Record	11-01-2015	Waterloo teen takes on Einstein, world takes notice
CBC.ca	11-02-2015	Two Ontario teens among the finalists for \$250K Breakthrough scholarship
University of Nottingham	11-02-2015	Academic affiliated with Institute for Quantum Computing, University of Waterloo
Gizmodo	11-03-2015	There's Always More Room at the Quantum Hilbert Hotel
Grand Magazine	11-10-2015	Just a matter of time
Science Daily	11-12-2015	Spooky action at a distance' is really real
FreshGhana.com	11-12-2015	NIST Team Proves 'Spooky Action during a Distance' is Really Real
Waterloo News	11-13-2015	Waterloo graduate students win Vanier scholarships for transformational research at Waterloo
Morning Exchange	11-17-2015	Waterloo graduate students win Vanier scholarships for transformational research at Waterloo
Globe & Mail	11-17-2015	Harnessing quantum law for new technologies
uWaterloo	11-18-2015	UN Year of Light: Waterloo grad students create light exhibit
The Toronto Star	11-22-2015	How Canada reversed the 'brain drain'
proof	11-24-2015	Equation Series: John Fish
Record - Tech Spotlight	11-24-2015	Startups pave way for quantum computer future; "There are people who are forward thinking and want to be ahead of the curve."
Maclean's	11-25-2015	Ten steps to make Canada a leader in science
I Programmer	11-29-2015	Quantum Cats
Canadian Business	12-01-2015	Canada shows a "disturbing" decline in innovation and R&D
3D Perspectives	12-04-2015	Quantum leap
Epoch Times	12-13-2015	Quantum Physics Just Got Less Complicated
Daily Bulletin	12-16-2015	Waterloo makes a solid CASE for communications excellence
APS Physics	12-16-2015	Viewpoint: Closing the Door on Einstein and Bohr's Quantum Debate
The Sydney Morning Herald	12-17-2015	Quantum Physics for Babies: Mark Zuckerberg reads his daughter a book by Sydney author Dr Chris Ferrie

Publication	Date	Title
Nature Photonics	12-24-2015	Quantum optics: Arithmetic with photons
Chathamdailynews.ca	12-27-2015	Chatham native's book a hit with Zuckerberg family
Exchange Magazine	Jan-Feb	A Baker's Dozen from Exchange
@Uwaterloo	January	Waterloo makes a solid CASE for communications excellence
Exchange Magazine	March/April	Through the lens of opportunity
Exchange Magazine	Sept/Oct 15	Challenge Accepted
Empire State Tribune		IBM's Quantum Leap Technology is Paving the way for the Next Generation of Super Computers
2016-2107		
Benzinga	42671	Christie Projectors Light Up Science Exhibition in Kitchener, Ontario
@UWaterloo alumni	42684	Quantum: The Exhibition
CPAC	42702	Conference Canada 2020
Communitech News	42708	President of Croatia
TheRecord.com	42708	Girls Matter at UW physics event
Daily Trust	42709	Microsoft speeding up its quantum computing effo
@UWaterloo	42713	Waterloo welcomes President of Croatia, Kolinda Grabar-Kitarovic to Campus
The Community edition	42713	Quantum Exhibition Informs, Is All Over the Place
The USB Port	05-04-2016	IBM makes Quantum-Computing available to the public IBM quantum processor
Daily Bulletin	01-01-2017	Beyond 60 lecture kicks off anniversary year
FrogHeart	01-01-2017	2016 thoughts and 2017 hopes from FrogHeart
University Herald	01-04-2017	The Year 2017 Could Be The Start Of Quantum Computers
Daily Bulletin	01-05-2017	Celebrating Canada's 150th
The Province	01-17-2017	GE and Actua host digital technology event for "Generation Now"
Daily Bulletin	01-19-2017	Vancouver hosts anniversary reception, launch of QUANTUM: The Exhibition
Government of Canada	01-19-2017	Government of Canada celebrates science as part of Canada 150
Government of Canada	01-19-2017	Le gouvernement du Canada fait honneur aux sciences dans le cadre du 150e anniversaire du Canada
New Scientist	01-23-2017	Exotic black holes caught turning into a superfluid
Daily Bulletin	01-24-2017	Vancouver hosts 60th anniversary reception, launch of QUANTUM: The Exhibition
CBC News	01-25-2017	New Canadian quantum computer called twice as powerful as last one, but what does that mean?

Publication	Date	Title
EurekAlert!	04-05-2016	Changing the colour of single photons in a diamond quantum memory
nextBIG Future	04-05-2016	Storage and retrieval of terahertz-bandwidth single photons via a quantum memory in room-temperature bulk diamond
Opli	04-05-2016	CHANGING THE COLOUR OF SINGLE PHOTONS IN A DIAMOND QUANTUM MEMORY
Phys.org	04-05-2016	Changing the colour of single photons in a diamond quantum memory
sci24h.com	04-05-2016	Storage and retrieval of terahertz-bandwidth single photons via a quantum memory in room-temperature bulk diamond
University of Waterloo News	04-05-2016	Changing the colour of single photons in a diamond quantum memory
newswise	04-06-2016	Changing the colour of single photons in a diamond quantum memory
Nanotechnology Now	04-07-2016	Changing the colour of single photons in a diamond quantum memory
Haptic	04-08-2016	Quantum frequency conversion in a diamond quantum memory
Weekendavisen	04-08-2016	Kvantedalen
Space Daily	04-13-2016	Changing the color of single photons in a diamond quantum memory
Ask Men	04-15-2016	Canadian Prime Minister Justin Trudeau Explains Quantum Computing
betakit	04-15-2016	Prime Minister Justin Trudeau announces \$50 million investment in Waterloo's Perimeter Institute
Business Insider	04-15-2016	Justin Trudeau gave a sarcastic reporter a quick lesson in quantum computing
CBC News Kitchener-Waterloo	04-15-2016	Prime Minister Justin Trudeau affirms \$50M for physics think-tank in Waterloo, Ont.
CBC Player	04-15-2016	PM has fun explaining quantum computing
CJAD	04-15-2016	Trudeau gives quantum computing lesson
CTV Kitchener	04-15-2016	Trudeau 1-on-1: Talking Waterloo Region, Saudi arms deal and refugees
engadget	04-15-2016	Canada's prime minister schools reporter on quantum computing
Fusion	04-15-2016	A reporter tried to stump Justin Trudeau with a question about quantum computing, and got royally Trud-owned
Global News	04-15-2016	PM Justin Trudeau gives reporter quick lesson on quantum computing during visit to Waterloo
Globe and Mail	04-15-2016	'Don't get me started': Trudeau gives quick quantum computing lesson
Gossip Monthly Magazine	04-15-2016	PM Justin Trudeau gives reporter quick lesson on quantum computing during visit to Waterloo

Publication	Date	Title
HackRead	04-15-2016	Justin Trudeau owns reporter on sarcastic question about quantum computing
Huffington Post	04-15-2016	Justin Trudeau Drops Quantum Computing Answer To Question About ISIS
Huffpost Good News	04-15-2016	Justin Trudeau Gives Snarky Reporter A Lesson In Quantum Computing
imgur	04-15-2016	Justin Trudeau correctly answered a question about quantum computing
Indian Express	04-15-2016	Canadian PM Justin Trudeau impresses everyone with his knowledge on quantum computing
Kicker	04-15-2016	Justin Trudeau effortlessly explained quantum computing
Macleans.ca	04-15-2016	Justin Trudeau's quantum leap
Mashable	04-15-2016	Justin Trudeau explains quantum computing like a boss
mic.com	04-15-2016	Journalist Challenges Justin Trudeau to Explain Quantum Computing, Trudeau Nails It
Mother Jones	04-15-2016	Maybe Quantum Physics Can Explain How An Object Can Be So Hot and Cool at the Same Time
National Post	04-15-2016	'Don't get me started:' Trudeau delivers impromptu quantum computing lesson
Popular Science	04-15-2016	Canada's Prime Minister Knows A Thing Or Two About Quantum Computers
RCI	04-15-2016	PM at the Perimeter Institute
Refinery29	04-15-2016	Justin Trudeau Knows About Quantum Computing, Don't Test Him
Reuters video	04-15-2016	Trudeau nerds out over quantum theory
Slate - XXfactor	04-15-2016	Handsome Canadian Prime Minister Justin Trudeau Gives Passable Off-the-Cuff Lecture on Quantum Computing
Talking Cloud	04-15-2016	Video: Watch Canadian PM Explain Quantum Computing
The Quint	04-15-2016	Justin Trudeau Silences a Reporter With Quantum Computing Gyaan
The Register	04-15-2016	Canny Canadian PM schools snarky hack on quantum computing
The Verge	04-15-2016	Canadian prime minister schools journalist in how quantum computing works
Time	04-15-2016	Watch Justin Trudeau Explain Quantum Computing to a Sarcastic Reporter
Times of Malta	04-15-2016	Canadian Prime Minister Justin Trudeau nerds out over quantum theory
Toronto Star	04-15-2016	PM shows off knowledge of quantum computing
WCCFTech	04-15-2016	Handsome Canadian Prime Minister Justin Trudeau Reveals His Inner Computer Geek

Publication	Date	Title
9news	04-16-2016	Canadian PM Justin Trudeau flawlessly explains quantum computing
Balochistan Express	04-16-2016	Canada's PM stuns audiences with knowledge of Quantum computing
Best Techie	04-16-2016	This Politician Understands Quantum Computing Better Than Most People
Canada Journal	04-16-2016	Justin Trudeau explains quantum computing like a boss (Video)
Canoe.com	04-16-2016	Internet abuzz after quantum computing lesson by Justin Trudeau
Daily News and Analysis	04-16-2016	Ladies breathe easy: When Justin Trudeau gave a class in quantum computing to a journalist
Epoch Times	04-16-2016	Canadian Prime Minister Explains Quantum Computing
Esquire.com	04-16-2016	Canadian Prime Minister Justin Trudeau Casually Explained Quantum Computing Like a Boss
Gizmodo	04-16-2016	Everyone Should Be Able To Explain Quantum Computing Like Justin Trudeau
India Today	04-16-2016	Justin Trudeau turns professor, gives quick lesson in quantum computing
Metro	04-16-2016	Justin Trudeau just proved he's a quantum computing badass
MSN.com	04-16-2016	Justin's Quantum Leap
New York Post	04-16-2016	Hunky Justin Trudeau shuts reporter down on quantum computing
news.com.au	04-16-2016	Canadian PM was jokingly asked about quantum computing and gives perfect answer
Next Big Future	04-16-2016	Canada has a technology geek Prime Minister
Pedestrian TV	04-16-2016	WATCH: Justin Trudeau Explains Quantum Computing Like It's No Big Deal
Pulse Headlines	04-16-2016	Canada's PM, Justin Trudeau, amazed the world while explaining quantum computers
Scoop Whoop	04-16-2016	A Sarcastic Journalist Asked Justin Trudeau A Question On Quantum Computing. Here's How He Shut Him Up
Story Pick	04-16-2016	Watch How Justin Trudeau Silenced A Reporter With His Awesome Speech On Quantum Computing
Tech Times	04-16-2016	Canada's Justin Trudeau: Feminist, Yogi, And Apparently Quantum Computing Whiz Too
The Daily Heights	04-16-2016	Canada's PM stuns audiences with believe of Quantum computing
The Express Tribune	04-16-2016	Canada's PM stuns audiences with knowledge of Quantum computing

Publication	Date	Title
The Guardian	04-16-2016	The reaction to Justin Trudeau's explanation of Quantum Computers shows we should raise our expectations
The Irish Times	04-16-2016	Justin Trudeau explains quantum computing to stunned reporters
The Tech News	04-16-2016	See Justin Trudeau Prime Minister of Canada Explaining Quantum Computing
The Virginian Pilot	04-16-2016	Trudeau Shows Geek Side in Video Gone Viral
UPI.com	04-16-2016	Canadian PM Justin Trudeau shows off quantum computing knowledge
UPROXX	04-16-2016	Justin Trudeau Delivers A Lecture In Quantum Computing, So Everyone Can Feel Inadequate Now
Vanity Fair	04-16-2016	Man of Your Dreams Justin Trudeau Casually Drops Quantum Computing Lecture in Press Conference
Washington Post	04-16-2016	Watch Canadian Prime Minister Justin Trudeau's charming quantum computing lesson
World News Day	04-16-2016	Canada PM Justin Trudeau impresses all with his knowledge on quantum computing
ABC Online	04-17-2016	Justin Trudeau: Canadian PM gives impromptu quantum computing explanation, gets standing ovation
Al Arabiya	04-17-2016	Watch: Canada's Trudeau shows geek side in video gone viral
Carbonated TV	04-17-2016	Canadian PM's Impromptu Quantum Computing Lecture Is Gold
Catch News	04-17-2016	Canadian PM Justin Trudeau talks about Quantum Computing & the internet cannot handle it
CBS New York	04-17-2016	VIDEO: Internet Freaking Out Over Justin Trudeau's Quantum Computing Explanation
Daily Caller	04-17-2016	Here's The True Story Behind Trudeau's 'Explanation' Of Quantum Computing
Daily Mail	04-17-2016	Not just a pretty face then? Justin Trudeau stuns room full of reporters and scientists with perfect answer to complex quantum computing question
Daily Star	04-17-2016	Canada's Trudeau explains quantum computing in viral video
Enstarz	04-17-2016	Justin Trudeau Update: Prime Minister Schools Reporter For Asking A Flip Question [VIDEO]
Fortune	04-17-2016	Justin Trudeau Explains Quantum Computing, And the Crowd Goes Wild
Herald Scotland	04-17-2016	Canadian PM Justin Trudeau's quantum computing explanation goes viral
Inquisitr	04-17-2016	Canada's Prime Minister Justin Trudeau explains quantum computing, goes viral

Publication	Date	Title
Interrobang	04-17-2016	Justin Trudeau Explains Quantum Computing
Irish Examiner	04-17-2016	Canadian PM Justin Trudeau's quantum computing explanation goes viral
Irish Independent	04-17-2016	Canadian PM Justin Trudeau's quantum computing explanation goes viral
ITV News	04-17-2016	Canadian PM gives impromptu quantum computing lesson
Kansas City Star	04-17-2016	Canada's Justin Trudeau explains quantum computing in viral video
Malay Mail Online	04-17-2016	Justin Trudeau takes on question on quantum computing and Twitter goes nuts
Motherboard	04-17-2016	We Asked Some Experts to Score Justin Trudeau's Explanation of Quantum Computing
NBC News	04-17-2016	Internet Abuzz After Quantum Computing Lesson by Canadian PM Trudeau
Newser	04-17-2016	Go Ahead, Ask Justin Trudeau About Quantum Computing
Newshub	04-17-2016	Canadian PM floors room with quantum computing knowledge
Parent Herald	04-17-2016	Canadian Prime Minister Justin Trudeau Gives Impressive Explanation Of Quantum Computing
Pink News	04-17-2016	Justin Trudeau just totally schooled a room full of journalists about quantum computing
Shtetl-Optimized	04-17-2016	Grading Trudeau on quantum Computing
Tech News Plus	04-17-2016	Justin Trudeau Gives Quantum Computing Lecture to Journalist
Telegraph	04-17-2016	Canadian prime minister Justin Trudeau expertly explains quantum computing in viral video
The American Spectator	04-17-2016	Why I'm Not Impressed With Justin Trudeau's Answer on Quantum Computing
The Hindu	04-17-2016	Canadian PM can explain quantum computing. Can you?
The Independent	04-17-2016	Justin Trudeau shuts down sarcastic reporter with impromptu quantum computing explanation
The Times of India	04-17-2016	Canadian PM Trudeau shows geek side in video
Times India	04-17-2016	Is Justin Trudeau the smartest leader the world has seen?
Today Online	04-17-2016	Canada PM lights up Internet explaining quantum computing
tvnz	04-17-2016	Showing his geek side - Canadian PM wows crowd with quantum computing knowledge
Tweaktown	04-17-2016	PM explains quantum computing to a reporter, like a boss
BGR	04-18-2016	Canadian PM's amazing quantum computing answer was too good to be true

Publication	Date	Title
CBC News	04-18-2016	Google, NASA put big money on D-Wave's quantum computer
Express Tribune	04-18-2016	Canada's PM stuns audiences with knowledge of Quantum computing
Gawker	04-18-2016	Justin Trudeau's Quantum Computing Explanation Was Likely Staged for Publicity
GMA News Online	04-18-2016	Internet abuzz after quantum computing lesson by Canada's Trudeau
GOOD Magazine	04-18-2016	Canada's Prime Minister Justin Trudeau Nails Question On Quantum Computing
IFL Science	04-18-2016	Watch Canadian Prime Minister Justin Trudeau Perfectly Explain Quantum Computers
Macleans.ca	04-18-2016	When a Prime Minister scrums (Or: why democracy isn't dead)
Mail Online	04-18-2016	Trudeau never fails to impress and explains quantum theory
National Post	04-18-2016	'I'm really hoping people ask me how quantum computing works': Trudeau's 'geek' lecture not so off-the-cuff
News18.com	04-18-2016	Watch: Canadian PM Explains Quantum Computing in Under 1 Minute
Strait Times	04-18-2016	Quantum leap in Trudeau's popularity
The China Post	04-18-2016	Canada PM lights up Internet explaining quantum computing
The Nation	04-18-2016	Canadian PM drops quantum computer knowledge
The Star Online	04-18-2016	Canada PM lights up Internet explaining quantum computing
Toronto Sun	04-18-2016	Media at Justin Trudeau's feet
Washington Post	04-18-2016	Actually, Justin Trudeau doesn't get quantum computing
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Lifeboat blog	12-30-2016	Quantum Computing and why we need to replace the Internet
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K. Industry Canada Evaluation of IQC 2013



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Evaluation of Industry Canada's Grant to the Institute for Quantum Computing

Final Report

December 2013

Presented to the Departmental Evaluation Committee on November 29, 2013

Approved by the Deputy Minister on December 12, 2013

Canada

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List of acronyms used in this Report

Acronym	Meaning
CFI	Canada Foundation for Innovation
CIFAR	Canadian Institute for Advanced Research
FTE	Full Time Equivalent
HQP	Highly Qualified Personnel
IQC	Institute for Quantum Computing
NSERC	Natural Sciences and Engineering Research Council
R&D	Research and Development
S&T	Science and Technology
STIC	Science, Technology and Innovation Council
STIA	Strategic Technical Information Analysis

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EXECUTIVE SUMMARY

Program Overview

The Institute for Quantum Computing (IQC) is a multidisciplinary research organization within the University of Waterloo and is supported by a partnership of the federal and provincial governments and the philanthropy of Mike and Ophelia Lazaridis. Building on the University of Waterloo's internationally recognized strengths in mathematics and computer science, IQC was officially established as a research institute at the University of Waterloo in 2002.

In order to expand its leadership role and build on the reputation it had developed, IQC sought to create a research environment and facility conducive to growth. In 2008, the Institute launched a \$300 million project to build, purchase and recruit the resources needed to support IQC's growth. The project included:

- the construction of an \$80 million new facility to house IQC activities;
- the acquisition of \$20 million worth of quantum science equipment;
- up to \$100 million to establish and staff a world-leading program in quantum information science, including training programs and knowledge transfer mechanisms; and,
- the establishment of a \$100 million endowment to secure the future operating costs of IQC.

As part of this project the Government of Canada's Budget 2009 allocated a \$50 million grant, over five years, to IQC to support the construction and establishment of a new world class research facility that would contribute to achieving the goals of the federal Science and Technology (S&T) Strategy. The project was also supported by private donors (Mike and Ophelia Lazaridis), the Government of Ontario, and the University of Waterloo.

Evaluation Purpose and Methodology

In accordance with the *Treasury Board Policy on Evaluation* and the *Directive on the Evaluation Function*, the purpose of this evaluation was to assess the core issues of relevance and performance of Industry Canada's grant to IQC. The evaluation covers the period of 2009-10 to 2013-14 and findings are based on the analysis of multiple lines of evidence. The methodology included a document review, literature review, interviews, environmental scan, scientific data analysis, and case studies.

Findings

Relevance

There is a continued need to increase Canada's research and innovation capacity as a means to provide social and economic benefits to Canadian society. IQC responds to this need through a multi-disciplinary approach that spans the innovation spectrum and focuses on quantum information and quantum computing sciences, a technology area with widespread potential benefits. IQC is uniquely positioned, within Canada and internationally, to contribute to the development of quantum sciences and its related technologies.

Support for IQC is consistent with federal government priorities related to science and technology as set out in the 2007 *S&T Strategy* and subsequent Federal Budgets. The objectives and activities of IQC are also in line with Industry Canada's strategic outcomes.

Support for IQC is consistent with federal roles and responsibilities to encourage the development of science and technology and aligns with Industry Canada's mandate. In addition, the delivery of support to IQC through Industry Canada appears to be logical and complimentary with other funding initiatives.

Performance

Overall, IQC is achieving the majority of its immediate outcomes: IQC researchers have access to some of the best quantum information sciences facilities and equipment in the world; and IQC is attracting and developing top-ranked researchers and students. With respect to increased awareness and knowledge, IQC has attracted interest among a variety of audiences.

IQC's research has increased in intensity and excellence as demonstrated by improved collaboration networks, increased publication and citation rates, as well as its reputation in the scientific community. IQC is also on track to being recognized as a leader in quantum information.

IQC's current delivery structure has demonstrated efficiency and economy by leveraging additional resources, minimizing transaction costs and using existing University of Waterloo management processes.

Recommendations

Overall, the evaluation did not find any major issues with the grant to IQC and as a result makes no recommendations.

1.0 INTRODUCTION

This report presents the results of an evaluation of Industry Canada's Grant to the Institute for Quantum Computing (IQC). The purpose of the evaluation was to assess the relevance and performance of Industry Canada's grant to IQC. The report is organized into four sections:

- Section 1 provides the program context and profile of IQC;
- Section 2 presents the evaluation methodology along with a discussion of data limitations;
- Section 3 presents the findings pertaining to the evaluation issues of performance and relevance; and
- Section 4 summarizes the study's conclusions.

1.1 Program Context

IQC is a multidisciplinary research organization within the University of Waterloo and is supported by a partnership of the federal and provincial governments and the philanthropy of Mike and Ophelia Lazaridis. Building on the University of Waterloo's internationally recognized strengths in mathematics and computer science, IQC was officially established as a research institute at the University of Waterloo in 2002. IQC was created to foster pioneering research in quantum information science, as part of a larger vision that "harnessing quantum mechanics will lead to transformational technologies that will benefit society and become a new engine of economic development in the 21st century"¹. The organization is guided by three strategic objectives:

- to establish Waterloo as a world-class centre for research in quantum technologies and their applications;
- to become a magnet for highly qualified personnel (HQP) in the field of quantum information science; and,
- to establish IQC as the authoritative source of insight, analysis and commentary on quantum information science.

In the years following the establishment of IQC, world-class researchers were recruited and scientific output and collaborations intensified. In order to expand its leadership role and build on the reputation it had developed, IQC sought to create a research environment and facility conducive to growth. In 2008, the Institute launched a \$300 million project to build, purchase and recruit the resources needed to support IQC's growth. The project included:

- the construction of an \$80 million new facility to house IQC activities;
- the acquisition of \$20 million worth of quantum science equipment;
- up to \$100 million to establish and staff a world-leading program in quantum information science, including training programs and knowledge transfer mechanisms; and,
- the establishment of a \$100 million endowment to secure the future operating costs of IQC.

¹ IQC website: <http://iqc.uwaterloo.ca/institute>

As part of this project, Budget 2009 committed to providing \$50 million, over five years, to IQC to support the construction and establishment of a new world class research facility that would contribute to achieving the goals of the federal Science and Technology (S&T) Strategy. The project was also supported by private donors (Mike and Ophelia Lazaridis), the Government of Ontario, and the University of Waterloo.

1.2 Description of IQC

IQC brings together researchers to conduct collaborative research, provides training and mentorship opportunities to graduate students, and delivers various scientific outreach activities.

The research approach at IQC is fundamentally interdisciplinary, aiming to bring together a critical mass of researchers in computer science, mathematics, physical science and engineering. IQC's research breadth spans from the foundations of quantum information science to the development of quantum technologies. Theorists and experimentalists pursue a number of different but complementary research avenues to better understand and utilize quantum information. The focus is on three main applications: computing, communication, and sensing.

Quantum mechanics allow these applications to be more efficient and more precise than what can be done through classical devices. For instance, quantum computing is a future design for computers based on quantum mechanics. It uses the "qubit," or quantum bit, which can hold an infinite number of values as opposed to the binary 1s and 0s in a classic computer. It is believed that such a device can handle multiple operations simultaneously and can factor large numbers 10,000 times faster than today's computers. While the science is still at the research stage, the potential applications of this technology are innumerable.

IQC, in collaboration with the University of Waterloo's Faculties of Science, Mathematics and Engineering, offers graduate students opportunities to learn about and engage in research in quantum information through a wide range of advanced research projects and advanced courses on the foundations, applications and implementation of quantum information processing. Students complete the requirements of their home faculty alongside the specific requirements of the quantum information program. As well, a mentorship program for post-doctoral fellows has been developed.

IQC also pursues a broad outreach agenda aimed at sharing and explaining its research. Outreach efforts are tailored to different target audiences, from prospective students and faculty to the general public and partners from government, academia and industry. Activities include graduate fairs, public lectures, conferences, cultural collaborations, high school visits, publications, and social media.

1.3 Program Design and Governance

Industry Canada's Science Partnerships Directorate (part of the Program Coordination Branch within the Science and Innovation Sector) is responsible for the delivery of the federal grant to IQC, as well as the ongoing management and oversight of the funding. The funding agreement

with IQC is one of a number of agreements within Industry Canada that use third-party organizations as a delivery mechanism for the government's S&T Strategy.

IQC is governed through an Executive Committee, a Board of Directors, an Executive Director and a Scientific Advisory Committee. Roles and responsibilities are as follows:

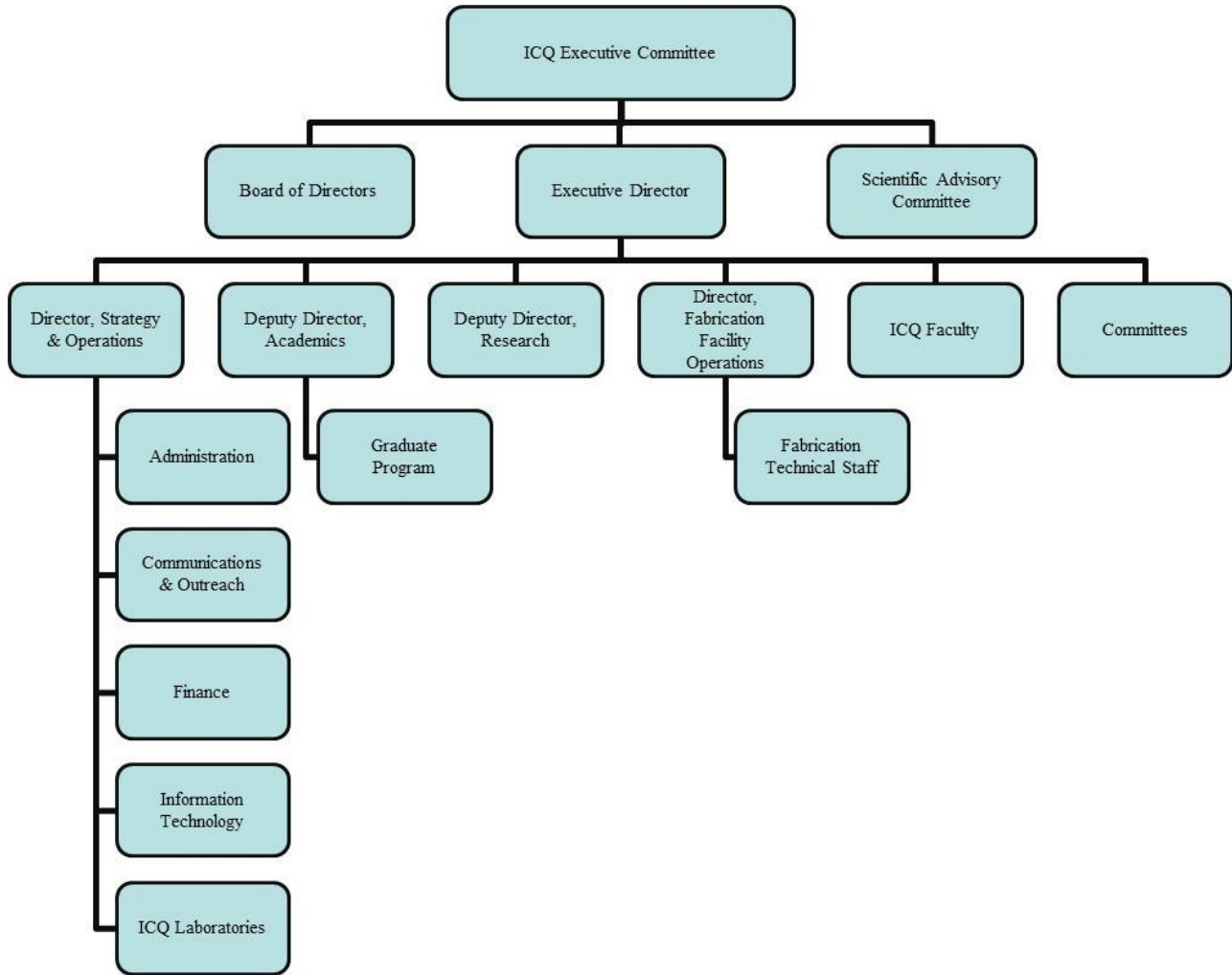
- *Executive Committee*: is made up of senior administrators from the University of Waterloo who provide guidance to IQC's Executive Director and senior management team. The Executive Committee is responsible for monitoring IQC's overall direction and performance.
- *Board of Directors*: is made up of internationally recognized leaders from academia, business and government. The Board meets twice a year, and provides strategic advice on all aspects of management including finances, planning, commercialization and outreach.
- *Executive Director*: oversees the IQC Directors, faculty and committees. Faculty members at IQC hold appointments in departments at the University of Waterloo and as such, are governed by the University's policies on appointment, promotion and tenure. All faculty participate in annual evaluations (performance assessments) conducted by their home departments. The Executive Director of IQC gives input to the heads of departments about the contributions of each member.
- *Scientific Advisory Committee*: is an independent body that meets on an annual basis (more often, if necessary). The Scientific Advisory Committee consists of seven internationally-recognized scientists in the field of quantum information.² It provides advice on research direction, focus, and long-term strategy of IQC and reports to the Executive Committee.

In addition, the institute tracks information on research, outreach and other contributions to IQC for its own membership renewal process. Members are elected to IQC for a period of five years. IQC holds monthly faculty meetings to discuss issues arising related to faculty and postdoctoral fellow hiring, visiting scientists, the graduate program, upcoming colloquia and seminars, scholarships and other matters as they arise.

Figure 1 depicts IQC's current organizational structure:

² IQC Constitution and on the IQC website: retrieved October 16, 2013 from: <http://iqc.uwaterloo.ca/iqc-directory/scientific-advisors?searchterm=scientific+adv>

Figure 1: IQC’s Current Governance Structure



Source: 2013 IQC Annual Report to Industry Canada

1.4 Stakeholders

In addition to Industry Canada, a number of stakeholders have been and continue to be involved in the development of IQC. The most prominent of these stakeholders are as follows:

- *Funding partners:* Including Mike and Ophelia Lazaridis, the Government of Ontario, University of Waterloo, The Canada Foundation for Innovation (CFI), and The Natural Sciences and Engineering Research Council (NSERC).
- *Industry partners:* IQC works with industry partners such as COM DEV (a leading supplier to the aerospace industry), Blackberry, Excelitas Technologies (optoelectronics and electronic systems), and Neptec (3D machines for space, industrial and military applications).

- *The Perimeter Institute for Theoretical Physics*: With its focus on computer science and experimental physics, IQC is meant to complement the Perimeter Institute's programs in theoretical physics.
- *Business Incubators*: The science and technology ecosystem in the Waterloo Region includes other centres that are engaged in entrepreneurship and commercialization such as: The Waterloo Accelerator Centre, Communitech, and Accelerator for Commercialization Excellence.

1.5 Resources

Funding of \$50 million over five years was provided, as a grant, by the federal government to:

- support the construction costs of a new building (\$25 million);
- purchase small equipment (\$5 million); and
- recruit and retain highly qualified personnel, conduct knowledge transfer/communication activities, support administrative/technicians staff, and cover material/supplies costs (\$20 million).

The funding was allocated as follows:

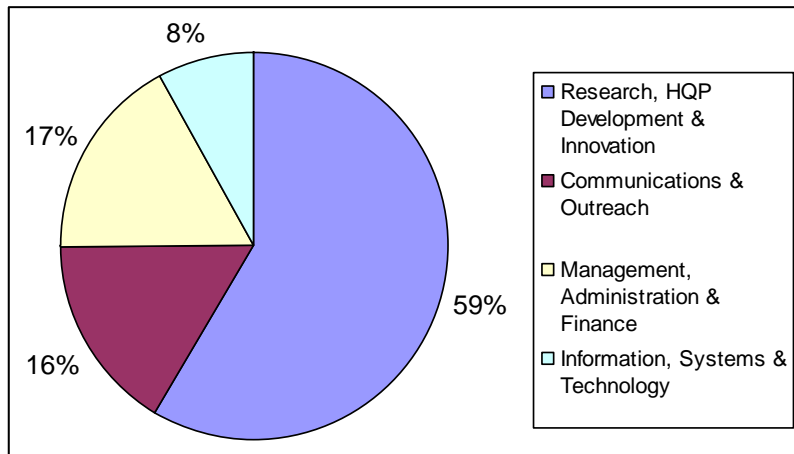
Table 1: IQC Expenditures ('000s) 2009-10 to 2013-14

	2009-10 (actual)	2010-11 (actual)	2011-12 (actual)	2012-13 (actual)	2013-14 (forecast)	Total
Building	12,615	12,385	-	-	507	25,507
Research Equipment	938	1,062	1,309	529	1,600	5,438
People & Operations	2,947	3,553	3,691	5,164	3,700	19,055
Total	16,500	17,000	5,000	5,693	5,807	50,000

Source: Industry Canada and IQC financial records

IQC allocated \$11.1 million of the expenditures in the *People and Operations* category to *Research, HQP Development and Innovation*. \$3.1 million and \$3.2 million were allocated respectively to *Communication and Outreach* and *Management, Administration and Finance* and \$1.5 million to *Information Systems and Technology*. Figure 2 summarizes this breakdown as percentages of the total expenditures on *People and Operations*.

**Figure 2: Breakdown of IQC Expenditures on People and Operations
2009-10 to 2013-14**



Source: Industry Canada and IQC financial records

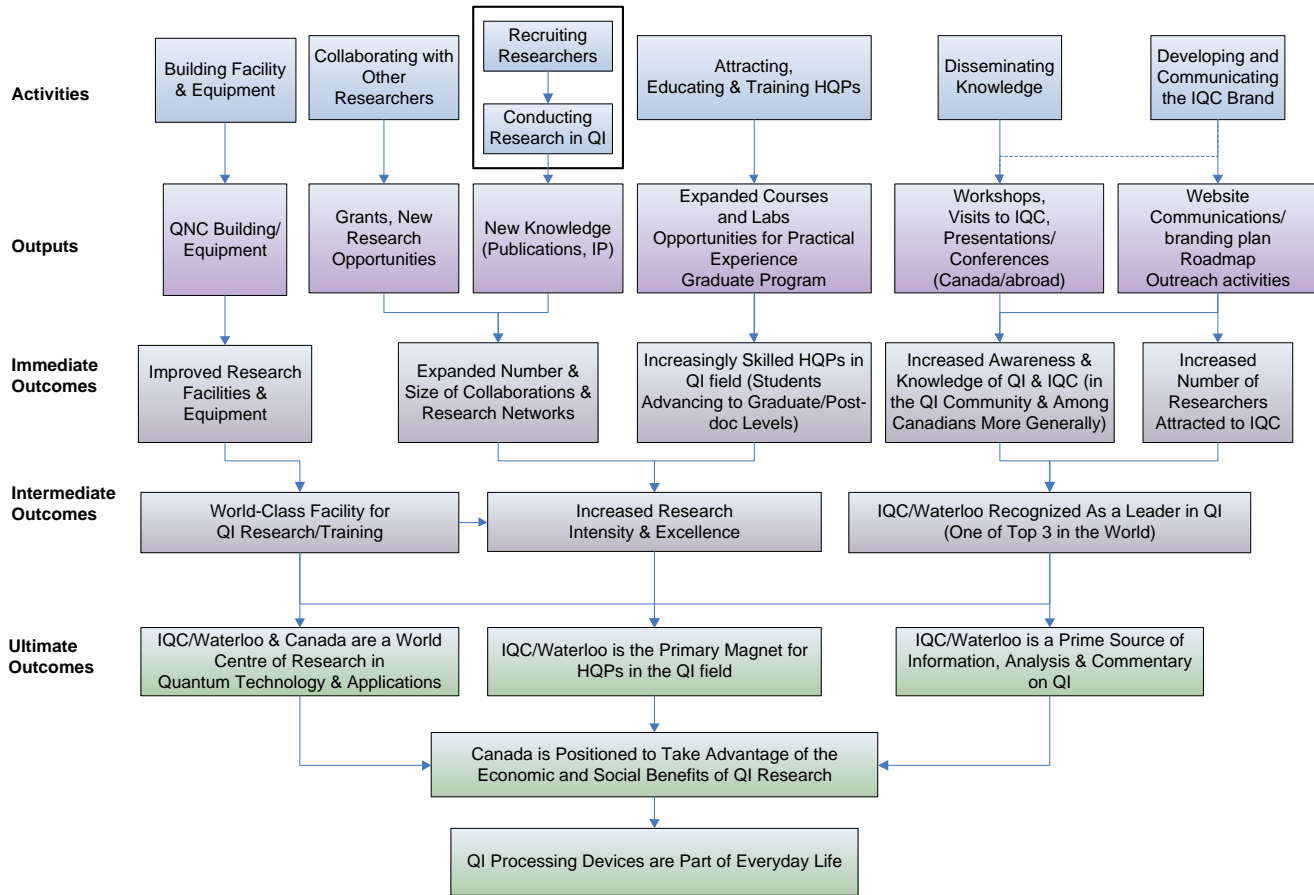
1.6 Expected Results of the Program and Logic Model

The expected results of the \$50 million federal investment in the IQC are:

- to increase knowledge in the various fields and sub-fields of quantum computing;
- to create new opportunities for students to learn and to apply new knowledge to the benefit of Canada;
- to brand Canada as the destination of choice for conducting research in quantum technologies, attracting the best in the world to Canada; and
- to position Canada to take full and privileged advantage of the economic and social benefits of research in this field.

The logic model for the program, represented in Figure 3, was developed in 2009 as part of IQC's Performance Measurement Strategy. The immediate and intermediate outcomes that align with the expected results of the \$50 million federal investment were used to guide the assessment of the core evaluation issue "achievement of expected outcomes".

Figure 3: Logic Model of the Institute of Quantum Computing



2.0 METHODOLOGY

This section provides information on the evaluation approach, objective and scope, the specific evaluation issues and questions that were addressed, the data collection methods, and data limitations for the evaluation.

2.1 Evaluation Approach

Like many evaluations of government programs, this evaluation was based on expected outcomes of the program as stated in the program's foundational documents and logic model. The evaluation used a variety of research methods, including a document review, a literature review, interviews, case studies, an environmental scan, a scientific peer review, and an analysis of social media.

2.2 Objective and Scope

An evaluation of IQC is required under section 42.1 of the *Financial Administration Act*. In accordance with the Treasury Board *Policy on Evaluation* and *Directive on the Evaluation Function*, the purpose of this evaluation was to assess the core evaluation issues of relevance and performance.

The evaluation study covered the period from April 2009 to September 2013.

2.3 Evaluation Issues and Questions

Based on the program Performance Measurement Strategy, and subsequent consultations with the program, the evaluation addressed the following questions:

Relevance

1. Is there a continued need to increase Canada's research and innovation capacity? Does IQC respond to this need?
2. To what extent do the objectives and activities of IQC align with federal government priorities and Industry Canada's strategic outcomes?
3. Does support to IQC align with federal roles and responsibilities?

Performance

4. To what extent has IQC achieved its immediate outcomes?
 - To what extent have IQC research facilities and equipment improved?
 - To what extent has IQC attracted and developed highly qualified personnel (top-ranked researchers and students)?

- To what extent have awareness and knowledge of quantum information and IQC increased?
5. To what extent is IQC on track to achieving its intermediate outcomes?
- Has the research and training conducted at IQC increased in intensity and/or excellence?
 - Is IQC on track to being recognized as a leader in quantum information?
6. To what extent does the program demonstrate efficiency and economy?

2.4 Data Collection Methods

Multiple lines of evidence were used to address all evaluation questions. The data collection methods included a document review, a literature review, interviews, an environmental scan, a scientific peer review, data analysis, and case studies.

Document Review

The document review was conducted to gain an understanding of the program and to gain insight into both the relevance and the performance of the program. Key documents included Federal Budgets and Speeches from the Throne, IQC's Treasury Board Submission, other policy documents, relevant federal and provincial legislation, Departmental Reports on Plans and Priorities, Departmental Performance Reports, program business plans, annual reports, performance reports and the recipient-led mid-term evaluation of IQC. Internal policies and processes within IQC were also assessed to provide evidence of the extent to which resource optimization mechanisms to ensure efficiency and economy are in place.

Literature Review

The literature review primarily addressed the core evaluation issues of continued need and federal roles and responsibilities. Specifically, the literature review examined the continued need to increase research and innovation capacity and the role of federal funding in supporting R&D in Canada and other jurisdictions outside of Canada.

Interviews

The objective of the interviews was to gather in-depth information for evaluation purposes, including views, explanations and factual information that address the evaluation questions. The interviews were designed to obtain qualitative feedback from a range of respondents. The interviews were conducted in-person, in conjunction with two site visits to IQC, or by telephone if an in-person interview was not possible.

Interviews were conducted with a total of 38 participants and include the following types of respondents:

- IQC management (4)
- IQC Board member / University of Waterloo management (4)
- Industry Canada (4)
- Advanced level students (8 conducted as 2 group interviews)
- Interviews were also conducted to support other lines of evidence, specifically the environmental scan (5), scientific peer review (6), and case studies (7)

Environmental Scan

An environmental scan was conducted to assess the role of IQC within the innovation and commercialization ecosystem of the Kitchener-Waterloo area or “Quantum Valley” vision. Quantum Valley is a term used to characterize the vision of the future of the Kitchener-Waterloo region. The vision includes creating a cluster of research around quantum information sciences, while fostering an entrepreneurial culture and supporting the development of a related technology sector focused on the commercialization of quantum technologies. Literature examining the theory and success of regional clusters in fostering innovation was reviewed. Interviews with 5 key stakeholders, who form part of the Quantum Valley vision, were conducted as follows:

- Business Incubators (2): Several organizations designed to support the creation, growth and success of entrepreneurial companies through an array of business support resources and services have been established in the Kitchener-Waterloo area. These include Communitech, and the Accelerator for Commercialization Excellence.
- Related Research Institutes (1): Perimeter Institute, as part of the cluster of complementary research.
- University of Waterloo (2): Representatives from the VeloCity program³ and the Technology Transfer Office (within the University’s Office of Research) were asked about processes in place to foster an entrepreneurial culture.

Scientific Peer Review

Scientific peer review is widely recognized as a key mechanism for assessing research quality and excellence. The evaluation team leveraged the existing experience and findings of the IQC Scientific Advisory Committee through a review of its annual reports and subsequent focused telephone interviews with select members of the Committee. Interview guides were designed to build upon the findings of the Scientific Advisory Committee panel and structured to require a low level of effort from panel members (e.g. opinions based on current knowledge was solicited rather than requiring panel members to review additional material). Additional interviews with

³ The Velo-City program provides services geared towards entrepreneurially-inclined students including a residence, access to mentors and services, office space, and a competitive venture capital fund.

independent scientific experts were also conducted. These included experts from the Massachusetts Institute of Technology (MIT), the California Institute of Technology (Caltech) and Hebrew University in Jerusalem. This line of evidence enabled the objective assessment of the overall quality of research outputs and of IQC more generally (i.e., as a world-leading facility, as a destination of choice for highly qualified personnel).

Data Analysis

Two types of data were analysed, including:

- Administrative data: Information on the operations of the Institute were analysed to assess the efficiency and economy of program delivery.
- Web analytics: Social media tracking and web metrics, as published in the 2013 annual report, were analyzed to measure awareness and knowledge of quantum information and IQC. Examples include trends in the numbers of Youtube hits for IQC videos and Twitter followers.

Case studies

In conjunction with the 2012 annual report, IQC prepared four case studies that demonstrate several scientific achievements that have led to transferable knowledge in the field of quantum information. The evaluation built upon three of these case studies by conducting seven interviews with Principal Investigators, Co-investigators, and industry partners who are the potential users of IQC research. This line of evidence addressed performance issues, specifically the achievement of immediate outcomes and whether IQC is on track to achieving intermediate outcomes.

2.5 Data Limitation

Timing was a limitation for this evaluation. To fulfill the requirements under Section 42.1 of the *Financial Administration Act*, this evaluation was scheduled to be completed by March 2014. As a result, the evaluation was conducted only one year following completion of the construction of the new facilities. This limited the evaluation's ability to assess the full impact of the new facilities on enabling new forms of advanced research. To mitigate this, the evaluation design included a mix of lines of evidence to assess the results to date as well as anticipated results.

3.0 FINDINGS

3.1 Relevance

3.1.1 Is there a continued need to increase Canada's research and innovation capacity? Does IQC respond to this need?

Key Finding: There is a continued need to increase Canada's research and innovation capacity as a means to provide social and economic benefits to Canadian society. IQC responds to this need through a multi-disciplinary approach that spans the innovation spectrum and focuses on quantum information and quantum computing sciences, a technology area with widespread potential benefits. IQC is uniquely positioned, within Canada and internationally, to contribute to the development of quantum sciences and its related technologies.

The need to increase Canada's research and innovation capacity

In May 2007, the Prime Minister released the Government of Canada's national S&T Strategy, *Mobilizing Science and Technology to Canada's Advantage*, setting out a multi-year framework to improve Canada's long-term competitiveness and quality of life. This strategy was introduced to address Canada's economic and societal challenges, most notably Canada's widening productivity gap relative to the United States.⁴ Since 2007, the labour productivity gap between Canada and the United States has continued to widen.⁵

It is generally accepted that the material standard of living of a society depends on productivity, which drives increases in average per capita incomes and business competitiveness, and that productivity is primarily the result of innovation.⁶ According to the 2012 Science, Technology and Innovation Council (STIC) Report, innovation requires the introduction of knowledge or technology into the marketplace, where value is created, or into an organization, where efficiencies are generated.⁷ At the heart of the innovation process are the people who "generate the ideas and knowledge...and then apply this knowledge and the resulting technologies, products and services in the workplace and as consumers."⁸

Science and technology, including research and development, involves the creation of new knowledge or technology.⁹ Canada's science, technology and innovation ecosystem involves numerous players, including governments, businesses, universities and colleges, non-governmental organizations, communities and individuals. The links among these players facilitate the exchange and creative deployment of the knowledge, capital, talent and other

⁴ *Mobilizing Science and Technology to Canada's Advantage*, Government of Canada, p.2, 2007
[http://www.ic.gc.ca/eic/site/icgc.nsf/vwapj/STsummary.pdf/\\$file/STsummary.pdf](http://www.ic.gc.ca/eic/site/icgc.nsf/vwapj/STsummary.pdf/$file/STsummary.pdf)

⁵ STIC (2012). *State of the Nation 2012*.

⁶ Review of Federal Support to Research and Development – Expert Panel Report. Innovation Canada: A Call to Action. (i.e., the Jenkins Report). 2011.

⁷ STIC (2012). *State of the Nation 2012*.

⁸ OECD, "Key Findings," Ministerial Report on the OECD Innovation Strategy (2010), p. 9.

(<http://www.oecd.org/sti/45326349.pdf>)

⁹ STIC (2012). *State of the Nation 2012*.

resources required for innovation. Specifically, universities are seen to be essential in the innovation system, both producing and attracting the human capital needed for innovation.¹⁰

IQC's response to these needs

IQC responds to the needs outlined above through a multi-disciplinary approach that spans the innovation spectrum and focuses on quantum information and quantum computing sciences, a technology area with widespread potential benefits.

As part of the University of Waterloo, IQC is positioned within a unique science and technology ecosystem in Canada. It is located close to the Perimeter Institute, which is considered a world-leader in theoretical physics and supports IQC by conducting basic research in quantum physics. IQC's research includes six academic faculties and is focused on the full continuum of research related to quantum computers and quantum information. This includes 'basic research' (experimental or theoretical work, undertaken without any particular application or use in view); 'applied research' (original investigations directed towards a specific application); and 'experimental development' (systematic work directed at improving or producing new materials, products or devices) – all essential components of the innovation system.¹¹

Literature suggests that on the commercialization end of the innovation spectrum, the Waterloo region has a well-developed and high-performing technology cluster. The University is highly integrated into this cluster and is actively supporting its development by building a large pool of highly-skilled labour, patenting new technologies, spin-off companies and other entrepreneurial activities. In this regard IQC has developed a number of relationships with the University of Waterloo Programs and not-for-profit organizations to help facilitate interaction with the existing network of local and global firms. The following organizations are part of the science, technology and innovation ecosystem in the Waterloo Region and are engaged with IQC to help facilitate entrepreneurship and commercialization of research:

- The University of Waterloo Commercialization Office provides services in the form of intellectual property assessments, investments and management (e.g. patents, copyright); commercialization-pathway assessments and strategies; and prototype-development and assisting in writing applications to government programs;
- The University of Waterloo VeloCity program supports students through workshops, discussions and networking events; mentoring, advice and free work spaces to build start-ups; and a venture fund that allows students to compete for a \$25,000 start-up grant;
- Communitech supports tech companies at all stages of their growth and development—from start-ups to rapidly-growing mid-size companies, and large global players. This includes facilitating partnerships between industry and academics, such as IQC's participation under the DATA.BASE program that seeks to invest in data capturing capabilities and improve data mining techniques;

¹⁰ OECD, "Key Findings," Ministerial Report on the OECD Innovation Strategy (2010), p. 10. (<http://www.oecd.org/sti/45326349.pdf>)

¹¹ STIC (2012). *State of the Nation 2012*.

- The Accelerator Centre cultivates technology entrepreneurship by promoting commercialization of research and technology rising out of academic institutions.
- The Quantum Valley Investments is a \$100 million private fund that invests in breakthroughs in quantum information science that have the potential to lead to new commercializable technologies and applications. Currently, two IQC faculty members sit on the Investment Fund's scientific advisory committee.

According to the Jenkins Report (2011), an ecosystem such as this is essential for effective collaboration between business and higher education and eventual commercialization of research.¹² It also helps ensure that Waterloo (and Canada for that matter) is positioned to benefit from commercialization opportunities related to quantum technologies.¹³

As indicated by interviewees, quantum technologies (including computers and other devices) are a logical extension of the current technology trajectory¹⁴ and will have enormous advantages over classical devices that will likely have widespread social and economic impacts. For example, according to David Cory, Chair of the Quantum Valley Investments Scientific Advisory Committee and IQC faculty:

Quantum mechanics is the ultimate law of nature and when we build quantum devices we can realize efficiencies that greatly exceed any existing classical devices. Today we have robust quantum technologies that can be deployed as sensors, actuators, communication channels and small processors. The opportunity is to creatively connect such devices to important applications in a broad range of areas including medical, health, energy, security, environment, nanoscience, nondestructive testing, etc...
[\(http://quantumvalleyinvestments.com/management/\)](http://quantumvalleyinvestments.com/management/)

In addition, the National Research Council Strategic Technical Information Analysis (STIA) Assessment of Quantum Capability (2010) found that there is a high capacity for quantum applications to be disruptive.¹⁵ While several companies have already entered the market with products in the area of quantum key distribution, encryption, and communication networks, certain technical issues are still being observed and most projects are still at the demonstration stage of development. This report also found that the quantity and quality of IQC research was highly regarded – in 2010 IQC was ranked fifth on NSERC's top 20 international list for quantum capabilities and was the only Canadian organization on the list.¹⁶

¹² Review of Federal Support to Research and Development – Expert Panel Report. Innovation Canada: A Call to Action. (i.e., the Jenkins Report). 2011.

¹³ It is widely accepted that financing collaborative research involving networks between universities and industry is an effective strategy for supporting regional economic development and economic clusters. For more information refer to the OECD, May 2007 Policy Brief - Competitive Regional Clusters: National Policy Approaches. Retrieved from: <http://www.oecd.org/regional/regional-policy/38653705.pdf>

¹⁴ The exponential improvements in the capabilities of electronic digital devices are largely the result of the miniaturization of transistors. As transistors approach the size of an atom, quantum mechanics come into play. (Schaller, R.R. (1997). Moore's Law: Past, Present and Future. IEEE Spectrum. 34 (6), 52-59.)

¹⁵ Disruptive technology is a term coined by Harvard Business School professor Clayton M. Christensen to describe a new technology that unexpectedly displaces an established technology. (1997) Christensen, C.M. The Innovator's Dilemma; Harper-Collins.

¹⁶ National Research Council (2010). STIA Assessment, Quantum Capabilities.

Interviews with independent quantum scientists also indicated that IQC has one of the largest quantum computing programs in the world and is setting the international research agenda in a number of quantum information areas. It has consistently attracted top-ranked researchers, is actively partnering with internationally recognized researchers and has partnered with a number of private sector organizations, all of which are viewed to be essential to improving the strength of Canada's science and technology.^{17,18,19}

3.1.2 To what extent do the objectives and activities of IQC align with federal government priorities and Industry Canada's strategic outcomes?

Key Finding: Support for IQC is consistent with federal government priorities related to science and technology as set out in the 2007 *S&T Strategy* and subsequent Federal Budgets. The objectives and activities of IQC are also in line with Industry Canada's strategic outcomes.

The S&T Strategy outlines the Government's intention to foster three distinct Canadian S&T advantages: a Knowledge Advantage, a People Advantage, and an Entrepreneurial Advantage. Industry Canada's 2012-13 Report on Plans and Priorities emphasized the continued need to focus on the S&T framework's three criteria. IQC, in its activities and mandate, are aligned with all three:

- **Knowledge Advantage:** is based on the premise that Canadians must be positioned at the leading edge of the important developments that generate health, environmental, societal, and economic benefits. The S&T Strategy identifies information and communications technologies as one of four priority knowledge areas. IQC is directly aligned with this advantage by conducting ground-breaking/leading-edge research with a particular focus on interdisciplinary and/or international collaboration related to quantum information and quantum computing;
- **People Advantage:** is based on the premise that Canada must be a magnet for the highly skilled people we need to thrive in the modern global economy with the best-educated, most-skilled, and most flexible workforce in the world. IQC is aligned with this advantage by providing training and learning opportunities to highly qualified personnel;
- **Entrepreneurial Advantage:** is based on the premise that Canada must do more to translate knowledge into commercial applications. IQC research projects partner with private and industrial sectors to facilitate knowledge transfer. IQC is actively working with the existing Waterloo high-tech cluster infrastructure to help realize the Quantum Valley vision. The vision includes creating a cluster of research around quantum physics, while fostering an entrepreneurial culture and supporting the development of a related technology sector focused on the commercialization of quantum technologies.

¹⁷ STIC (2012). *State of the Nation 2012*.

¹⁸ Review of Federal Support to Research and Development – Expert Panel Report. Innovation Canada: A Call to Action. (i.e., the Jenkins Report). 2011.

¹⁹ OECD, "Key Findings," Ministerial Report on the OECD Innovation Strategy (2010), p. 10. (<http://www.oecd.org/sti/45326349.pdf>)

Subsequent Budgets have reiterated the Government’s commitment to the S&T Strategy Advantages. Some examples of these references are outlined in Table 2:

Table 2: Government Support for Advances in Science and Technology, Knowledge and Innovation

Announcements	Reference to Support for Advances in Science and Technology, Knowledge and Innovation
2009 Budget	Budget 2009 will provide \$50 million to the Institute for Quantum Computing to support the construction and establishment of a new world-class research facility that will contribute to achieving the goals of the Government’s science and technology strategy.
2010 Budget	Canada’s Economic Action Plan invests approximately \$5 billion in multi-year science and technology initiatives, an unprecedented investment which underlines the Government’s commitment to its science and technology strategy.
2011 Budget	<p>Knowledge and innovation are the drivers of success in the 21st century global economy. In order to be a world leader in knowledge and innovation, Canada must attract and develop talented people, increase our capacity for world-leading research and development, improve the commercialization of research, and promote education and skills development.</p> <p>Budget 2011 further demonstrates this leadership by proposing new resources to support leading-edge research, international collaborations, and world-class research centres in Canada.</p>
Budget 2013	<p>Investing in World-Class Research and Innovation and fostering a vibrant entrepreneurial culture where new ideas are translated from laboratories into the marketplace.</p> <p>By supporting advanced research and technology, the Government is choosing to invest in the current and future prosperity of Canadians.</p>

In addition, support for IQC aligns with Industry Canada’s priorities under the Science, Technology and Innovation Capacity Program Activity of Industry Canada’s Program Alignment Architecture (PAA). This Program Activity contributes to the *Strategic Outcome: Advancements in Science and Technology, Knowledge, and Innovation Strengthen the Canadian Economy*. Industry Canada’s grant to IQC also aligns with and supports the department’s priority to foster a knowledge-based economy by further developing the federal S&T Strategy and continuing to build Canada's advantages in knowledge, people and entrepreneurship.²⁰

²⁰ Industry Canada 2013–2014 Estimates — Report on Plans and Priorities.

3.1.3 Does the support to IQC align with federal roles and responsibilities?

Key Finding: Support for IQC is consistent with federal roles and responsibilities to encourage the development of science and technology and aligns with Industry Canada’s mandate. In addition, the delivery of support to IQC through Industry Canada appears to be logical and complimentary with other funding initiatives.

Alignment between support for IQC, the mandate of Industry Canada and the federal government’s roles and responsibilities

Industry Canada’s mandate for supporting Canadian S&T activities and policy goals stems from the *Department of Industry Act*, 1995. Subsection 4(1) defines the powers, duties and function of the Minister, which include matters related to industry, technology, and science in Canada. In exercising these powers, the Minister is responsible for initiating, recommending, coordinating, directing, promoting and implementing national policies, programs, projects and practices with respect to the objectives set out in section 5 of the Act.

The grant to IQC is provided under the authority of paragraph 14(1) of the Act²¹ and is consistent with the objectives established under section 5(d) “[to] encourage the fullest and most efficient and effective development and use of science and technology” and 5(e) “[to] foster and promote science and technology in Canada.”

The legitimacy of the federal government’s role in supporting S&T is supported by a review of policy documents and peer-reviewed literature. S&T policy-related documents outlining the rationale for such support were observed in multiple jurisdictions, including the US,²² Australia,²³ Japan,²⁴ the OECD,²⁵ and Europe²⁶. These policy statements and recommendations all identify a key role for direct and indirect public sector support for research and innovation in order to ensure the country/region achieves a strong and competitive economy. Importantly, this support is needed for basic and applied research conducted in the higher education sector, including activities that contribute to downstream business innovation.

In the Canadian context, the importance of government support for basic and applied research was highlighted in the Jenkins Report (2011), “The federal and provincial governments play an important role in fostering an economic climate that encourages business innovation—for

²¹ Paragraph 14(1) that states that the Minister may make grants and contributions to any person to facilitate the implementation of any program under the *Department of Industry Act*, 1995.

²² President’s Council of Advisors on Science and Technology. (2012). *Report to the President - Transformation and Opportunity: The Future of the U.S. Research Enterprise*. Retrieved from: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_future_research_enterprise_20121130.pdf; Board on Higher Education and Workforce. (2012). *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation’s Prosperity and Security*. Retrieved from: http://www.nap.edu/openbook.php?record_id=13396

²³ Australian Government. (2011). *Focusing Australia’s Publicly Funded Research*. Retrieved from: <http://www.innovation.gov.au/Research/Pages/FocusingAustraliasPubliclyFundedResearch.aspx>

²⁴ Council for Science and Technology Policy. (2010). *Japan’s Science and Technology Basic Policy Report*. Retrieved from: <http://www8.cao.go.jp/cstp/english/basic/4th-BasicPolicy.pdf>

²⁵ OECD. (2007). *Innovation and Growth: Rational for an Innovation Strategy*. Retrieved from: <http://www.oecd.org/science/inno/39374789.pdf>

²⁶ European Commission. (2010) A Rationale For Action - Europe 2020 Flagship Initiative - Innovation Union. Retrieved from: http://ec.europa.eu/research/innovation-union/pdf/rationale_en.pdf

example, by supporting basic and applied research and related training of highly qualified, skilled people [...] the higher education and government sectors are key players in Canada's innovation system and complement the role of business.”²⁷ The contributions of the higher education sector to the innovation system have also been highlighted in numerous policy documents and academic literature.^{28, 29} In fact, the higher education sector is currently the second largest performer of R&D in Canada (about 38% based on expenditures) and relies on the federal government to provide for about 25% of these activities. Universities are widely seen to play a strong and strategic role in the Canadian innovation system,³⁰ including the development and maintenance of a highly skilled workforce^{31,32}.

In addition, Industry Canada's grant to IQC appears to be consistent with support provided to quantum information sciences by governments in other countries. All interviewees, including researchers from other countries, indicated that other governments provide funding to quantum research. Although it is difficult to determine the exact amount of funding, a steep increase in international publication rates suggests that governments are supporting researchers in this field. The National Research Council Strategic Technical Information Analysis (STIA) Assessment of Quantum Capability (2010)³³ reports that there was a 300% increase internationally in publications between 2000 and 2009, with the top 20 organizations located in the following countries (shown alphabetically):

- Australia
- Canada
- China
- Germany
- Japan
- Singapore
- UK
- USA

Degree of overlap between Industry Canada's contribution to IQC and other government programs

IQC receives funding from a variety of sources, including federal funds provided by NSERC, Canadian Institute for Advanced Research (CIFAR) and CFI. All three of these funding initiatives are within the Industry Canada portfolio but administered independently from the

²⁷ Review of Federal Support to Research and Development – Expert Panel Report. Innovation Canada: A Call to Action. (i.e., the Jenkins Report). 2011. (p. 1-2).

²⁸ Nelson, R.R. & Romer, P.M. (1996). Science, Economic Growth and Public Policy. *Challenge*, 39, 9-21.

²⁹ Hessels, L.K., van Lente, H & Smits, R. (2009). In search of relevance: the changing contract between science and society. *Science and Public Policy*, 36, 387-401.

³⁰ Sa, C. & Litwin, J. (2011). University-industry research collaborations in Canada: the role of federal policy instruments. *Science and Public Policy*, 38, 425-435.; Sa, C. (2010). Canadian Provinces and Public Policies for University Research. Higher Education Policy, 23, 335-357.; OECD. (2012). Canada. *Science, Technology and Industry Outlook*. Retrieved from <http://www.oecd.org/canada/sti-outlook-2012-canada.pdf>; Expert Panel Review of Federal Support to Research and Development. (2011). *Innovation Canada: A Call to Action*. Retrieved from [http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/\\$FILE/R-D_InnovationCanada_Final-eng.pdf](http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/$FILE/R-D_InnovationCanada_Final-eng.pdf); Expert Panel Review of Federal Support to Research and Development. (2011). *Innovation Canada: A Call to Action*. Retrieved from [http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/\\$FILE/R-D_InnovationCanada_Final-eng.pdf](http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/$FILE/R-D_InnovationCanada_Final-eng.pdf)

³¹ Collin, C. (2006). *Federal Investments in Research and Development and Capacity Building in the Higher Education Sector*. Parliamentary Information and Research Service, Library of Parliament.

³² Government of Canada. (2007). *Mobilizing Science and Technology to Canada's Advantage*. Retrieved from: http://www.ic.gc.ca/eic/site/icgc.nsf/eng/h_00231.html

³³ National Research Council (2010). STIA Assessment, Quantum Capabilities.

department. Generally speaking, they each support research, equipment and networking through competitive processes. Although there is potential for overlap between these funding sources, interviewees pointed out that IQC is already making use of these other funding initiatives and that without Industry Canada's grant there would not have been enough funding to cover all the targeted aspects of its proposed \$300 million project.

Moreover, Industry Canada's grant and the other federal funding sources (such as NSERC, CIFAR and CFI) are guided by the S&T Strategy and therefore have supportive rationales and goals. In terms of implementation approaches, the flexible design of the Industry Canada's grant³⁴ allowed IQC to manage the funding in a way that eliminated conflicts with other funding sources. In this regard, interviewees reported a high degree of strategic thinking and coordination around how the different funding sources fit together.

3.2 Performance

3.2.1 To what extent has IQC achieved the following expected immediate outcomes?

- Improved research facilities and equipment
- IQC attracts and develops HQP (top-ranked researchers and students)
- Increased awareness and knowledge of quantum information and IQC

Key Finding: Overall, IQC is achieving the majority of its immediate outcomes: IQC researchers have access to some of the best quantum information sciences facilities and equipment in the world; and IQC is attracting and developing top-ranked researchers and students. With respect to increased awareness and knowledge, IQC has attracted interest among a variety of audiences.

Improved research facilities and equipment

In September 2012, IQC expanded into its new headquarters, the Mike and Ophelia Lazaridis Quantum-Nano Centre (QNC), a 285,000 square foot (sq. ft.) facility. Within QNC, the institute occupies a total of 51,832 sq. ft. of lab space and shares the 6,700 sq. ft. cleanroom/fabrication facility with the University of Waterloo Institute for Nanotechnology. This new facility has over twice the square footage compared to its previous facilities and is designed to control for vibration, temperature fluctuation and electromagnetic radiation. It also has spaces to accommodate conferences, public lectures, and common areas for scientists to meet and collaborate.

The building was completed in 2012-13 and some researchers are still in the process of moving to the new location, which limits the ability of the evaluation to assess the impact the facility is having on IQC. Nonetheless, the evaluation was able to assess early impacts and gather opinions of its potential from researchers internal and external to IQC, as well as from students attending the institute.

³⁴ Under the funding agreement between Industry Canada and IQC, the institute received multi-year funding that was to be disbursed towards a number of eligible expenses (e.g., construction costs of building the research facility, purchase of small equipment, outreach). Beyond these conditions, IQC had the discretion to manage the funds to support their broader goals.

Interviewees, including scientific peers independent of IQC, indicated that the new facilities are “state-of-the art”, “the best in the world” and “a huge step up over the past five years”. It was also noted that although different institutions might have the same or similar equipment, interviewees did not know of any single institution with the breadth of equipment available to IQC researchers. Having the breadth of equipment on site is important for conducting experiments because it allows researchers to control the entire process (including fabrication of highly sensitive devices). This helps reduce inconsistencies and improves the quality of research. For example, one researcher explained that he recently developed a new tool that allows his team to work with magnetic fields with superconductors without contamination. With this tool the researcher and his team can work more precisely than their competitors.

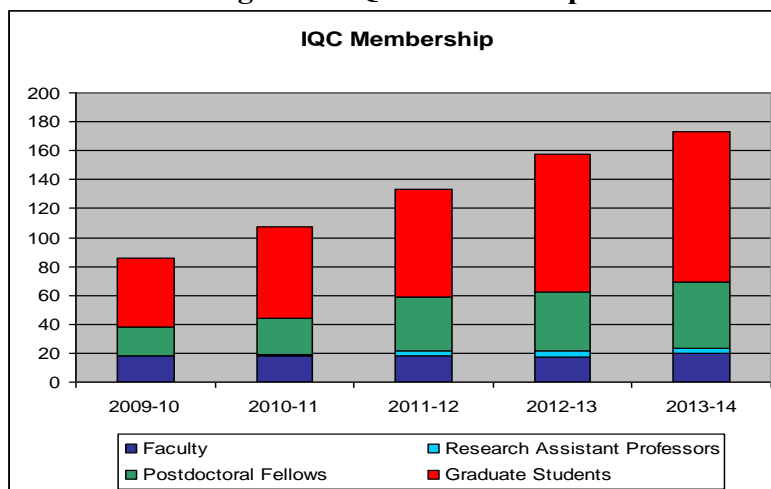
Industry partners indicated that the equipment available to IQC researchers is unique and allows the researchers to work with industry in areas that would not otherwise be possible. For example, according to interviewees it would not be cost-effective for industry to build a lab similar to IQC’s optics lab, and therefore it is seen to be essential for IQC’s partnerships on the Quantum Communications Network via Satellite project.

In addition, interviewees indicated that because of the facilities and the equipment, IQC has been able to attract top-ranked researchers and students who would have gone elsewhere. For example, students indicated that IQC is on par with bigger labs, but where IQC stands out is the collaborative approach that fosters interaction and provides opportunities for students to work with the labs and equipment.

IQC attracts and develops HQP (top-ranked researchers and students)

The ability to attract and develop HQP (top-ranked researchers and students) is a key measure in any academic institution’s success. As show in Figure 4, over the past five years, IQC has seen an overall growth in the number of graduate students, Postdoctoral Fellows and researchers.

Figure 4: IQC Membership



Source: IQC Annual Report to Industry Canada, 2013

With regard to graduate students, IQC launched a collaborative graduate studies program in 2009-10 that includes courses in quantum information processing and theory, quantum algorithms, open science systems, nanoelectronics, quantum electronics and photonics. The program attracted 104 applications in its first year, and approximately 120 applications every year since (those applying directly to the quantum information graduate program). IQC admits approximately 20% of those applying with 20-25 new graduate students accepted annually. Currently there are 103 students actively participating in the program. According to interviewees this is one of the largest (in terms of number of students and breadth of courses offered) graduate studies programs in quantum information sciences in the world and it is consistently attracting students from top-ranked international universities.

IQC has also instituted a growing Postdoctoral Fellowship program that currently includes 46 members, which is more than double the number in 2009. Positions in this program are highly competitive, as seen with the rising number of applicants in recent years. In the past five years there have been 87-119 applicants annually with IQC accepting 5-18 new Postdoctoral Fellows each year. Interviews with Postdoctoral Fellows indicated that IQC's reputation and quality of research were key factors in their decision to choose IQC over other institutions.

With respect to researchers, IQC has maintained approximately 20 faculty members, 3 Research Assistant Professors and 14 associate members/long term visitors. The goal for the institute is to recruit a total of 33 faculty members with a focus on attracting the right researchers to compliment existing research areas and improve the overall caliber of the institute. Interviewees, including members of the Scientific Advisory Committee, concurred with the preference for prioritizing the quality of new hires over quantity.

Since 2009, IQC was able to recruit Professor David Cory, one of the leading quantum experimentalists and Canada Excellence Research Chair in quantum information, and more recently Dr. Amir Yacoby of Harvard University as a visiting faculty member. Although these are major accomplishments, interviewees acknowledged that recruiting researchers is extremely competitive and scientific peers felt that IQC should continue developing capacity in experimental research in order to meet future needs.

Increased awareness and knowledge of quantum information and IQC

IQC has established a communications and scientific outreach team that helps to share its research with a variety of audiences including other research institutions, government, industry and the general public. IQC organizes annual meetings, workshops, conferences, and uses social media (such as Facebook, Twitter and Youtube) to highlight the research undertaken at the institute. Interviewees indicated that the communications team is very important and that IQC plays a leading role in the quantum information sciences field with respect to raising awareness and disseminating knowledge to the scientific community, students, as well as to the general public.

Since 2009 IQC has held 27 public outreach events that attracted approximately 5,500 participants. Events include specialized conferences, workshops, summer school for young students, open houses, public lectures and panel discussions. Within this same timeframe, 675 people toured IQC's facilities, including 580 academics (including visitors from 108 research

institutions worldwide), 61 industry members and 34 people from government. It is challenging for the evaluation to assess the impact in terms of improving general awareness and knowledge of quantum information and IQC because no information, beyond the numbers of events and visitors, is collected.

According to data tracked by the analytic services associated with social media outlets, IQC social media presence has grown in recent years. Table 3 below shows the cumulative increase in social media attention at IQC since 2010.

Table 3: Summary of Social Media Attention 2010 – 2013

Year	Facebook Likes	Twitter Followers	YouTube Subscribers	YouTube Views to Date
2010	197	195	6	103
2011	457	649	116	30977
2012	809	1,747	558	104,059
2013	1583	2,492	1,760	293,475

IQC has garnered significant attention on social media sites. Although the type of online conversations and shared content can vary widely, the public is increasingly using social media as a way to learn about science by following scientific opinions, reading updates from conferences and meetings, learning about upcoming events and watching scientific clips. As such, social media offer a powerful way for scientists to boost their professional profile and act as a public voice for science.

3.2.2 To what extent has IQC achieved the following expected intermediate outcomes?

- Increased research intensity and excellence
- IQC is recognized as a leader in quantum information

Key Finding: IQC’s research has increased in intensity and excellence as demonstrated by improved collaboration networks, increased publication and citation rates, as well as its reputation in the scientific community. IQC is also on track to being recognized as a leader in quantum information.

Increased research intensity and excellence

To determine research intensity, the evaluators reviewed the trends in the numbers of research collaborations and publications. To assess excellence in research the evaluators relied on the number of citations of IQC research, rankings of journals in which IQC researchers published, as well as opinions gathered through interviews with scientific peers, business incubators and industry partners.

Collaboration in research

Collaboration is widely regarded as a practice that can improve the quality, impact and reach of research. Academic collaboration with fellow university scientists drives knowledge creation,

whereas collaboration with industry partners drives knowledge application.³⁵ At IQC, researchers from a variety of disciplines come together to form the Institute. IQC spans six departments including: Applied Mathematics; Physics & Astronomy; Chemistry; Combinatorics & Optimization; Computer Science; and Electrical & Computer Engineering. Areas of specialization explored by IQC's theoretical and experimental scientists include:

- Spin-Based Quantum Information Processing
- Quantum Algorithms Nanoelectronics-Based
- Quantum Information Processing
- Quantum Complexity
- Optical Quantum Information Processing
- Quantum Error Correction
- Fault Tolerance
- Quantum Cryptography

IQC research is further enhanced by collaborations between researchers in a variety of fields from different institutions and with industry partners worldwide. The number of collaborations, including research projects and joint publications, with researchers from other institutions has grown from 141 researchers from 61 institutes in 2009 to 221 researchers from 185 institutions in 2012-13.³⁶ The growth in the number of collaborations, with institutions worldwide, allows IQC researchers opportunities to advance knowledge creation by building social capital, enhancing creativity, integrating specialized skills, and pooling resources.³⁷

In terms of collaborations with industry partners, the case studies revealed a number of industry partnerships in applied and experimental projects. For example, the Quantum Communications Network via Satellite project is collaborating with COM DEV, a global designer and manufacturer of space hardware, to create global quantum communications networks by sending equipment into orbit on a satellite. Although still in the testing phases, interviewees indicated that they are working towards developing a quantum communications network. Another example involves an IQC researcher who works with industry partner ID Quantique³⁸ to test the security of quantum cryptography systems. The company is able to maintain a level of security and performance of their systems by collaborating with the IQC researcher who tests the systems' security. In both of these examples, relationships with industry happened at the researcher level such that partners work directly with IQC researchers and relationships were developed through networking opportunities.

³⁵ Lavie, D.& Drori, I. (2012). Organization Science. *Collaborating for knowledge creation and application: The case of nanotechnology research programs*. 23, 3, 704-724.

³⁶ IQC Annual Reports, 2009-2013

³⁷ Lavie, D.& Drori, I. (2012). Organization Science. *Collaborating for knowledge creation and application: The case of nanotechnology research programs*. 23, 3, 704-724.

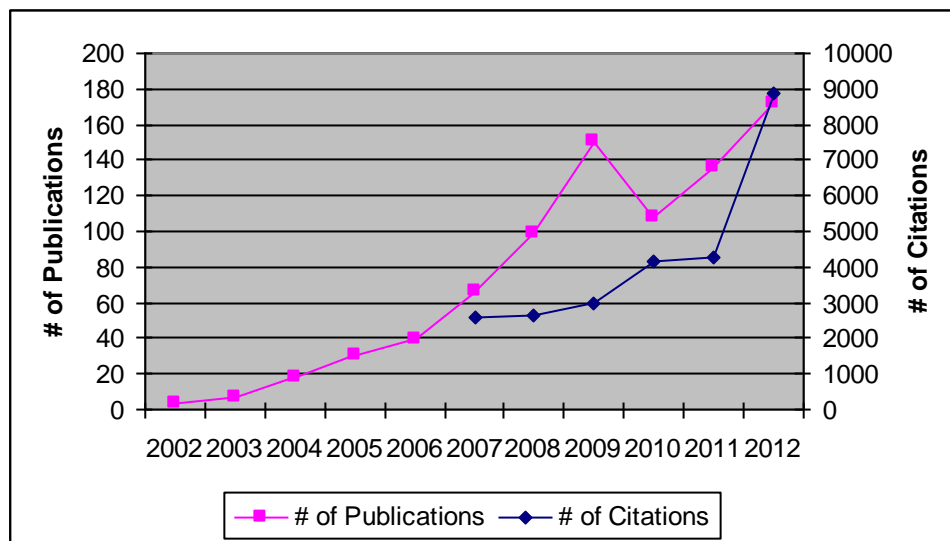
³⁸ ID Quantique (<http://www.idquantique.com/>) is a spin off company from the University of Geneva. It works on the application of quantum technology and cryptography.

Industry partners indicated that IQC researchers provide the expertise and theoretical knowledge as well as access to world-class facilities and equipment to address some of the practical problems identified by industry. Other interviewees indicated that partnerships with industry are “the next frontier” and that quantum technologies are getting closer to the stage where the private sector is getting more interested.

IQC researchers: publications and citations

Publications are one of several indicators of research output used by organizations that create or support the creation of new knowledge. In addition, citation count is used to gauge the importance of a publication by counting the number of times it has been cited by other scholars. Although a formal bibliometric analysis was beyond the scope of this evaluation, the evaluators nonetheless reviewed IQC’s publication and citation rates, as reported in the annual reports to Industry Canada. These reports were approved by the University of Waterloo Board of Governors. Since IQC’s inception in 2002, there has been an overall increase in the number of publications and citations, as shown in Figure 5³⁹ below.

Figure 5: Annual Number of IQC Publications and Annual Number Citations of all Papers Published by IQC Researchers



Source: IQC 2013 Annual Report

Beyond counting publications and citations, journal ranking is widely used in academic circles to assess an academic journal’s impact and quality. IQC researchers regularly publish in world-leading journals. Between 2009 and 2012, 113 (or 20%) of IQC publications were published in the following journals (reported as prominent by IQC):

- Nature
- Nature Photonics
- Nature Physics

³⁹ It should be noted that although the figure indicates that annual publication rates and citation rates are increasing, the increase in citation rates includes all publications for IQC researchers (which includes work published prior to joining IQC).

- Nature Communications
- Physical Review Letters
- Science
- Symposium on Theory of Computing proceedings
- Foundations of Computer Science proceedings
- Journal of Mathematical Physics

In addition, interviewees, independent from IQC, indicated that IQC’s research “leaves a huge foot print, both in terms of sheer volume but also in the quality”. Furthermore, independent interviewees indicated that IQC is “driving the agenda” in a number of quantum science areas. This is corroborated by the National Research Council Strategic Technical Information Analysis (STIA) Assessment of Quantum Capability (2010) that concluded IQC was ranked fifth internationally for quantum capabilities.⁴⁰

IQC is recognized as a leader in quantum information

The previous findings indicate the following: IQC’s researchers have access to some of the best quantum science facilities and equipment in the world; IQC is attracting and developing top-ranked researchers and students; IQC’s research has increased in intensity and excellence; and that scientific peers expressed that IQC is one of the most respected institutions in this field of research. Based on these findings, the evaluation concludes that at this stage of development IQC is on track to being recognized as a leader in quantum information. As research moves along the innovation spectrum, it will become increasingly important to measure how IQC is having an impact on industry.

3.2.3 To what extent does the program demonstrate efficiency and economy?

Key Finding: IQC’s current delivery structure has demonstrated efficiency and economy by leveraging additional resources, minimizing transaction costs and using existing University of Waterloo management processes.

The efficiency and economy of the delivery of Industry Canada’s grant to IQC was considered over the following areas: the general efficiency and economy of using a third-party delivery model and evidence that mechanisms are in place to facilitate an efficient and economic use of funds.

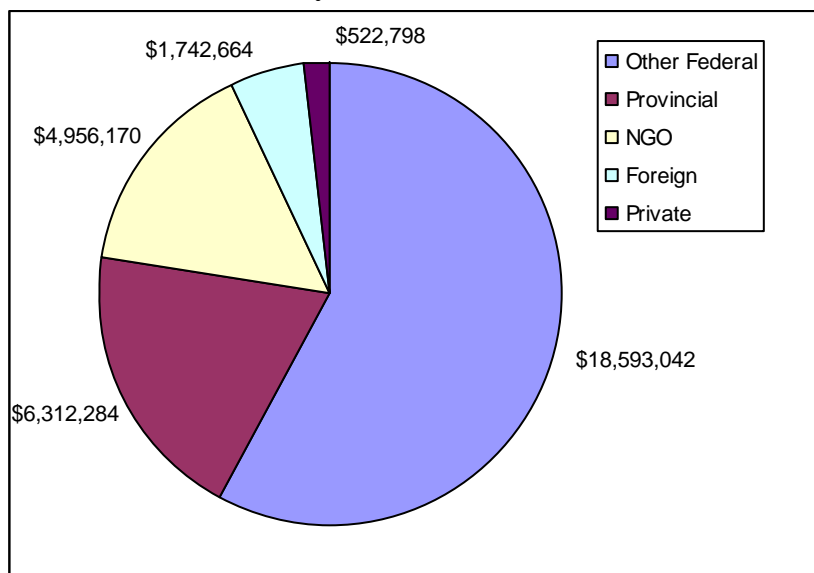
Efficiency and Economy of Third-Party Delivery Model

The ability to leverage additional funding is a principle financial benefit of conducting research through an independent institute. As previously discussed, the \$50 million Industry Canada grant was provided to support a larger \$300 million project, which represents a 1:5 leverage ratio. Furthermore, as shown in Figure 6, IQC reported that its researchers had attracted an additional \$32.1 million in grants, donations, gifts, and awards between 2009-10 and 2012-13 to

⁴⁰ National Research Council (2010). STIA Assessment, Quantum Capabilities.

support research undertaken at the institute. This demonstrates IQC’s ability to gain wider support and remain relevant to a broad number of stakeholders.

Figure 6: Breakdown of Grants, Donations, Gifts and Awards Received by IQC, 2009-10 to 2012-13



Source: IQC Annual Reports to Industry Canada, 2011-12 and 2012-13

In addition to the ability to leverage, a third-party delivery model has a number of advantages that would not be possible if IQC were a government lab. These include an increased ability for IQC to attract highly qualified representatives, including those from industry, to participate in the institute’s governance structure; an increased ability to take risks and partner with industry; and, as an institute within the University of Waterloo, IQC is better able to offer advanced courses and train students.

According to the literature, the principle drawback of this delivery model is the additional transaction costs incurred by arm’s length organizations and by Industry Canada. In the case of IQC, there do not appear to be significant transaction costs resulting from the delivery structure. Industry Canada allocated roughly one FTE to manage the delivery of the grant. This included drafting the foundation documents, developing and overseeing the implementation of the funding agreement, and liaising with IQC. Although these activities are considered transaction costs, interviewees noted that there are a number of efficiencies (such as developing insights on science policy and expertise in managing funding agreements) that result from having one program manage all of the department’s grants and contributions to arm’s length science organizations.

At the University of Waterloo, the Office of Research is responsible for administration of the funding. IQC is responsible for developing annual budgets to access the funding, liaising with Industry Canada and providing the Minister with an annual report on the activities and results of the previous year as well as anticipated activities and results for the following year. It is important to note that the annual budgets are not limited to the Industry Canada grant; they are developed for IQC as a whole and therefore are not considered to be additional transaction costs (i.e., budgets would be developed, with or without Industry Canada funding). Also, IQC

purposefully designed the annual report to Industry Canada to support outreach activities, a key priority for the institute, in order to maximize the benefits of these requirements.

Analysis of Governance Structure

In 2006, NSERC commissioned a review of IQC that was led by a committee of independent experts. This review concluded that the governance structure of the institute is appropriate to ensure proper guidance to the IQC management team, specifically noting the commitment from the University of Waterloo Executive, the impressive list of Board of Directors and the eminent international scientists on the Scientific Advisory Committee.⁴¹

The Board of Directors continues to be made up of internationally recognized leaders from academia, business and government and is seen to be effective at providing overall strategic direction to the institute, including outreach and ensuring that IQC maintains a commercialization orientation. The Scientific Advisory Committee includes internationally recognized researchers with expertise related to quantum information sciences and is responsible for advising on research direction, recruitment and faculty performance assessments.

With respect to administration, IQC uses the University administrative functions when appropriate, to reduce duplication. IQC is overseen by an Executive Committee of Senior University of Waterloo officials that is responsible for reviewing academic direction, annual budgets and major capital expenditures. This committee is chaired by the Vice President of Research and includes the Deans of the faculties of Mathematics, Sciences and Engineering. In the past, the Dean of Sciences was responsible for financial management of the grant. However, given the collaborative nature of IQC, it has recently been decided to consolidate this function under the Executive Committee to avoid duplication between faculties.

This structure ensures that IQC is subject to same level of scrutiny and internal controls as a faculty department, including major capital investments such as purchasing equipment. For example, as a result of the governance structure, IQC is responsible for ensuring that management of the Industry Canada grant adheres to the Standard from the Tri Council Memorandum⁴², is subject to the same budget review process, and is considered in the scope of the University's annual audit.

⁴¹ NSERC (September 27, 2006). Review of the Institute for Quantum Computing

⁴² Agreement on the Administration of Agency Grants and Awards by Research Institutions.

http://www.science.gc.ca/Research_Funding_Collaboration/Policies_and_Guidelines/Institutional_Agreement-WS56B87BE5-1_En.htm

4.0 CONCLUSIONS

4.1 Relevance

- There is a continued need to increase Canada's research and innovation capacity as a means to provide social and economic benefits to Canadian society. IQC responds to this need through a multi-disciplinary approach that spans the innovation spectrum and focuses on quantum information and quantum computing sciences, a technology area with widespread potential benefits. IQC is uniquely positioned, within Canada and internationally, to contribute to the development of quantum sciences and its related technologies.
- Support for IQC is consistent with federal government priorities related to science and technology as set out in the 2007 *S&T Strategy* and subsequent Federal Budgets. The objectives and activities of IQC are also in line with Industry Canada's Strategic Outcome: Advancements in Science and Technology, Knowledge, and Innovation Strengthen the Canadian Economy.
- Support for IQC is consistent with federal roles and responsibilities to encourage the development of science and technology and aligns with Industry Canada's mandate. In addition, the delivery of support to IQC through Industry Canada appears to be logical and complimentary with other funding initiatives.

4.2 Performance

- Overall, IQC is achieving the majority of its immediate outcomes: IQC researchers have access to some of the best quantum information sciences facilities and equipment in the world; and IQC is attracting and developing top-ranked researchers and students. With respect to increased awareness and knowledge, IQC has attracted interest among a variety of audiences.
- IQC's research has increased in intensity and excellence as demonstrated by improved collaboration networks, increased publication and citation rates, as well as its reputation in the scientific community. IQC is also on track to being recognized as a leader in quantum information.
- IQC's current delivery structure has demonstrated efficiency and economy by leveraging additional resources, minimizing transaction costs and using existing University of Waterloo management processes.

Overall, the evaluation did not find any major issues with the grant to IQC and as a result makes no recommendations.

Institute for Quantum Computing Scientific Advisory Committee

December, 2016

Report to Director

The IQC Scientific Advisory Committee (SAC) met in Waterloo on December 6-7, 2016. In attendance were Christopher Monroe (Chair), Anthony Leggett, and Harry Buhrman. Anton Zeilinger and Umesh Vazirani joined parts of the meeting remotely.

Following an overview report from acting IQC Director Kevin Resch, we heard research presentations from new IQC faculty members and reports on the graduate (John Watrous) and postdoctoral (Jonathan Baugh) programs, including separate meetings with select graduate students and postdocs. We concluded with the annual student-led poster session, while also meeting with David Cory concerning the new large CFREF award related to IQC. This report summarizes our findings and recommendations.

Director Kevin Resch is skilfully guiding the IQC, and as an IQC veteran, he is proving to be an excellent leader in the operations and administration of IQC as the Laflamme era comes to a close. Overall, the IQC continues to be a shining light in the field of Quantum Information Science (QIS), and is rightfully seen to be ahead of its time as the rest of the world doubles down on their investments (both public and private) in Quantum Science and Technology. The explosion of private investments in quantum technology, and the announcements of new programs in other countries including the United States, European Union, China, and Australia, bring even more visibility to the IQC.

In the next several years, the IQC is ideally positioned to lead the world forward in both academic and industrial settings. The IQC, taken along with the Perimeter Institute, and the continued vital support from the University of Waterloo, keep the Waterloo Valley at the forefront of this coming quantum revolution. Overall, the IQC is a model of how to effectively manage a university/private/government partnership in this frontier area of science and technology.

With the leading posture of IQC comes many challenges of growth and the maintenance of their leadership. We list below several items that emerged in our assessment of the IQC in general, with the first two having overriding importance:

1. The search for a new IQC Director to succeed IQC Founding Director Raymond Laflamme. The search committee has been charged, and the search has been underway for some time. It will be very difficult to fill Laflamme's shoes, but we encourage the committee to consult with SAC and the growing Quantum Sciences community at large to identify the right candidate, and obviously make heroic efforts to secure the deal.
2. The IQC has seen impressive growth over the past several years, and while this is an excellent indicator of IQC health, it also presents challenges in the coming years,

especially for the new Director. The number of IQC Faculty has grown to 28, with top notch recent hires, and the number will grow further to 40 faculty in the future. The field of QIS continues to broaden in scope and disciplines, and the IQC is ably spreading its wings in these various directions. However, it may be preferable for IQC to adopt a more distributed leadership structure in the future, perhaps with an executive committee led by the Director, all charged with steering the IQC forward while representing all IQC members. This could lead to a more open strategy in future growth areas. For instance, it was felt that the general growth at IQC was not reflected in Mathematics and theoretical computer science. Moreover, the reasoning behind the moratorium from hiring engineers was not clear.

3. IQC is leading one of the inaugural Canada First Research Excellence Fund (CFREF) initiatives, at a level of \$140M over the next years, with \$75M from CFREF. This is an enormous accolade for IQC, and with the able leadership of David Cory this opportunity will propel IQC forward. This is also an opportunity for IQC to take some risks in speculative directions of QIS, this would exercise a competitive advantage of IQC – they can take risks where others cannot.
4. An ongoing challenge at IQC is the separation between QNC and RAC buildings and the co-mingling of students and staff between these locations. The Wednesday seminar for students/postdocs is thus a very important venue. However, this seminar series suffers from poor attendance and parochial talks. We would strongly recommend that this seminar be offered at 12noon with free lunch (and if there are any university restrictions to this policy that an exception be granted). This will result in better attendance and better talks, but most importantly it would likely become the main event for IQC researchers to enjoy the company of their colleagues in different areas.
5. Many researchers in IQC noted issues with the university machine shop. There seem to be lengthy backlogs for work related to the IQC, with no good reason. We would recommend the university take innovative approaches to ensuring smooth operation of the shops. Examples could be the expanded training of students to perform shop work themselves, and the outsourcing of machining jobs when the shops become overloaded.



Centre for Bioengineering and Biotechnology (CBB)

University of Waterloo
East Campus 4, Room 2001
cbb.uwaterloo.ca

Transition to a University Centre

April 2017

Prepared for: Secretariat, Senate Graduate and Research Council
Prepared by: Dr. Catherine Burns, Director, CBB



Introduction and Vision

In November, 2011 the Senate of the University of Waterloo approved establishment of the Centre for Bioengineering and Biotechnology (CBB), an initiative jointly supported by the Faculties of Engineering and Science to encourage interdisciplinary cross-cutting research in the areas of biotechnology and bioengineering. CBB has a Board of Directors and an Industrial Advisory Board. CBB reports to the Deans of Engineering and Science. The CBB Director is Dr. Catherine Burns, and the Associate Directors are Dr. Karim Karim (Engineering) and Dr. Trevor Charles (Science).

The vision behind establishing CBB was to expand the base of research in biomedical engineering, biotechnology and related life science areas. These areas are interdisciplinary, extending beyond the footprint of any one department or Faculty. For this reason, the structure of a centre was needed to provide a point of contact to promote Waterloo's research, and to build an academic community for Waterloo researchers in an area where multi-disciplinary approaches are required for success.

Why a University Centre

In 2011 CBB began operations with 86 faculty members, largely from the Faculties of Engineering and Science. As of 2017, CBB has grown to 135 faculty members from 5 of the 6 Faculties at the University of Waterloo and over 120 student members.

To date, CBB has had a seminal impact on research success at the University of Waterloo and aspires to play an even stronger role as a 'University Center' in the future. This will entail:

1. **Increasing research funding:** Biotechnology, bioengineering and biomedical engineering research at Waterloo collectively account for approximately \$49 million in research funding (over a four year period 2011-2015). CBB researchers have indicated that approximately 9.8%, or \$4.8 million, of this is attributable to the existence of the Centre. Factors such as the aging demographic and increasing health care costs as a proportion of government spending suggest that these areas of research will continue to increase in the future, and the University of Waterloo should be positioned to take advantage of this opportunity.
2. **Deepening relationships with healthcare organizations:** CBB has worked closely with the Office of Research to develop deep relationships with the hospitals in the local area, most notably Grand River Hospital. This has resulted in a sustainable pattern of interactions, available research space at the hospitals, and many new research relationships for researchers at the University of Waterloo. The MOA between Waterloo and GRH will be renewed this year, and CBB has played a strong role in building that relationship for the University of Waterloo.
3. **Strengthening international relationships:** CBB is developing an international presence. CBB has provided support for a number of Waterloo delegations to Europe, Asia and the United States to develop research partnerships with Korea, China, India, The Netherlands, Belgium, France, Germany and California. CBB has begun an international partnership strategy with two academic institutions, the University of Twente in the Netherlands and the Sorbonne Universités in France. Both of these partnerships are funded by International Research Partnership Grants (IRPG) from the University of Waterloo, seed funding from CBB, and

substantial financial commitments from the partner universities. The Sorbonne relationship has resulted in a 130,000 euro collaboration grant and is a key factor in an NSERC CREATE grant being led by CBB. The Twente relationship has resulted in two grant proposals with different Waterloo teams, several joint publications and an international conference hosted by Waterloo researchers in 2018.

4. **Supporting student talent:** CBB has played a seminal role in attracting talent to the Biomedical Engineering program that was started in 2014. CBB has supported several student groups including Velocity, Engineers in Medicine, Waterloo iGEM and uwDNA, enabling them to deepen their research and entrepreneurial experience and acquire relevant skills.
5. **Enhancing industry relations:** CBB has developed a strong network of industry connections, having provided opportunities for researchers to meet with 162 companies within the last four years. It is noteworthy that 77% of CBB researchers have taken part in at least one of these industry interactions.
6. **Enhancing academic partnerships:** CBB has initiated a partnership with Conestoga College in food science and technology that involves several researchers. Initiatives are currently underway to develop new partnerships in environment, waste water treatment and remediation, and precision agriculture.

Rationale underlying the request that CBB be granted 'University Centre' status:

1. CBB has members from all Faculties at UW in keeping with the fact that its research is inherently interdisciplinary. Biotechnology, bioengineering and biomedical engineering problems require diverse perspectives to develop transformative solutions. CBB has advocated strongly for the diversity of perspectives needed for this research, and status as a University Centre would reinforce this broad multi-Faculty perspective.
2. CBB has an emerging international reputation, having successfully established international research collaborations with strong partners that have resulted in significant joint funding. This success demonstrates that the activities of CBB serve to enhance the international reputation of the University of Waterloo.
3. CBB has established strong and accountable governance structures, in keeping with the requirements of Policy 44. CBB has the maturity in its processes to operate as a 'University Centre'.
4. CBB has a solid financial plan for using the increased funding of a University Centre effectively; as emphasized below highlighting the top five priorities.

In 2016 CBB undertook a planning exercise to map strategy for the next five years. Input was sought from CBB members, the CBB advisory board and the CBB board of directors. From this process, five clear priorities emerged. CBB should focus on:

1. **More and deeper international partnerships:** CBB is developing an international presence but has the potential to develop stronger and more effective international partnerships. As one example, CBB was recently named as a co-recipient of a 130,000 euro award to the Sorbonne Universities to promote student and researcher exchange. This will enable 20 students (10 from each university) to participate in exchanges. With

additional funding, CBB could target and develop other strategic international relationships.

2. **Stronger government and hospital relationships:** Funding in health related areas is often tied to government priorities and programs. CBB and the University of Waterloo must develop a stronger, more influential voice in the Canadian health care technology funding landscape. CBB has developed a good working relationship with GRH, but could expand its efforts to the other regional hospitals as well as develop strategic relationships with hospitals and institutions outside of the region. Currently this relationship is managed by CBB's Director and a part-time staff member who is funded from a CBB research project and is willing to volunteer some time for this. Additional funding would be used to hire a person with strong experience in these areas to develop Waterloo's position further.
3. **Research support and industrial partnerships:** CBB must continue to deepen industrial partnerships capable of supporting partnered research for researchers at the University of Waterloo, but must improve its ability to convert these relationships to funded projects. CBB works well with the Office of Research Managers for Corporate Partnerships. However, a staff member who could follow up on these relationships, successfully deepen them into research projects, and play a strong role in attracting research funding would help to convert connections into funded relationships. Currently, CBB is very good at building the initial connection, but does not have the resources to deepen the connections, or build the funding applications. While our researchers certainly contribute and currently do most of the grant writing, the research funding programs CBB wants to pursue (NSERC CREATE, CIHR, Strategic Networks, NCE) require higher levels of coordination, deeper relationships, and more advanced funding acquisition skills. Adding expertise to the CBB team with a strong track record of securing funding will improve our success with these programs.
4. **A seed funding program:** Waterloo research is still under-funded by agencies such as CIHR and this can be a blockade for early researchers or new teams. CBB should consider a peer grant review process and a seed grant funding program to help advance research proposal development and improve the odds of success in programs such as CIHR, CHRP, and government and foundation funded research.
5. **Stronger communications:** A communications specialist would help CBB researchers to communicate their successes and enhance Waterloo's reputation as a stronghold for research in biotechnology and bioengineering. This role could be part-time or shared with another unit at the University of Waterloo.

CBB has had a very successful first five years and brings significant value to the University of Waterloo. The additional funding and status inherent in being named a 'University Center' would enable CBB to expand activities in targeted areas and increase its research impact.

Supplementary Materials

Please find included in this application the relevant CBB documents.

- A. Centre renewal to Senate Grad and Research Council (September 2016)
- B. Constitution (draft)
- C. Governing Boards:
 - 1. Board of Directors
 - 2. Advisory Board
 - 3. Operations Committee
- D. Letters of Support
 - 1. Dean of Engineering
 - 2. Dean of Science
 - 3. Dean of Applied Health Sciences
 - 4. Dean of Math
 - 5. Grand River Hospital – Dr. Tina Mah, VP Planning, Performance Management and Research
 - 6. Grand River Hospital – Dr. Doug Dittmer, Medical Director, Rehab, Freeport Campus



Centre for Bioengineering and Biotechnology (CBB)

University of Waterloo

East Campus 4, Room 2001

cbb.uwaterloo.ca

5 Year Renewal Report

November 2011 – 2016

Prepared: September 2016



UNIVERSITY OF
WATERLOO

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Executive Summary

In November, 2011 the Centre for Bioengineering and Biotechnology (CBB) was approved as a Centre by the Senate of the University of Waterloo. CBB was established and supported jointly by the Faculties of Engineering and Science to encourage trans-disciplinary cross-cutting research and relationships in the areas of biotechnology and bioengineering. CBB has a Board of Directors and an Industrial Advisory Board. CBB reports to the Deans of Engineering and Science. The CBB Director is Dr. Catherine Burns and the Associate Directors are Dr. Karim Karim (Engineering) and Dr. Trevor Charles (Science).

The vision behind establishing CBB was to expand the base of research in biomedical engineering, biotechnology and related life science areas. For this reason, the structure of a centre was needed to provide a point of contact to promote Waterloo's research, and to build an academic community for Waterloo researchers in an area where multi-disciplinary approaches are required for success.

In 2011 CBB began operations with 86 faculty members, largely from the Faculties of Engineering and Science. By 2016, CBB has grown to 150 faculty members, including members from 4 of 6 Faculties at the University of Waterloo and over 100 student members.

This four-year report describes the many achievements of CBB, key impacts on the success of the University of Waterloo and looks to continue to play a strong role in the future. In particular:

1. **Increased research funding:** Biotechnology, bioengineering and biomedical engineering research at Waterloo represent a research portfolio of approximately \$49 million in research funding. CBB researchers have indicated that the presence of the Centre has increased this portfolio by approximately 9.8%, or \$4.8 million. Factors such as the aging demographic, and increasing health care costs as a proportion of government spending, suggests that these areas of research will continue to increase in the future and the University of Waterloo should play a strong role in these areas.
2. **Deeper relationships with healthcare organizations:** CBB has worked closely with the Office of Research to develop deep relationships with the hospitals in the local area, most notably Grand River Hospital. This has resulted in a sustainable pattern of interactions, available research space at the hospitals, and many new research relationships beginning for researchers at the University of Waterloo.
3. **Stronger international relationships:** CBB is developing an international presence. CBB has provided support for a number of Waterloo delegations to Europe, Asia and the United States to develop research partnerships with, Korea, China, India, The Netherlands, Belgium, France, Germany and California. CBB has begun an international partnership strategy with two academic institutions, the University of Twente in the Netherlands and the Sorbonne Universités in France. Both of these partnerships are funded by International Research Partnership Grants (IRPG) from the University of Waterloo, seed funding from CBB, and substantial financial commitments from the partner universities.
4. **Support for student talent:** CBB has supported and has been a key factor in attracting talent to the Biomedical Engineering program that was started in 2014. CBB has supported several student groups, such as Velocity, Engineers in Medicine, Waterloo iGEM and uwDNA, to encourage and develop their research and entrepreneurial experience and skills.

5. **Enhanced industry relations:** CBB has developed a strong network of industry connections and in four years, provided opportunities for our researchers to meet with 162 companies. 77% of our researchers have taken part in at least one of these industry interactions.
6. **More academic partnerships:** CBB has initiated and developed a relationship with Conestoga College in food science and technology that involves several researchers. Initiatives are currently underway to develop new partnerships in environment, waste water treatment and remediation, and precision agriculture.

In 2016 CBB initiated a process to ask our members to help plan the next five years of CBB at the University of Waterloo. Our advisory board and board of directors were also asked to reflect on where CBB should go in the next five years and how to get there. From this process, five clear priorities emerged. CBB should focus on:

1. **More international partnerships:** CBB is developing an international presence but has the potential to develop further and advance Waterloo research in biotechnology and bioengineering internationally.
2. **Stronger government relationships:** Funding in health related areas are often tied to government priorities and programs. CBB and the University of Waterloo must develop a stronger and more influential voice in the Canadian health care technology funding landscape.
3. **Research support:** CBB must continue to deepen industrial partnerships capable of supporting partnered research for researchers at the University of Waterloo.
4. **A seed funding program:** CBB should consider a peer grant review process, and seed grant funding program to help advance research proposal development and improve the odds of success in programs such as CIHR, CHRP, and government and foundation funded research.
5. **Stronger communications:** A dedicated communications specialist would help CBB researchers to communicate their successes and build Waterloo presence as stronghold for research in biotechnology and bioengineering.

This report summarizes CBB's activities and impact over the last four years, with a rationale for renewing CBB as a centre at the University of Waterloo. CBB has had a very successful first four years and brings significant value to the University of Waterloo. A plan is presented to expand CBB's activities in targeted areas to increase its research impact.

Background, Mission and Objectives

In November, 2011 the Centre for Bioengineering and Biotechnology (CBB) was approved as a Centre by the Senate of the University of Waterloo. CBB was established and supported jointly by the faculties of engineering and science to encourage trans-disciplinary cross-cutting research and relationships in the areas of biotechnology, and bioengineering. The intention behind establishing CBB was to expand the base of research in biomedical engineering, biotechnology and related life science areas. For this reason, the structure of a Centre was needed to provide a point of contact to promote Waterloo's research, and to build an academic community for Waterloo researchers in an area where multi-disciplinary approaches are required for success.

In 2011 CBB began operations with 86 members, largely from the faculties of engineering and science. In 2016 CBB has grown to 150 members, including members from 4 of 6 faculties at the University of Waterloo. In Fall 2014, Waterloo launched a new program in biomedical engineering that has hired 2 faculty members (2015) and intends to hire several more. CBB will provide guidance, assistance and coordination to meet their research needs.

CBB researchers span a very wide range of research interests and this breadth is one of the strengths of CBB as it allows for rich multi-disciplinary teams with a range of diverse talents and perspectives. Over the past four years, however, certain clusters of research strength have emerged from CBB researchers. These areas are:

- Biomedical (75 researchers)
- Environmental (40 researchers)
- Bioprocessing and Food Technology (16 researchers)
- Healthcare Systems (30 researchers)
- Imaging (38 researchers)
- Wearable Devices and Healthcare Devices (41 researchers)

Note: Some researchers may be in more than one research group.

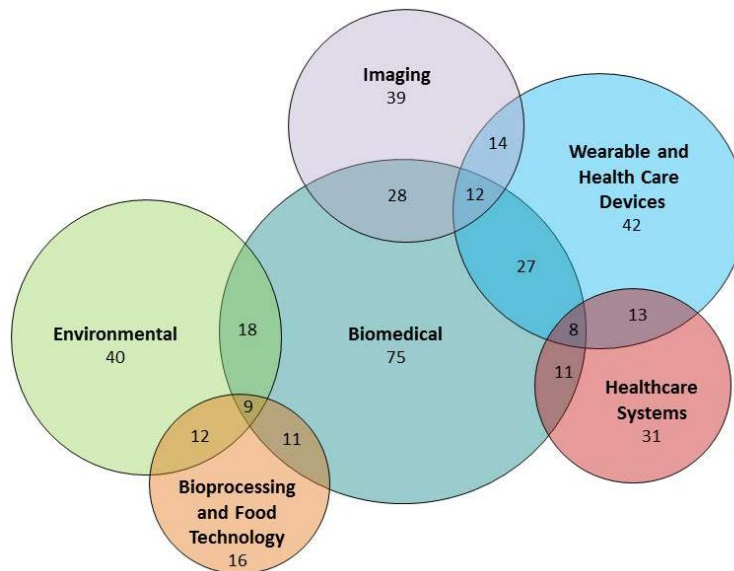


Figure 1: Overlap of membership in various research groups (significant connections highlighted)
Centre for Bioengineering and Biotechnology

Mission Statement

At its founding in 2011, CBB established the following mission:

“The Centre for Bioengineering and Biotechnology will facilitate strategic multidisciplinary engineering research that applies technology to improve human health, the environment, and industry.” (Proposal to Establish the Centre for Bioengineering and Biotechnology at the University of Waterloo, October 21, 2011)

This statement still reflects the mission of CBB in 2016.

Management Plan and Objectives

CBB reports to the Deans of Engineering and Science and is managed by a Director and two Associate Directors, one from the Faculty of Engineering and one from the Faculty of Science. CBB reports to a Board of Directors which is the governing body for CBB. Daily activities of CBB are managed through an Operations Committee of CBB members. Further details of the governance structure of CBB are presented later in this document in the section Governance and Administration. The policies and principles by which CBB is governed are stated in CBB’s Constitution, included in the Appendix.

In year one, with consultation from the associate directors and the operations committee, CBB established a business plan). This plan defines the core goals of CBB, and outlines the metrics used to measure the Centre’s progress towards those goals. Each year, CBB conducts a yearly review, measuring its success against the goals in the CBB Business Plan. The Business Plan is a living document and is reviewed each year and adjusted as necessary to ensure the goals of the Centre are still appropriate, and the metrics are measurable and relevant. This cycle of measurable goals, progress, and reflection is core to the successful management of the Centre.

The structure of this five year report follows the tenets of the CBB Business Plan and reports our success along our metrics. Given the time to prepare this report, metrics are reported in most cases using data available up to April 30, 2016. Unlike our yearly reports, however, our intent here is to present an assessment of the Centre’s success over the past 4-5 years, with a plan for the next five years of the Centre.

*These documents are available on request but not included here, as much of the information in this report is a summary of those documents.

The CBB has five core objectives as a Centre:

1. Show Tangible Value

CBB receives support from the university, currently through the offices of the Deans of Engineering and Science. CBB as an organization is appreciative of this commitment and strives to provide the greatest value possible for this investment.

2. Attract New Research Funding

As a Centre, CBB provides a trans-disciplinary function which should increase research activity in the areas the Centre covers. Research funding is a reasonable measure of research activity.

3. Improve Academic Environment

CBB works to support academic collaboration and community. In multi-disciplinary fields, isolated academic work is unlikely to be successful. A healthy academic community builds a good foundation for future work and attracts and retains top talent.

4. Achieve Research Recognition

CBB strives to support recognition of the excellent work being done at Waterloo in these areas. We advertise and advocate for researchers with the goal of being recognized as one of the best places to come for research in the bioengineering, biomedical engineering and biotechnology areas.

5. Increase Partnerships

The foundation of future research lies in building strong relationships, sometimes years ahead of the research that will emerge. For this reason, CBB reaches out to begin the formation of those relationships most likely to lead to exciting research in the future.

Achievements and Results

The achievements of CBB are discussed in direct reference to our track record in meeting our stated objectives from our business plan.

Show Tangible Value

CBB generates value for the University of Waterloo by attracting overhead-generating research projects, providing project management services for larger projects, and providing support to increase researcher success in granting programs, thereby improving the overall funding situation for faculty members in CBB.

Overhead generation

In four years, CBB has generated \$225,369 in overhead to the University of Waterloo from CBB managed projects. CBB has managed a range of grants from corporate contracts, to industry leveraged research.

Project management services

In the case of the Lockheed Martin project, the company approached CBB with a vision of what they wanted to accomplish. CBB recruited the appropriate research team and facilitated the interaction by managing reporting to the company, visits of the company representatives, visits of the research team to other locations, and support to lead the research team through leveraged funding. For these services, CBB was able to charge a management fee to the contract, which was used to pay some expenses for administrative assistant time and travel. This approach of Centre managed projects has been very successful in this case, but is likely most appropriate for larger companies with larger projects, where the Centre can help to form and manage the research team. However, this kind of coordination is a unique value that can be offered by the Centre in these situations.

CBB began initially with a plan of attracting corporate memberships to the Centre, in exchange for a range of Centre services. While a few companies have pursued this route and purchased memberships with CBB, the overall experience with this model has shown it not to be successful. For smaller

companies, a membership fee can be prohibitive and actually discourage interaction with the Centre. For larger companies, it is more effective that their funds be directed straight to researchers who can match those funds for their projects. It is our plan that the CBB membership program be discontinued in terms of its fee based structure. However, companies will still be encouraged to affiliate with CBB and be recognized for their contributions to the research activities of our members.

Support for grant applications

CBB tracks its interactions with researchers and companies, noting when the Centre has directly contributed to proposals. In supporting grant applications, CBB regularly works with researchers to build larger research teams for infrastructure and equipment grants, where increased utilization can be a factor in the success of the grant. CBB will also draw on its network of companies to organize letters of support for grant proposals. CBB regularly hosts industry networking events where companies meet researchers. These events always include information of relevant ways to fund research, and CBB follows up with the most promising synergies to try to encourage research support. CBB can provide non-technical grant review and editing services.

Attract New Research Funding

In four years, CBB has contributed directly to 75 research proposals, of which 32% were successfully funded. The ways that CBB contributes to these proposals is by connecting researchers with companies, organizing letters of support, improving the diversity of research teams looking for large group grants, and providing grant writing or editing advice. These numbers were generated directly from our tracked interactions.

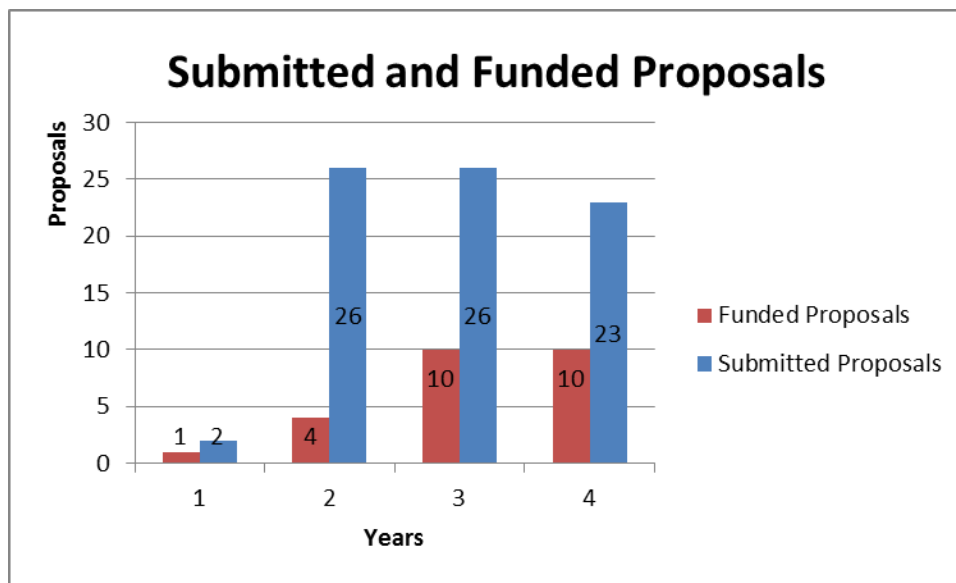


Figure 2: Submitted and Funded Proposals over a four year period (2011-2015)

Funding analysis, total and influenced

In support of our renewal and planning process, in 2016 CBB conducted a wider analysis of our funding impact. The intent of this analysis was to understand the funding landscape in the biomedical engineering, bioengineering and biotechnology spaces more clearly, and to attempt to understand the perceived influence of the Centre on this landscape. The approach for this analysis was developed in

consultation with the Associate Deans (Research) for Engineering and Science, and John Thompson, Associate Vice President, University Research.

For this analysis, funding data for each researcher in CBB in the faculties of engineering and science were collected and isolated into an individual spreadsheet by their Associate Dean of Research's office. The ADR office then sent these files to the individual researchers. The researchers were asked, if comfortable, to then release their data to the Centre by returning the file. This was taken as consent for the Centre to use the researcher's data. When returning the funding data to the Centre, the researcher was asked to indicate, for each funding source, whether the source was related to the general area of biotechnology or bioengineering, or biomedical engineering, and if they felt the Centre had "influenced" their success on the grant. Influence was defined as providing direct support or having presented an indirect influence, for example, having held a networking activity where they found a collaborator for the research. 44% of our members responded.

Our researchers indicated that about \$49 million of their funding was in areas related to biotechnology and bioengineering and that 9.8% of this funding (\$4.8 million) could be considered as directly influenced by the activities of CBB.

University of Waterloo researchers in CBB in have been increasing their funded research activity consistently over the last 8 years, and this pattern has continued since CBB was founded in 2011. This shows that these areas of research are active and growing and CBB continues to be needed to support these researchers.

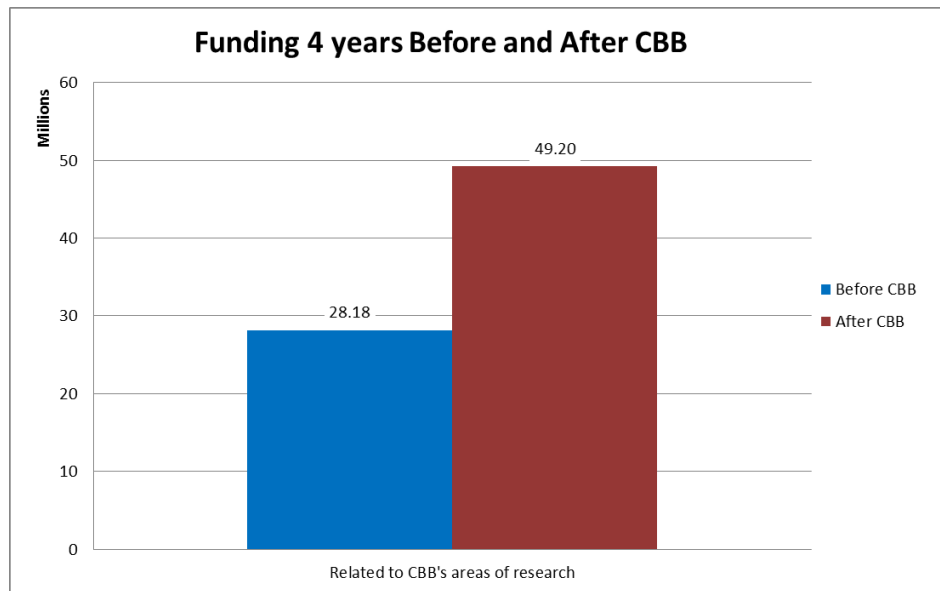


Figure 3: Funding received by researchers four years before and after CBB (2011-2015)

Industry networking activities

A core activity of CBB has been promoting relationships between Centre researchers and relevant companies. Over the past four years, CBB has engaged in 58 industry interactions that have involved

162 companies and 77% of our researchers (115/150¹). Forty of these interactions have been interactions directly with a company and one or two researchers, and 16 of these interactions have been industry networking events.

Industry networking events have two key formats. Large industry networking events involve multiple companies and researchers at the same event. These events often have short introductions of the various parties, combined with some networking time for companies and researchers to meet up. CBB has run these large events in collaboration with the Office of Research. These events, while promoted by CBB, are often attended by other researchers from outside CBB as well. The second key format used by CBB is the industry focus day. In this case, CBB invites a company to come to Waterloo to meet with researchers. The company's needs and objectives are discussed before the meeting, and researchers invited who are most likely to fit with those needs. The company usually starts the day with a presentation of their context and needs, and researchers then give response presentations of their research and how they could fit.

Improve Academic Environment

CBB works to improve the academic environment of researchers in the areas of biotechnology and bioengineering by hosting seminars and networking forums. CBB has hosted 17 research seminars, five distinguished lectures, five professional development workshops and two conferences. (See Appendix E for a full listing). We have surveyed our membership twice to ensure we are responding to our members. The first survey in November 2014 examined the usefulness of our activities to our members. 50% of members thought CBB's activities were important to them personally (90% importance to the University), including a high interest in connecting with industry or business meetings that focused in areas of healthcare, drugs, and food research. The second survey in June 2016 (see Appendix G) asked our members for input into our five year plan. Members identified that CBB should continue to focus on providing company networking days for faculty, followed by building business relationships with the international groups, and government sectors respectively. The group also supported a CBB pilot/seed funding program, and improved communications and updates on business development activities. Some particular activities that CBB supports on an ongoing basis are:

Academic Groups

The Biomedical Discussion Group

The Biomedical Discussion Group had started before the founding of CBB but moved under CBB management once CBB was available. This is a group of 124 members comprised of faculty and students, with common research interests in biomedical science and engineering. The biomedical discussion group meets roughly once a month, September to April. CBB arranges the meeting, advertises the talk, and provides small amounts of support for the speaker on the scale of one night hotel stay, or transportation, as well as coffee and cookies for the meeting.

¹ Actual percentage may be higher, as not all event attendance has been tracked, and membership count has fluctuated over the past four years.

The Wearables and Fall Prevention Group

The wearables and fall prevention group is comprised of 25 members from 8 departments on campus and Grand River Hospital (GRH) representatives developed as a follow on from UW and GRH “Meet and Greet” evenings which were organized by the Office of Research.

Student Groups and Teams

CBB regularly supports the student teams of Engineers in Medicine, iGEM, and uwDNA and has at times supported the Health Informatics Student Club and the UW Pre-Vet Club. Support for student teams has included funding for team meetings and activities, arrangement of meeting facilities, contacting and coordinating guest speakers, and advertising team events and successes.

CBB was supportive of Velocity Science in its pre-founding days and works closely to include Velocity Science students in its events. CBB has also promoted Velocity Science through its media opportunities and regularly makes its partners aware of Velocity Science.

Transdisciplinary Interactions

CBB has been particularly pro-active and effective in developing cross-faculty and trans-disciplinary interactions that would not have occurred without the existence of a broad based Centre in this area. Bioengineering, biotechnology and biomedical engineering are rich transdisciplinary fields of study that extend well beyond the boundaries of a single department or faculty. It is not uncommon for a successful approach in these areas to require solid life science expertise, engineering to develop the application, psychology and public health expertise to manage the end user and policy level adoption. Some examples of interactions in this area are:

Design of an Active Compression Cardiac Device: This project was supported by Lockheed Martin with over \$1 million in funding over four years. The research team was built by CBB and included one researcher from Applied Health Studies, one from Electrical Engineering and two from Mechanical Engineering. The research has continued with large government grants (OCE VIP II and an NSERC CRD) and a spin-out company has been launched with the assistance of Communitech and UW Velocity incubators.

Modeling of Social Behaviors creating “Superbugs” and Microbial Resistance: This research project is managed by CBB and brings together researchers from Mechanical and Mechatronics Engineering, Pharmacy, Systems Design Engineering and the School for Public Health and Health Systems. This research was developed from an International Research Partnership grant with the University of Twente in the Netherlands and funding is being sought from the Trans Atlantic Partnership for Digging into Data.

Advanced Manufacturing for Food Processing: This research project managed by CBB brings together researchers in Chemical Engineering, Biology and Conestoga College’s Food Processing Institute. An NSERC CCI-IE has been submitted.

Wearable Technologies and Fall Prevention: This group includes faculty members from Physics and Astronomy, Chemistry, Kinesiology, Mechanical and Mechatronics Engineering, Electrical and Computer Engineering, Computer Science, and Systems Design Engineering.

Achieve Research Recognition

In the last four years, 46 CBB members have been mentioned in the media and the Centre has been mentioned 7 times. In analytics to the CBB website, 58% of our hits are from Canada and 42% are international. CBB has received 106 requests for information on researchers from internal sources and 62 external requests.

Increase Partnerships

In the last four years, CBB has fostered 162 company connections for our researchers. CBB has also worked to improve the relationship between our researchers and the local hospitals.

Company Partnerships

CBB has fostered 162 company interactions and works to advance these into deeper partnerships. Some examples of these deeper partnerships are:

Christie Medical Holdings: Participates on CBB's advisory board, has sponsored multiple Mitacs projects, and is hosting a UW spin-off company KA Imaging, at their location.

Sanofi Pasteur: Participates on CBB's advisory board, has sponsored NSERC Engage and Collaborative Research and Development projects.

UW-Hospital Partnerships

After the Office of Research held meet and greet activities between Waterloo and Grand River hospital personnel, CBB took the lead on following up by establishing a research group in Wearables and Fall Prevention (described in the previous section) and initiated a lecture series at the Freeport site of Grand River Hospital called "Pizza with the Profs". In the spring of 2016 CBB hosted a one-day conference called MEDTECH to bring together researchers, government, the health care community and technology companies. CBB has been working with the hospitals to establish space on site for researchers. Currently Grand River has research space at both their main campus and Freeport campus for researchers. CBB is working with Grand River Hospital to locate funding to renovate a larger space at the Freeport campus to develop a broader research base at the hospital.

Conestoga College

CBB has strengthened partnerships with Conestoga College in the area of food technology, partnering with them on two proposals to date. In June 2016, Conestoga submitted an NSERC LOI for the IFTP/CC bringing together members from Chemical Engineering and Mechanical and Mechatronics Engineering.

International Partnerships

CBB has provided support for a number of UW delegations to Europe, Asia and the United States to develop research partnerships with, Korea, China, India, The Netherlands, Belgium, France, Germany and California. CBB has begun an international partnership strategy with two academic institutions, the University of Twente in the Netherlands and the Sorbonne Universités in France. Both of these partnerships are funded by International Research Partnership Grants (IRPG) from the University of Waterloo, seed funding from CBB, and substantial financial commitments from the partner universities.

University of Twente (Netherlands) is a globally recognized Centre for e-health excellence. The partnership with the University of Twente has resulted in:

- Two students from Twente hosted by Waterloo researchers (before the IRPG was awarded).
- Two students from Waterloo (School of Public Health and Health Systems) are attending the CuriousU workshop at Twente in Summer 2016.
- A visit from Waterloo researchers to Twente in June 2016.
- A visit from Twente researchers to Waterloo in May 2015, and November 2016.
- Proposal to Digging Into Data: *Bits, Bytes and Superbugs: Understanding and modeling social behaviours in high risk contexts* (under review).
- Proposal to Weston Seeding Food Innovation: *Eating for a better world: Designing for behavioural change in consumption habits* (under review).
- Horizon 2020: *Personalized coaching for well being* (in preparation).

Sorbonne Universités (France) has an internationally renowned Institute for Health Engineering. The partnership with Sorbonne Universities has begun with:

- A visit from the Sorbonne Universités to Waterloo in May 2016.
- A visit by Waterloo Researchers to Sorbonne in November 2016.
- Discussions are in progress on joint proposals and student exchange.

Outreach

CBB continually tries to reach out to new faculty who could benefit from being part of CBB. As a point of contact in the biotechnology, bioengineering and biomedical engineering areas, CBB often fields first requests from high school and university students interested in undergraduate or graduate programs, and requests for Postdoc supervisor recommendations. CBB has participated in WE Innovate and Explorations events that were hosted by the Faculty of Engineering. Working together with other institutes and departments on campus has allowed the centre to extend its reach, for example CBB co-organized the Biophysical Society of Canada Conference (June 2015) with WIN, and the Greenhouse Gases Academic-Industry networking forum (October 2016) with WISE, IC3 and the Office of Research. CBB has worked with Co-operative Education and Career Services on one joint trip to a bioengineering conference and regularly promotes co-op education opportunities to our corporate members, who often hire students. CBB is also working to develop deeper connections locally within Communitech and the Waterloo Regions chapter for Hacking Health Peer2Peer networking group.

[Assessment of results to date](#)

CBB has had an active and productive four years. The importance of the areas of biotechnology and bioengineering to the University of Waterloo has increased in the past four years. CBB has made particularly strong contributions in connecting with industry, and connecting with the local hospitals. Both of these activities have built a solid foundation for a strong future for the University of Waterloo in these research areas.

CBB continues to actively reach out to new faculty in the departments that are already quite active in CBB but has also been reaching out to other faculties.

Five Year Plan

A Collaborative Planning Process

The CBB Five Year Plan was developed through a staged process that invited feedback from all faculty members in the Centre. The following steps were followed in developing the plan.

1. Initial survey (May 2016)

An initial survey was distributed to the operations committee. This survey listed all of the activities that CBB currently facilitates, as well as new activities that had been mentioned by members, or were provided by other Centres at Waterloo. The operations committee members were asked to indicate which activities CBB should do “more”, “the same”, or “less”. Finally the survey asked the committee members to comparatively rank the activities. Survey results were discussed at a meeting of the Operations committee on May 30, 2016. The objective of the meeting was to provide elaboration on the responses and to determine the next steps. The committee decided to issue a smaller survey to CBB faculty members, restricted to the highest priority activities, and asking members to confirm “yes/no” as to their interest in the activity. A comparative ranking question similar to the first survey was included.

The results from the initial survey indicated that, from the operations committee perspective, academic events like seminars were currently occurring at a reasonable level, large multi-company networking events may be less valuable than more focused interactions, and that CBB should push to facilitate larger team grants while maintaining support for the smaller more individual grants. Obtaining financial support from companies is very important and needs to increase. If CBB had a larger a budget, a seed fund program where funds went to the researcher would be useful. Funds to scholarships or travel grants were not seen as useful. International activities, government activities, and communications should increase. The top three priorities were ranked as government activities, international activities, and networking events.

2. All member survey (June 2016)

A survey to all faculty members of CBB was conducted in the first half of June with 36% of the members participating. Operations Committee members would not have participated. The results of the survey indicated some key priorities for CBB to achieve in the next five years (full results are available in the appendix). While all the priorities proposed by the operations committee were supported by at least 60% of the membership, the top three priorities were

1. Company focus days (100%)
2. International partnerships (94.4%)
3. Government relations (88.9%)

A seed funding program was the fourth supported priority at 83.3%, which matched the support level for improved communications. Grant preparation activities were supported at 64-67%, suggesting that a pilot program in this might be a good idea, but the activities should possibly be reviewed to see how well they were working.

In the comparative rankings, the most often ranked number one activities were networking events (19), research support (8), and international activities (8). When looking at what activities were most often

ranked in the top three, the results were networking events (29), research support (21), and seed funding (21).

This survey provides strong support for CBB to continue to host company focus days in our next term.

New activities that CBB should develop are:

1. More international partnerships
2. Stronger government relationships
3. Research support
4. A seed funding program
5. Stronger communications

It would be reasonable for CBB to consider a pilot run of a peer grant review program. It would be prudent to evaluate this program after 2-3 years and seek feedback on the value of the program.

3. Review with the Board of Directors (June 23, 2016).

On June 23, 2016, the CBB Board of Directors was asked for input to the five year planning process. The board felt that the role of CBB in the next five years was important to support research in these biomedical engineering and bioengineering in the absence of a medical school. Networking events were confirmed as a key value that CBB adds. The general weakness of UW in terms of government relations was also identified as a priority to improve on in the next five years. One member of the board identified precision agriculture as a new area that CBB should grow in.

4. Review with the Advisory Board (June 28, 2016).

The CBB Advisory Board participated in a “Blue Sky” CBB planning session on June 28, 2016. The board reaffirmed that CBB has made a lot of progress very quickly and should be part of the strategic university vision. Achieving international recognition is an important five year goal. The focus of the Centre was discussed with most members reaffirming that the broad spread of CBB is particularly important in the research areas of biotechnology and bioengineering.

[Accomplishing the Five Year Plan](#)

In this section, we discuss how CBB intends to execute the five year plan.

Priority 1: Company relationships

CBB has maintained part time business development support through a part time staff position, as well as worked closely with the office of Research, and WatCo. To continue our successful company relationships, we will need strategic outreach to companies that have already been reached by CBB to deepen relationships, as well as continuing relationships with our companies that are already familiar with CBB. The Office of Research has a strong network of corporate partnership managers that are dedicated to full time company outreach and it does not make sense for CBB to duplicate these activities. However, CBB has a stronger knowledge of member research activities and a better capability to host focus days and similar events. Focus days are a format that work very well for our members, as opposed to larger multi-company networking events which have not had as much support. This points to the importance of providing networking activities with deep interaction opportunities for our members.

CBB has met with Mike Szarka, Director, Corporate Partnerships and Evelyn Allen, Manager, Corporate Partnerships for Life Sciences. Our plan is to work closely with Mike and Evelyn to use their resources for broad outreach, then moving to deeper relationship building with CBB.

Actions to take: Developing corporate partnerships for our members requires further staff support from CBB. Developed properly, corporate partnerships tend to develop like a web, building and expanding over time as more partners are added, existing relationships are maintained, and faculty interests develop further. CBB intends to hire a full time Manager, Corporate Partnerships to develop this priority. This person will be responsible for developing new corporate partnerships and advancing existing partnerships into successfully funded research relationships.

Priority 2. International Partnerships

Canada is a small country in terms of population and has a relatively small presence in the areas of biomedical engineering and biotechnology. To be competitive Canadian researchers must interact on a global stage. In the next few years it is anticipated that there will be more opportunities for internationally supported research.

Actions to take: To achieve this priority, CBB should develop an international engagement strategy to look for opportunities for joint research, joint funding, student exchange, and shared seminars. CBB members will be asked to participate in a strategic development exercise to identify the highest priority relationships and CBB staff will work with our members to develop those relationships further. CBB has previous experience with Waterloo International staff and has two successful international partnerships in progress. When the international program reaches a level of maturity CBB may seek to hire specific talent to manage these relationships.

Priority 3. Stronger government relationships.

Provincial and federal government relationships can be important in responding to opportunities and these groups can provide input into future opportunities. Presently CBB does not have anyone on its team with this expertise or set of relationships.

Actions to take: CBB will need to hire talent in this direction through either incorporating this experience need in the hire of the Managing Director, or a Manager, Government Relations, depending on funding.

Priority 4. Research support

Continuing to seek large team grants is certainly a role of a Centre, and CBB must continually push its research activities in this direction. Our feedback on research support however still acknowledges that smaller grants are useful and help researchers to get started, so these activities cannot be ignored. Deepening company relationships to the stage where the company is willing to make a significant investment in research is important and can take several years to establish. Some of the other activities such as peer grant review and seed funding may also be helpful to increase the odds of Waterloo researchers obtaining larger grants.

Actions to take: CBB must continue its support for smaller grants but push for larger team grants. The hire of a manager, corporate partnerships (Priority 1) must look for someone with prior successful experience with grant programs and a track record of advancing corporate relationships to funded

research. Establishing a seed funding program (Priority 5) and peer grant review (Priority 6) will also improve research success.

Priority 5. Seed funding program

Actions to take: CBB should initiate a seed funding program for its members. The exact definition of the program should be set by a program committee. The intention of the program should be to support early stage research that will lead to promising grant applications. A seed amount of \$7-10k is suggested, enough to support a graduate student or co-op student for 4-6 months.

Priority 6. Peer grant review

Actions to take: CBB should pilot a peer grant review process. This process would allow researchers preparing grants to submit them to the CBB committee. The committee would review the grant and provide feedback to the researcher. The peer grant review could also work together with the seed funding program (Figure 4) whereby recipients of the seed funding program commit to submitting a proposal to a granting agency, for review by the peer review committee before the proposal moves forward. This process would tie together priorities 4, 5, and 6.

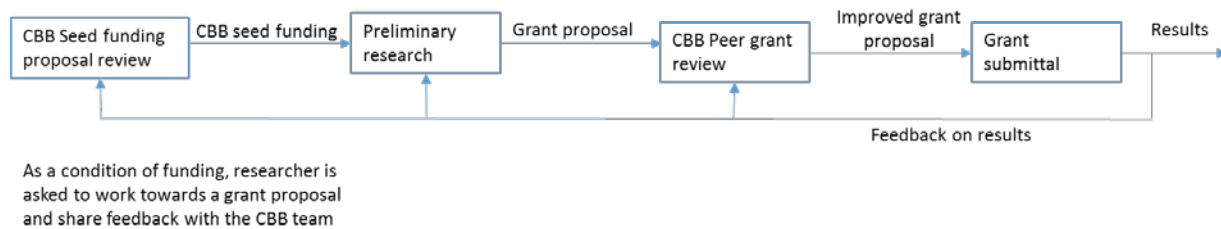


Figure 4. Improving research results by initiating seed funding and peer grant review.

Priority 7. Communications

The need for stronger communications support has been identified by CBB members. CBB needs to communicate the work of its members internally and externally. UW Communications can provide some of this role, but having a person at CBB who could liaise and help UW Communications as well as contribute additional communications for CBB in traditional and social media would be helpful.

Actions to take: CBB should hire a part-time or co-op communications specialist, and expand the role if needed.

Governance and Administration

As a university Centre, CBB is governed by Policy 44, Research Centres and Institutes. While this section includes a summary of the governance structure, details and terms of reference are outlined in the CBB Constitution in the Appendix.

Management Team and Staff

CBB is managed by an elected Director (on a three year term) and has two Associate Directors, one from Engineering and one from Science. Currently these roles are

- Director, Catherine Burns, Systems Design Engineering
- Associate Director (Science), Trevor Charles, Biology
- Associate Director (Engineering), Karim Karim, Electrical and Computer Engineering

CBB has one full time employee, an administrative assistant, Krystina Bednarowski. From time to time, CBB has hired occasional or part time personnel to help with Centre activities on an as-needed basis. Currently CBB supports a part-time business development person (seconded) and a full time project manager (on contract for a specific project).

Reporting Structure

CBB reports to the Deans of Engineering and Science. Financial management for the Centre comes from the office of the Dean of Engineering. Space for the Centre offices has been provided by the Dean of Engineering. The Director for CBB is appointed by the Dean of Engineering, after seeking feedback from CBB members.

Boards and Committees

CBB has three core governing structures, an Operations Committee, a Board of Directors and an Advisory Board. In all of these groups, CBB strives to have a membership that reflects the diversity of CBB member interests.

Operations Committee

The Operations Committee advises on day to day operations of the Centre. This committee meets formally typically once a semester and provides guidance and advice at many other points throughout the year. Current members of the operations committee are:

1. Director of CBB, Catherine Burns, Systems Design Engineering
2. Associate Director (Engineering) CBB, Karim Karim, Electrical and Computer Engineering
3. Associate Director (Science) CBB, Trevor Charles, Biology
4. Melanie Campbell, Physics and Astronomy
5. Brendan McConkey, Biology
6. Marc Aucoin, Chemical Engineering
7. Safieddin Safavi-Naeini, Electrical and Computer Engineering
8. John Yeow, Systems Design Engineering

The Operations committee has met on the past dates:

- 2012 – October 23
- 2013 – January 10, April 11, November 26
- 2014 – January 22, March 26, June 10, October 10
- 2015 – May 4, September 15
- 2016 – February 1, May 30, August 31

Board of Directors

The Board of Directors is the governing body for CBB as per Policy 44. The Board of Directors takes a unique position in advising CBB from a higher perspective ensuring that CBB works well for its member departments, and with other organizations on campus. Members of the Board of Directors serve two year terms, staggered across the membership. By constitutional requirement, the Board members are

the Dean of Engineering (also Chair of the Board), the Dean of Science, the Director of CBB, six faculty members of CBB and 3 external members. The Board of Directors meets once a year. Current members of the Board of Directors are:

1. Pearl Sullivan, Dean of Engineering
2. Robert Lemieux, Dean of Science
3. Catherine Burns, CBB Director
4. Karim Karim, Associate Director – Engineering
5. Trevor Charles, Associate Director – Science
6. Jan Huissoon, Mechanical and Mechatronics Engineering
7. Eric Croiset, Chemical Engineering
8. Carolyn Ren, Mechanical & Mechatronics Engineering
9. Chris Backhouse, Electrical and Computer Engineering
10. Elizabeth Meiring, Chemistry
11. Sue Horton, School of Public Health and Health Systems
12. Tyler Whale, Ontario Agri-Food Technologies (OAFT)
13. Andrey Lomako, Teledyne DALSA
14. Doug Dittmer, Grand River Hospital Freeport Campus

The past meeting dates of the Board of Directors were:

- 2013 – May 31
- 2014 – June 23
- 2015 – October 16
- 2016 – June 23

Advisory Board

In 2014, CBB decided to form an advisory board to seek guidance from industry leaders in areas relevant to CBB member interests. The advisory board also plays a key role in helping to build partnerships for the Centre. Members of the Advisory Board serve terms of 2-3 years, with subsequent renewals approved by the Operations Committee. The current members of the advisory board are:

1. John Thompson, Chair; Associate Vice-President, Research, University of Waterloo
2. Catherine Burns, Ex-officio, Director, CBB, University of Waterloo
3. Frank Cotter, VP, Mobile Computing, BlackBerry
4. Tony D'Amore, AVP, BioProcess R&D - North America, Sanofi Pasteur
5. Jason Dowd, Director Product Development, Biopharmaceuticals, Apotex Inc.
6. Fiona Fitzgerald, National Zone Leader, Life Science, GE Healthcare Canada
7. Brian Foody, President and CEO, Iogen Corporation
8. Luis Garcia, Craig Richardson Institute of Food Processing Technology and Trades and Apprenticeship (Millwright), Conestoga College
9. Donald Gerson, President and CEO, PnuVax, Inc. and PnuVax SL Biopharmaceuticals, Inc.
10. Gary Higgs, Integrated Chief Information Officer, Grand River Hospital/St. Mary's Hospital
11. Murray Moo-Young, Distinguished Professor Emeritus, Chemical Engineering, University of Waterloo
12. George Pinho, President, Christie Medical Holdings Inc.

The past meeting dates of the Industrial Advisory Board were:

- 2014 – June 26
- 2015 – June 12
- 2016 – March 14, June 28

Governing Documentation

CBB has a constitution that governs its basic operations. The constitution was established in 2011 and reviewed and updated in 2016 to be compliant with Policy 44. The CBB constitution outlines the membership categories and process for the approval of members. The constitution also outlines the composition, operation, and establishment of the Board of Directors, Advisory Board and Operations Committee. The revision of the constitution in 2016 was ratified by a vote by CBB members in September 2016.

Financials

1. Past funding level and sources (internal)

CBB Financials

Nov 2011-Apr 2017

	Year 0	Year 1	Year 2	Year 3	Year 4	Estimate	Year 6
						Year 5	commitments
Income	Nov-Apr	May-Apr	May-Apr	May-Apr	May-Apr	May-Apr	Year 6
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Seed Funding - Engineering	-	50,000	50,000	50,000	50,000	50,000	-
Seed Funding - Science	-	25,000	25,000	25,000	25,000	25,000	-
Membership revenue	-	5,000	-	-	5,000	-	-
Grant Awards 500 funding	-	-	-	-	-	28,109	10,000
Contract Research funding	-	40,000	10,696	18,687	119,916	58,368	40,833
Sub total	-	120,000	85,696	93,687	199,916	161,477	50,833
Expenses						Estimate	Year 6
Administrative Assistant	-	21,044	45,768	48,849	51,532	53,000	-
Business Development Manager	-	-	22,986	23,735	49,167	37,068	-
Project Manager	-	-	-	-	40,833	70,000	40,833
Temporary / Contract Worker	-	1,040	858	-	3,070	2,974	-
Salaries Sub total	-	22,084	69,613	72,584	144,602	163,043	40,833
Office expenses	-	4,942	11,490	10,220	17,568	21,010	-
Events	-	894	2,412	6,135	6,295	35,349	-
Travel	-	786	10,007	3,055	2,211	31,266	-
Sub total	-	6,622	23,909	19,410	26,073	87,625	-
Total expenses	-	28,707	93,521	91,993	170,676	250,668	40,833

2. Funds under administration in the past five years and continuing commitments

International Research Partnership Grant (IRPG)

- Waterloo/Twente Partnership to Accelerate Research in Data Driven Persuasive Health Technology, May 2016-April 2017
- Waterloo Sorbonne Partnership for Innovative Health Engineering, May 2016-May 2017

Research Contract

- Second-Heart, Lockheed Martin, October 2012-November 2017

Medical Device Commercialization Centre (MDCC)

- UW has committed \$300k from 2016-2021 to support medical device commercialization activities from UW research. CBB acts as the point of contact to help researchers interact with MDCC.

3. High level view of the new five year financial plan

This fall, CBB intends to apply for University Centre status. If successful, this would allow CBB to execute the five year plan proposed here. Following is the proposed budget to execute that plan over the next five years.

CBB Financials - next five years
May 2017-April 2022

	Year 6 May-Apr 2017/18	Year 7 May-Apr 2018/19	Year 8 May-Apr 2019/20	Year 9 May-Apr 2020/21	Year 10 May-Apr 2021/22
Expenses					
Administrative Assistant P/T Business Development Manager	55,000	55,000	60,000	65,000	65,000
Manager, Corporate USG10	40,000	40,000	40,000	40,000	40,000
Manager, Int/Gov USG10	40,000	70,000	75,000	75,000	80,000
Communications Project Manager	-	-	70,000	75,000	75,000
Temporary / Contract Worker	20,000	40,000	40,000	40,000	40,000
	-	-	-	-	-
Salaries Sub total	155,000	205,000	285,000	295,000	300,000
Office expenses	15,000	15,000	15,000	15,000	15,000
Events	10,000	10,000	10,000	10,000	10,000
Special Initiatives	20,000	20,000	20,000	20,000	20,000
CBB Seed Fund	50,000	50,000	50,000	50,000	50,000
Travel - Manager Corporate	10,000	10,000	10,000	10,000	10,000
Travel - Manager Int/Gov	10,000	10,000	10,000	10,000	10,000
Sub total	115,000	115,000	115,000	115,000	115,000
Total expenses	270,000	320,000	400,000	410,000	415,000

Appendix

A - Summary of member listing and Research Groups

B - Board members

C - Operations committee

D - Constitution

E - Listing of seminars and events

F - Member awards and achievements

G - Summary of Year 5 member survey

H - Letters of support

A - Summary of member listing and Research Groups

There are many engineering components, tools, and academia research that fall under the umbrella of our Centre, and are classified into the two main Priority Areas listed below. Collaborations are also developed with other universities, industry, and government laboratories that help create Highly Qualified Personnel (HQP), the potential of new industries and products, a reduced dependence on non-renewable fossil fuels, and the production of new and inexpensive medicinal drugs and vaccines. Some researchers may be in more than one priority area.

Priority Areas (2):

1. Biomaterials & Biomanufacturing Innovations (76 researchers)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/47>)

Priority Area Leader: Eric Prouzet, Chemistry

This priority area houses faculty members who collaborate jointly from the departments of Biology, Chemical Engineering, Chemistry, Civil & Environmental Engineering, Kinesiology Pharmacy, and Physics & Astronomy.

This priority area includes research focus of three sub categories:

1. Biopharmaceutical and high-value bioproducts
Category Leader: Marc Aucoin, Chemical Engineering
2. Biomass and environmental bioremediation
Category Leader: Trevor Charles, Biology
3. Bionano-derivatives for functional material
Category Leader: Frank Gu, Chemical Engineering

2. Biomedical Systems & Device Technologies (97 researchers)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/49>)

This priority area houses faculty members from Applied Mathematics, Chemical Engineering, Chemistry, Computer Sciences, Electrical & Computer Engineering, Kinesiology, Mechanical & Mechatronics Engineering, Management Sciences, Pharmacy, Physics & Astronomy, School of Public Health & Health Systems, and Systems Design Engineering.

This priority area includes research focus of three sub categories:

1. Biomedical imaging and biosensors
Category Leader: Karim S. Karim, Electrical & Computer Engineering
2. High-throughput systems and microfluidics
Category Leader: Carolyn Ren, Mechanical & Mechatronics Engineering
3. Mobile health and health informatics
Category Leader: Safieddin Safavi-Naeini, Electrical & Computer Engineering

Research efforts in this group focus on topics ranging from novel micro-nano-biomedical sensors, lab-on-the-chip, innovative bio-medical imaging devices and systems, and smart wireless sensor devices, to body-area-network, and large scale eHealth and mobile-Health system and network technologies.

Research Groups (6)

CBB researchers span a very wide range of research interests and this breadth is one of the strengths of CBB as it allows for rich multi-disciplinary teams with a range of diverse talents and perspectives. Over the past four years, certain clusters of research strength have emerged from CBB researchers (some researchers may be in more than one research group).

1. **Biomedical (75 researchers)**
2. **Environmental (40 researchers)**
3. **Bioprocessing and Food Technology (16 researchers)**
4. **Healthcare Systems (30 researchers)**
5. **Imaging (38 researchers)**
6. **Wearable Devices and Healthcare Devices (41 researchers)**

	Biomedical	Environmental	Bioprocessing and Food Technology	Healthcare Systems	Imaging	Wearable and Healthcare Devices
Engineering	39	22	12	14	23	28
Science	27	16	3	4	10	4
AHS	1	0	0	9	2	5
Math	8	2	1	3	3	4
	75	40	16	30	38	41

Members by Priority Area:

Contact	Faculty	Department	Biomaterials and Biomanufacturing Innovations	Biomedical Systems and Device Technologies
Eihab Abdel-Rahman	Engineering	Systems Design Engineering		X
Stacey Acker	Applied Health Sciences	Kinesiology		X
Adil Al-Mayah	Engineering	Civil & Environmental Engineering		X
Bill (William) Anderson	Engineering	Chemical Engineering	X	
Jose (Frank) Arocha	Applied Health Sciences	School of Public Health & Health Systems		X
Marc Aucoin	Engineering	Chemical Engineering	X	
Chris Backhouse	Engineering	Electrical & Computer Engineering	X	X
Gladimir Baranoski	Math	School of Computer Science		X
Jonathan Baugh	Science	Chemistry	X	
Mike Beazely	Science	Pharmacy	X	
Philip Beesley	Engineering	Architecture	X	
Kostadinka Bizheva	Science	Physics & Astronomy		X
Jonathan Blay	Science	Pharmacy	X	
Neils Bols	Science	Biology	X	
Slim Boumaiza	Engineering	Electrical & Computer Engineering		X
Wayne Brodland	Engineering	Civil & Environmental Engineering	X	
Hector Budman	Engineering	Chemical Engineering		X
Catherine Burns	Engineering	Systems Design Engineering		X
Melanie Campbell	Science	Physics & Astronomy		X
Shi Cao	Engineering	Systems Design Engineering		X
Naveen Chandrashekar	Engineering	Mechanical & Mechatronics Engineering		X
Trevor Charles	Science	Biology	X	
Helen Chen	Applied Health Sciences	School of Public Health & Health Systems		X
Jeff Chen	Science	Physics & Astronomy		X
Pu Chen	Engineering	Chemical Engineering	X	
Perry Chou	Engineering	Chemical Engineering	X	
David Clausi	Engineering	Systems Design Engineering		X
Don Cowan	Math	School of Computer Science		X
Eric Croiset	Engineering	Chemical Engineering	X	
Bo Cui	Engineering	Electrical & Computer Engineering	X	X
Mohamed Oussama Damen	Engineering	Electrical & Computer Engineering		X
Clark Dickerson	Applied Health Sciences	Kinesiology		
Brian Dixon	Science	Biology	X	X
George Dixon	Science	Biology	X	
Andrew Doxey	Science	Biology		X
Bernard Duncker	Science	Biology	X	
David Edwards	Science	Pharmacy	X	
Monica Emelko	Engineering	Civil & Environmental Engineering	X	

Contact	Faculty	Department	Biomaterials and Biomanufacturing Innovations	Biomedical Systems and Device Technologies
Kaan Erkorkmaz	Engineering	Mechanical & Mechatronics Engineering		X
Shahrzad Esmaeili	Engineering	Mechanical & Mechatronics Engineering	X	
Baris Fidan	Engineering	Mechanical & Mechatronics Engineering		X
Paul Fieguth	Engineering	Systems Design Engineering		X
Marianna Foldvari	Science	Pharmacy	X	X
James Forrest	Science	Physics & Astronomy	X	X
Lora Giangregorio	Applied Health Sciences	Kinesiology		X
Bernard Glick	Science	Biology	X	
Maud Gorbet	Engineering	Systems Design Engineering	X	X
Kelly Grindrod	Science	Pharmacy		X
Frank Gu	Engineering	Chemical Engineering	X	X
J Guy Guillemette	Science	Chemistry	X	X
Bae-Yeun Ha	Science	Physics & Astronomy	X	
Arsen Hajian	Engineering	Systems Design Engineering		X
John Heikkila	Science	Biology	X	
Jonathan Histon	Engineering	Systems Design Engineering		X
Danny Ho	Science	Pharmacy	X	
Jesse Hoey	Math	School of Computer Science		X
Laurie Hoffman-Goetz	Applied Health Sciences	School of Public Health & Health Systems		X
John Honek	Science	Chemistry	X	
Sue Horton	Applied Health Sciences	School of Public Health & Health Systems		
Peter Huck	Engineering	Civil & Environmental Engineering	X	
Chris Hudson	Science	Optometry		X
Richard Hughson	Applied Health Sciences	Kinesiology		X
Jan Huissoon	Engineering	Mechanical & Mechatronics Engineering		X
Stefan Idziak	Science	Physics & Astronomy		X
Brian Ingalls	Math	Applied Mathematics	X	
Ning Jiang	Engineering	Systems Design Engineering		X
Lyndon Jones	Science	Optometry	X	X
Vassili Karanassios	Science	Chemistry	X	X
Karim Karim	Engineering	Electrical & Computer Engineering		X
Behrad Khamesee	Engineering	Mechanical & Mechatronics Engineering		X
Jonathan Kofman	Engineering	Systems Design Engineering		X
Mohammad Kohandel	Math	Applied Mathematics	X	
Dana Kulic	Engineering	Electrical & Computer Engineering		X
Andrew Laing	Applied Health Sciences	Kinesiology		X
Vasudevan (Vengu) Lakshminarayanan	Science	Optometry		X
Edith Law	Math	School of Computer Science		X
Hyung-Sool Lee	Engineering	Civil & Environmental Engineering	X	
Raymond Legge	Engineering	Chemical Engineering	X	X

Contact	Faculty	Department	Biomaterials and Biomanufacturing Innovations	Biomedical Systems and Device Technologies
Zoya Leonenko	Science	Physics & Astronomy		X
Bosco Leung	Engineering	Electrical & Computer Engineering		X
Kam Tong Leung	Science	Chemistry	X	X
Peter Levine	Engineering	Electrical & Computer Engineering	X	X
Ming Li	Math	School of Computer Science		X
Dongqing Li	Engineering	Mechanical & Mechatronics Engineering	X	X
Juewen Liu	Science	Chemistry	X	X
Kesen Ma	Science	Biology	X	
Chandra Madhuranthakam	Engineering	Chemical Engineering	X	
Vivek Maheshwari	Science	Chemistry	X	X
Mungo Marsden	Science	Biology	X	
Brendan McConkey	Science	Biology	X	X
Bill McLroy	Applied Health Sciences	Kinesiology		X
Ken McKay	Engineering	Management Sciences		X
Ian McKillop	Applied Health Sciences	School of Public Health & Health Systems		X
John McPhee	Engineering	Systems Design Engineering		X
Elizabeth Meiering	Science	Chemistry	X	
Barbara Moffat	Science	Biology	X	
Murray Moo-Young	Engineering	Chemical Engineering	X	
Christine Moresoli	Engineering	Chemical Engineering	X	
David Nairn	Engineering	Electrical & Computer Engineering		X
Praveen Nekkar	Science	Pharmacy	X	
Patricia Nieva	Engineering	Mechanical & Mechatronics Engineering	X	X
Jeff Orchard	Math	School of Computer Science		X
Osman Ozaltin	Engineering	Management Sciences		X
Katerina Papoulia	Math	Applied Mathematics	X	
Sean Peterson	Engineering	Mechanical & Mechatronics Engineering	X	X
Kumaraswamy (Ponnu) Ponnambalam	Engineering	Systems Design Engineering		X
Pascal Poupart	Math	School of Computer Science		X
Eric Prouzet	Science	Chemistry	X	
Omar Ramahi	Engineering	Electrical & Computer Engineering		X
Bruce Reed	Science	Biology	X	
Carolyn Ren	Engineering	Mechanical & Mechatronics Engineering		X
Barbara Riley	Applied Health Sciences	School of Public Health & Health Systems		X
David Rose	Science	Biology	X	
Manoj Sachdev	Engineering	Electrical & Computer Engineering		X
Fatih Safa Erenay	Engineering	Management Sciences		X
Safieddin (Ali) Safavi- Naeini	Engineering	Electrical & Computer Engineering		X
Armaghan Salehian	Engineering	Mechanical & Mechatronics Engineering		X

Contact	Faculty	Department	Biomaterials and Biomanufacturing Innovations	Biomedical Systems and Device Technologies
Stacey Scott	Engineering	Systems Design Engineering		X
Matthew Scott	Math	Applied Mathematics	X	
George Shaker	Engineering	Electrical & Computer Engineering		X
Raed Shubair	Engineering	Electrical & Computer Engineering		X
David Simakov	Engineering	Chemical Engineering	X	
Sivabal Sivaloganathan	Math	Applied Mathematics		
Roderick Slavcev	Science	Pharmacy	X	
David Spafford	Science	Biology	X	
Daniel Stashuk	Engineering	Systems Design Engineering		X
Paul Stolee	Applied Health Sciences	School of Public Health & Health Systems		X
Michael Tam	Engineering	Chemical Engineering	X	
Shirley Tang	Science	Chemistry	X	X
Scott Taylor	Science	Chemistry	X	
John Thompson	Science	Biology	X	
Neil Thomson	Engineering	Civil & Environmental Engineering	X	
Hamid Tizhoosh	Engineering	Systems Design Engineering		X
Ehsan Toyserkani	Engineering	Mechanical & Mechatronics Engineering		X
James Tung	Engineering	Mechanical & Mechatronics Engineering		X
Matthijs van der Meer	Science	Biology	X	
Mathilakath Vijayan	Science	Biology	X	
Justin Wan	Math	School of Computer Science		X
Zhou Wang	Engineering	Electrical & Computer Engineering		X
Richard Wells	Applied Health Sciences	Kinesiology		X
John Wen	Engineering	Mechanical & Mechatronics Engineering	X	
Shawn Wettig	Science	Pharmacy	X	
Thomas Willett	Engineering	Systems Design Engineering	X	
Alex Wong	Engineering	Systems Design Engineering		X
Andrew K C Wong	Engineering	Systems Design Engineering		X
John Yeow	Engineering	Systems Design Engineering	X	X
David Yevick	Science	Physics & Astronomy		X
Alfred Yu	Engineering	Electrical & Computer Engineering	X	X
Boxin Zhao	Engineering	Chemical Engineering	X	
Norman Zhou	Engineering	Mechanical & Mechatronics Engineering	X	X

Members by Research Group:

Biomedical (75 members)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/74>)

Researchers under this group focus on various biomedical systems and applications:

- systems and applications
- drug delivery systems
- diagnostic and lab-on-a-chip devices
- genetic engineering
- protein engineering
- biomechanics, mechatronics, assistive devices
- optics, spectroscopy, microscopy
- microfluidics and nanofluidics

Contact	Faculty	Department
Adil Al-Mayah	Engineering	Civil & Environmental Engineering
Marc Aucoin	Engineering	Chemical Engineering
Chris Backhouse	Engineering	Electrical & Computer Engineering
Gladimir Baranoski	Math	School of Computer Science
Jonathan Baugh	Science	Chemistry
Mike Beazely	Science	Pharmacy
Kostadinka Bizheva	Science	Physics & Astronomy
Jonathan Blay	Science	Pharmacy
Wayne Brodland	Engineering	Civil & Environmental Engineering
Melanie Campbell	Science	Physics & Astronomy
Shi Cao	Engineering	Systems Design Engineering
Naveen Chandrashekar	Engineering	Mechanical & Mechatronics Engineering
Trevor Charles	Science	Biology
Pu Chen	Engineering	Chemical Engineering
Perry Chou	Engineering	Chemical Engineering
David Clausi	Engineering	Systems Design Engineering
Don Cowan	Math	School of Computer Science
Bo Cui	Engineering	Electrical & Computer Engineering
Clark Dickerson	Applied Health Sciences	Kinesiology
Bernard Duncker	Science	Biology
Baris Fidan	Engineering	Mechanical & Mechatronics Engineering
Marianna Foldvari	Science	Pharmacy
Maud Gorbet	Engineering	Systems Design Engineering
Frank Gu	Engineering	Chemical Engineering
J Guy Guillemette	Science	Chemistry
Arsen Hajian	Engineering	Systems Design Engineering
John Heikkila	Science	Biology

Jesse Hoey	Math	School of Computer Science
John Honek	Science	Chemistry
Lyndon Jones	Science	Optometry
Vassili Karanassios	Science	Chemistry
Karim Karim	Engineering	Electrical & Computer Engineering
Behrad Khamesee	Engineering	Mechanical & Mechatronics Engineering
Jonathan Kofman	Engineering	Systems Design Engineering
Mohammad Kohandel	Math	Applied Mathematics
Vasudevan (Vengu) Lakshminarayanan	Science	Optometry
Zoya Leonenko	Science	Physics & Astronomy
Kam Tong Leung	Science	Chemistry
Ming Li	Math	School of Computer Science
Dongqing Li	Engineering	Mechanical & Mechatronics Engineering
Peter Levine	Engineering	Electrical & Computer Engineering
Juewen Liu	Science	Chemistry
Mungo Marsden	Science	Biology
Vivek Maheshwari	Science	Chemistry
Elizabeth Meiering	Science	Chemistry
Murray Moo-Young	Engineering	Chemical Engineering
Praveen Nekkar	Science	Pharmacy
John McPhee	Engineering	Systems Design Engineering
Patricia Nieva	Engineering	Mechanical & Mechatronics Engineering
Sean Peterson	Engineering	Mechanical & Mechatronics Engineering
Omar Ramahi	Engineering	Electrical & Computer Engineering
Carolyn Ren	Engineering	Mechanical & Mechatronics Engineering
Safieddin (Ali) Safavi-Naeini	Engineering	Electrical & Computer Engineering
Armaghan Salehian	Engineering	Mechanical & Mechatronics Engineering
Matthew Scott	Math	Applied Mathematics
Sivabal Sivaloganathan	Math	Applied Mathematics
Roderick Slavcev	Science	Pharmacy
David Spafford	Science	Biology
Hamid Tizhoosh	Engineering	Systems Design Engineering
Michael Tam	Engineering	Chemical Engineering
Shirley Tang	Science	Chemistry
Scott Taylor	Science	Chemistry
John Thompson	Science	Biology
Ehsan Toyserkani	Engineering	Mechanical & Mechatronics Engineering
Daniel Stashuk	Engineering	Systems Design Engineering
Justin Wan	Math	School of Computer Science
Alex Wong	Engineering	Systems Design Engineering
Shawn Wettig	Science	Pharmacy
Thomas Willett	Engineering	Systems Design Engineering
Andrew K C Wong	Engineering	Systems Design Engineering

James Tung	Engineering	Mechanical & Mechatronics Engineering
John Yeow	Engineering	Systems Design Engineering
Alfred Yu	Engineering	Electrical & Computer Engineering
Boxin Zhao	Engineering	Chemical Engineering
Norman Zhou	Engineering	Mechanical & Mechatronics Engineering

Environmental (40 members)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/75>)

This research group specializes in solving various environmental problems:

- environmental monitoring
- bioremediation
- water and wastewater treatment
- filtration processes
- air pollution control
- biofuels

Contact	Faculty	Department
Bill (William) Anderson	Engineering	Chemical Engineering
Chris Backhouse	Engineering	Electrical & Computer Engineering
Neils Bols	Science	Biology
Trevor Charles	Science	Biology
Pu Chen	Engineering	Chemical Engineering
Perry Chou	Engineering	Chemical Engineering
Don Cowan	Math	School of Computer Science
Eric Croiset	Engineering	Chemical Engineering
Brian Dixon	Science	Biology
George Dixon	Science	Biology
Andrew Doxey	Science	Biology
Monica Emelko	Engineering	Civil & Environmental Engineering
Paul Fieguth	Engineering	Systems Design Engineering
Bernard Glick	Science	Biology
Frank Gu	Engineering	Chemical Engineering
John Heikkila	Science	Biology
Peter Huck	Engineering	Civil & Environmental Engineering
Brian Ingalls	Math	Applied Mathematics
Hyung-Sool Lee	Engineering	Civil & Environmental Engineering
Raymond Legge	Engineering	Chemical Engineering
Kam Tong Leung	Science	Chemistry
Dongqing Li	Engineering	Mechanical & Mechatronics Engineering
Peter Levine	Engineering	Electrical & Computer Engineering
Kesen Ma	Science	Biology
Chandra Madhuranthakam	Engineering	Chemical Engineering
Juewen Liu	Science	Chemistry
Brendan McConkey	Science	Biology
Barbara Moffat	Science	Biology
Murray Moo-Young	Engineering	Chemical Engineering
Patricia Nieva	Engineering	Mechanical & Mechatronics Engineering
Eric Prouzet	Science	Chemistry

Carolyn Ren	Engineering	Mechanical & Mechatronics Engineering
Safieddin (Ali) Safavi-Naeini	Engineering	Electrical & Computer Engineering
David Simakov	Engineering	Chemical Engineering
Michael Tam	Engineering	Chemical Engineering
Shirley Tang	Science	Chemistry
John Thompson	Science	Biology
Neil Thomson	Engineering	Civil & Environmental Engineering
Mathilakath Vijayan	Science	Biology
John Wen	Engineering	Mechanical & Mechatronics Engineering

Bioprocessing and Food Technology (16 members)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/70>)

This research groups specializes in various aspects of the food manufacturing industry who focus on:

- pathogen detection
- disinfection and sterilization technologies
- food production and processing
- food safety
- packaging
- baking process
- separation and filtration bioprocessing
- protein and pharmaceutical products
- waste utilization
- fermentation technology

Contact	Faculty	Department
Bill (William) Anderson	Engineering	Chemical Engineering
Marc Aucoin	Engineering	Chemical Engineering
Chris Backhouse	Engineering	Electrical & Computer Engineering
Perry Chou	Engineering	Chemical Engineering
Don Cowan	Math	School of Computer Science
David Edwards	Science	Pharmacy
Frank Gu	Engineering	Chemical Engineering
Jonathan Kofman	Engineering	Systems Design Engineering
Hyung-Sool Lee	Engineering	Civil & Environmental Engineering
Raymond Legge	Engineering	Chemical Engineering
Dongqing Li	Engineering	Mechanical & Mechatronics Engineering
Murray Moo-Young	Engineering	Chemical Engineering
Christine Moresoli	Engineering	Chemical Engineering
Carolyn Ren	Engineering	Mechanical & Mechatronics Engineering
Shirley Tang	Science	Chemistry
John Thompson	Science	Biology

Healthcare Systems (30 researchers)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/72>)

This research group specialize in healthcare information technologies, various system designs and computer program applications for:

- drug delivery systems
- health informatics management
- analytics
- workflow systems
- clinical diagnostic systems
- interface design

Contact	Faculty	Department
Jose (Frank) Arocha	Applied Health Sciences	School of Public Health & Health Systems
Chris Backhouse	Engineering	Electrical & Computer Engineering
Catherine Burns	Engineering	Systems Design Engineering
Shi Cao	Engineering	Systems Design Engineering
Helen Chen	Applied Health Sciences	School of Public Health & Health Systems
Marianna Foldvari	Science	Pharmacy
Lora Giangregorio	Applied Health Sciences	Kinesiology
Kelly Grindrod	Science	Pharmacy
Jesse Hoey	Math	School of Computer Science
Laurie Hoffman-Goetz	Applied Health Sciences	School of Public Health & Health Systems
Sue Horton	Applied Health Sciences	School of Public Health & Health Systems
Ning Jiang	Engineering	Systems Design Engineering
Karim Karim	Engineering	Electrical & Computer Engineering
Behrad Khamesee	Engineering	Mechanical & Mechatronics Engineering
Edith Law	Math	School of Computer Science
Juewen Liu	Science	Chemistry
Ken McKay	Engineering	Management Sciences
Ian McKillop	Applied Health Sciences	School of Public Health & Health Systems
Osman Ozaltin	Engineering	Management Sciences
Kumaraswamy (Ponnu) Ponnambalam	Engineering	Systems Design Engineering
Pascal Poupart	Math	School of Computer Science
Barbara Riley	Applied Health Sciences	School of Public Health & Health Systems
Fatih Safa Erenay	Engineering	Management Sciences
Stacey Scott	Engineering	Systems Design Engineering
Roderick Slavcev	Science	Pharmacy
Paul Stolee	Applied Health Sciences	School of Public Health & Health Systems
Alex Wong	Engineering	Systems Design Engineering
Richard Wells	Applied Health Sciences	Kinesiology
James Tung	Engineering	Mechanical & Mechatronics Engineering
Alfred Yu	Engineering	Electrical & Computer Engineering

Imaging (38 researchers)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/71>)

Researchers under this group focus on various biomedical imaging systems and applications and specialize in:

- biomedical and scientific image classification, analysis, processing
- large area digital medical imaging
- diagnostics (skin cancer imaging, diabetes, Alzheimer's, glaucoma, blindness and retinal diseases)
- ophthalmic instrumentation, sensors, technologies, and hardware design (MRI, CT, ultrasound)
- 3D imaging sensors and measurements

Contact	Faculty	Department
Adil Al-Mayah	Engineering	Civil & Environmental Engineering
Chris Backhouse	Engineering	Electrical & Computer Engineering
Gladimir Baranoski	Math	School of Computer Science
Jonathan Baugh	Science	Chemistry
Kostadinka Bizheva	Science	Physics & Astronomy
Wayne Brodland	Engineering	Civil & Environmental Engineering
Melanie Campbell	Science	Physics & Astronomy
Helen Chen	Applied Health Sciences	School of Public Health & Health Systems
David Clausi	Engineering	Systems Design Engineering
Bo Cui	Engineering	Electrical & Computer Engineering
Kaan Erkorkmaz	Engineering	Mechanical & Mechatronics Engineering
Paul Fieguth	Engineering	Systems Design Engineering
James Forrest	Science	Physics & Astronomy
Lora Giangregorio	Applied Health Sciences	Kinesiology
Frank Gu	Engineering	Chemical Engineering
Arsen Hajian	Engineering	Systems Design Engineering
Chris Hudson	Science	Optometry
Stefan Idziak	Science	Physics & Astronomy
Karim Karim	Engineering	Electrical & Computer Engineering
Behrad Khamesee	Engineering	Mechanical & Mechatronics Engineering
Jonathan Kofman	Engineering	Systems Design Engineering
Vasudevan (Vengu) Lakshminarayanan	Science	Optometry
Zoya Leonenko	Science	Physics & Astronomy
Kam Tong Leung	Science	Chemistry
Jeff Orchard	Math	School of Computer Science
Peter Levine	Engineering	Electrical & Computer Engineering
Safieddin (Ali) Safavi-Naeini	Engineering	Electrical & Computer Engineering
Hamid Tizhoosh	Engineering	Systems Design Engineering
Ehsan Toyserkani	Engineering	Mechanical & Mechatronics Engineering
Daniel Stashuk	Engineering	Systems Design Engineering

Justin Wan	Math	School of Computer Science
Zhou Wang	Engineering	Electrical & Computer Engineering
Alex Wong	Engineering	Systems Design Engineering
Andrew K C Wong	Engineering	Systems Design Engineering
James Tung	Engineering	Mechanical & Mechatronics Engineering
David Yevick	Science	Physics & Astronomy
John Yeow	Engineering	Systems Design Engineering
Alfred Yu	Engineering	Electrical & Computer Engineering

Wearable and Healthcare Devices (41 researchers)

(<https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/80>)

This research group specialize in developing various sensor designs and monitoring systems such as:

- wearable sensors (fitness, continuous health monitoring, fall prevention, Alzheimer's)
- diagnostics (skin cancer, infection testing, drinking water, lab-on-a-chip)
- monitoring (corneal and coronary, heart rhythm, sleep)
- smart technology for medical implants
- human-robot interaction
- assistive devices

Contact	Faculty	Department
Eihab Abdel-Rahman	Engineering	Systems Design Engineering
Stacey Acker	Applied Health Sciences	Kinesiology
Chris Backhouse	Engineering	Electrical & Computer Engineering
Gladimir Baranoski	Math	School of Computer Science
Shi Cao	Engineering	Systems Design Engineering
Naveen Chandrashekar	Engineering	Mechanical & Mechatronics Engineering
Helen Chen	Applied Health Sciences	School of Public Health & Health Systems
Don Cowan	Math	School of Computer Science
Baris Fidan	Engineering	Mechanical & Mechatronics Engineering
Lora Giangregorio	Applied Health Sciences	Kinesiology
Maud Gorbet	Engineering	Systems Design Engineering
Kelly Grindrod	Science	Pharmacy
Frank Gu	Engineering	Chemical Engineering
Jesse Hoey	Math	School of Computer Science
Richard Hughson	Applied Health Sciences	Kinesiology
Jan Huissoon	Engineering	Mechanical & Mechatronics Engineering
Ning Jiang	Engineering	Systems Design Engineering
Vassili Karanassios	Science	Chemistry
Karim Karim	Engineering	Electrical & Computer Engineering
Behrad Khamesee	Engineering	Mechanical & Mechatronics Engineering
Jonathan Kofman	Engineering	Systems Design Engineering
Dana Kulic	Engineering	Electrical & Computer Engineering
Bosco Leung	Engineering	Electrical & Computer Engineering
Peter Levine	Engineering	Electrical & Computer Engineering
Juewen Liu	Science	Chemistry
Vivek Maheshwari	Science	Chemistry
Bill McIlroy	Applied Health Sciences	Kinesiology
John McPhee	Engineering	Systems Design Engineering
Patricia Nieva	Engineering	Mechanical & Mechatronics Engineering
Sean Peterson	Engineering	Mechanical & Mechatronics Engineering

Pascal Poupart	Math	School of Computer Science
Carolyn Ren	Engineering	Mechanical & Mechatronics Engineering
Manoj Sachdev	Engineering	Electrical & Computer Engineering
Safieddin (Ali) Safavi-Naeini	Engineering	Electrical & Computer Engineering
Armaghan Salehian	Engineering	Mechanical & Mechatronics Engineering
George Shaker	Engineering	Electrical & Computer Engineering
Daniel Stashuk	Engineering	Systems Design Engineering
James Tung	Engineering	Mechanical & Mechatronics Engineering
John Yeow	Engineering	Systems Design Engineering
Alfred Yu	Engineering	Electrical & Computer Engineering
Boxin Zhao	Engineering	Chemical Engineering

B - Board members

Board of Directors

- Dean of Engineering – Pearl Sullivan or delegate Anwar Hasan
- Dean of Science – Robert Lemieux or delegate Bernard Duncker
- Director of CBB – Catherine Burns, Systems Design Engineering
- Associate Director Engineering – Karim Karim, Electrical and Computer Engineering
- Associate Director Science – Trevor Charles, Biology

3 Representatives from CBB Partners (Industrial)

- Tyler Whale, Ontario Agri Food Technologies (Jan15-17)
- Andrey Lomako, Teledyne DALSA (Jan15-17)
- Doug Dittmer, Grand River Hospital – Freeport Campus (Jan 15-17)

6 Representatives from CBB Members (Faculty)

- Jan Huissoon, Mechanical and Mechatronics Engineering (Jan 15-17)
- Eric Croiset, Chemical Engineering (Jan 15-17)
- Carolyn Ren, Mechanical and Mechatronics Engineering (Jan 16-18)
- Chris Backhouse, Electrical and Computer Engineering (Jan 16-18)
- Elizabeth Meiering, Chemistry (Jan16-18)
- Sue Horton, School of Public Health and Health Systems (Jan 16-18)

Past Board Members(Faculty):

- David Rose - BIO/SCI (Jan 2014-Jan 2016)
- Jonathan Blay - PHARM/SCI (Jan 2014-Jan 2016)
- Paul Fieguth - SYDE/ENG (Jan 2014-Jan 2016)
- Manoj Sachdev - ECE/ENG (Jan 13-15)
- John Honek – CHEM/SCI (Jan 13-15 + 1YR renewal ending Jan 16)
- Barbara Riley – AHS/SPHHS (Jan 13-15)
- David Edwards – Pharmacy/SCI (Jan 13-14)
- Lyndon Jones – Optometry/SCI (Jan 13-14)
- Murray Moo-Young – CHEM ENG/ENG (Jan 13-14)

Past Board Members (Industry):

- Aldo Badano, US FDA (Jan 13-15)
- George Pinho, Christie Medical (Jan 13-15)

The Terms of Reference for the Board of Directors is in Appendix D: Constitution

Advisory Board

- Catherine Burns, Ex-officio, Director, Centre for Bioengineering and Biotechnology, University of Waterloo
- John Thompson, Board Chair, Associate Vice-President Research, University Research, University of Waterloo
- Frank Cotter, VP, Mobile Computing, BlackBerry
- Tony D'Amore, VP, Product R&D - Global Sanofi Pasteur
- Jason Dowd, Director, Product Development, Biopharmaceuticals Apotex
- Fiona Fitzgerald, Zone Leader, Life Sciences Canada GE Healthcare
- Brian Foody, President and CEO IOGEN
- Luis Garcia, Chair, Institute of Food Processing Technology Conestoga College
- Donald Gerson, President and CEO PnuVax SL Biopharmaceuticals, Inc.
- Gary Higgs, Integrated Chief Information Officer St. Mary's and Grand River Hospitals
- Murray Moo-Young, Distinguished Professor Emeritus, Chemical Engineering University of Waterloo
- George Pinho, President Christie Medical Division

Past Advisory Board:

- Tim Karlsson, Director, Emerging Technologies Directorate, Industry Canada

The Terms of Reference for the Advisory Board is in Appendix D: Constitution

C - Operations committee

Operations Committee

- Catherine Burns, CBB Director, Centre for Bioengineering and Biotechnology, Systems Design Engineering
- Karim Karim, CBB Associate Director, Electrical and Computer Engineering
- Trevor Charles, CBB Associate Director, Biology
- Melanie Campbell, Physics and Astronomy (May 15)
- John Yeow, Systems Design Engineering (May 15)
- Marc Aucoin, Chemical Engineering (May 15)
- Brendan McConkey, Biology (Mar 12)
- Safieddin Safavi-Naeini, Electrical and Computer Engineering (Mar 12)

Past Operations Committee Members:

- Frank Gu, Chemical Engineering (Mar 12-Apr 15)

The Terms of Reference for the Operations Committee is in Appendix D: Constitution



Centre for Bioengineering and Biotechnology (CBB)
University of Waterloo

East Campus 4, Room 2001

cbb.uwaterloo.ca

STRUCTURE AND CONSTITUTION

Established October 2011

Revised September 2016



Mission of CBB

The Centre for Bioengineering and Biotechnology (CBB) at the University of Waterloo was formed in 2011 to promote research and education in the application of engineering and applied sciences principles and techniques to address human health, environmental and industrial challenges. The Centre promotes synergy among its researchers, provides efficient access to shared central services such as equipment and technical support for research, and serves as a focal point for research interaction with industry, hospitals and other external organizations. As a Centre at the University of Waterloo, CBB is governed by Policy 44. As a university entity, CBB is governed by all University of Waterloo procedures and policies.

3.1. Membership in CBB

There are two types of regular members in CBB, *Regular Members* and *Student Members*. Membership as Regular Members is open and virtually automatic for those faculty members at the University of Waterloo who are primarily concerned with research in biotechnology and bioengineering. Membership of faculty members from diverse perspectives is encouraged and these memberships will be decided by approval of the Director or one of the Associate Directors. Again, these memberships are highly encouraged and expected to be virtually automatic. Membership of student members is also highly encouraged and will be granted upon the endorsement of a regular member of the centre.

There are three other forms of CBB membership. *Institutional associates* are representatives of entities such as hospitals, professional schools, research institutes and government bodies. *Corporate associates* are firms or agencies active in the research, development, or application of CBB research. Membership entitles them to obtain notices of seminars, VIP invitations to research symposia, and research results updates. A third category recognizes *Key partners* who are noted for their extraordinary contribution to the centre in one or a combination of financial support, facility support, or educational support.

3.2. Role of Groups

Synergy is the major motivating factor for CBB. Intellectual synergy is facilitated by the open **individual** membership in CBB and its promotion of a healthy research environment. Part of this process is the free association of researchers in groups of a transitory nature, where the close collaboration extends over rather limited time frames such as the conduct of a single project or the creation of one paper. In other circumstances, the “organizational synergy” required to acquire and manage laboratories with large specialized requirements for hardware and technical support results in the emergence of more formal entities such as research groups.

The mandate of CBB is admittedly broad and as such there is a need for research groups in specific topic areas. For groups primarily concerned with research in a specific topic area and that wish to have formal recognition and designation of such, a formal entity within CBB is possible. Such groups are called **Working Groups of CBB**. Working groups can be proposed at any time and their status renewed by the Operations Committee. Working groups should be reviewed intermittently to make sure the group is still active, relevant and defined properly.. A listing of working groups can be found on the CBB website.

There is a clear need to coordinate the activities and interactions of the groups, as formal entities, in areas such as the cooperative acquisition, administration, maintenance and allocation of laboratory resources. Further, CBB can provide efficient access to many services by eliminating duplication. Such services might be document preparation, report distribution, advice on grant applications and proposals, and a public relations interface both on and off the campus.

Should the centre reach a point where it can offer funding or grants to its members, a formal proposal process will be established whereby members apply formally for funding and proposals are reviewed by a selection committee.

Other research groups within the University should have access to CBB services, negotiable with the Director of CBB and the appropriate CBB researchers where relevant.

3.3. Governance

Responsible Officer

The responsible officer for CBB is the Dean of Engineering.

Board of Directors

The Board of Directors is the Central Governing Body of CBB and provides guidance to CBB on policy, activities and budget planning.

The membership in the Board comprises senior members of the community whose responsibilities involve CBB members in a major way.

The composition is:

- Dean of Engineering or a delegate
- Dean of Science or a delegate
- Director of CBB
- Associate Director (Engineering)
- Associate Director (Science)
- Three representatives from the CBB Key Partners, Corporate Associates, or Institutional Associates.
- Six representatives from CBB regular members.

The appointment of members to the Board of Directors is governed by the Board of Directors Terms of Reference. Normally, the Chair of the Board will be the Dean of Engineering. The Deans of Engineering and Science are *ex officio* voting members of the Board of Directors. A quorum shall consist of a majority of the regular members.

The Board of Directors meets at least once per year and additionally if needed. Board meetings will be announced at least one month in advance with an agenda indicating all decision items and background material. Board meetings are open to all members of CBB. Minutes will be taken at all meetings and will be available to all members of CBB.

The Director of CBB is responsible to the Board of Directors for the operational management of CBB, preparation of its annual budget, supervision of staff members and guiding the research and outreach agenda, consistent with policies established by the Board and with input from the Centre's membership.

The Board of Directors has the authority to execute and monitor the affairs of CBB, subject to all applicable University policies, procedures and guidelines. This includes the ability to:

- Enact rules and regulations for membership of the Board of Directors and the conduct of its affairs;
- Recommend appointment of the Director and other leaders to the Responsible Officer;
- Recommend appointment and removal of staff to the Responsible Officer;
- Appoint and remove Members, and establish categories of membership and associated fees;
- Plan and implement CBB's development;
- Establish processes to manage and monitor the CBB's financial affairs;
- Establish and enforce rules and regulations governing the CBB's activities, provided such rules and regulations are consistent with University policies, procedures and guidelines; and
- Establish such committees as it deems necessary to discharge its responsibilities; this may include establishing advisory bodies comprised primarily of external Members for the purpose of providing strategic or scientific advice to the Board of Directors or the Director.

Director

1. The Director is appointed by the Responsible Officer on the recommendation of the Board of Directors. In making its recommendation, the Board of Directors will seek the views of CBB's members.
2. The Director shall hold a University of Waterloo faculty appointment.
3. The Director's term is determined by the Responsible Officer and is normally for a five year period. A Director's term may be extended or renewed by the Responsible Officer with the support of the Board of Directors.
4. If permitted by the Board of Directors, the Director may delegate some of his/her responsibilities to one or more Associate Directors and/or one or more staff members.
5. The Director is responsible for
 - a. overseeing CBB's operations and managing its budget;
 - b. supervising staff members;
 - c. establishing working groups or committees to provide appropriate guidance and advice in support of his/her responsibilities;
 - d. preparing an Annual Report to the Board of Directors; and
 - e. discharging all responsibilities set out in the constitution or charter, and as directed by the Board of Directors.
6. The Director's performance is reviewed annually by the Responsible Officer. With prior knowledge of the Director, the Responsible Officer will seek confidential input from the Board of Directors, Members of the CBB and its staff by any means s/he deems appropriate.

7. In the event of the Director's absence for any prolonged period, arrangements should be made for the Responsible Officer to appoint an Acting Director for a period of no more than one year.
8. If the office of Director becomes unexpectedly vacant, the Responsible Officer will appoint, after appropriate consultation, an interim Director and initiate the process of filling the vacancy.
9. A Director may only be removed from office for cause, which is to be understood in relation to the duties of the Director as described herein. Causes for removal include negligence, incompetence, unprofessional conduct, and inability to maintain the confidence of the Members. The procedures governing removal for cause shall be those set out in section 4 of [Policy 40 – The Chair](#), except that all references to the "Chair" shall mean the Director and references to the "Dean" shall mean the Responsible Officer.

Other Positions and Committees

Associate Directors

The Director will be assisted by two Associate Directors, one from the Faculty of Engineering and one from the Faculty of Science who will be responsible for the detailed direction and support of the Centre's research activities, including research-related workshops, seminars, and public talks. Associate Directors are appointed to their roles as Associate Directors consistent with the Associate Directors Terms of Reference.

Administrative Assistant

An administrative assistant manages the Centre's operations, provides organizational and logistical support, and serves as the initial point of contact between the Centre and internal and external individuals and organizations.

Operations Committee

The operations committee provides guidance on the day to day operations of CBB and ensures that CBB meets the needs of its members. A minimum of five regular member representatives of the CBB membership plus the Associate Directors comprise the Operations Committee. The Director shall seek advice from the Operations Committee about initiatives involving CBB members. Members are appointed to the Operations Committee consistent with the Operations Committee Terms of Reference.

Advisory Board

The CBB advisory board is comprised of leaders in industry, academia or other institutions who may be able to provide guidance to CBB. Members are appointed to the advisory board consistent with the Advisory Board Terms of Reference.

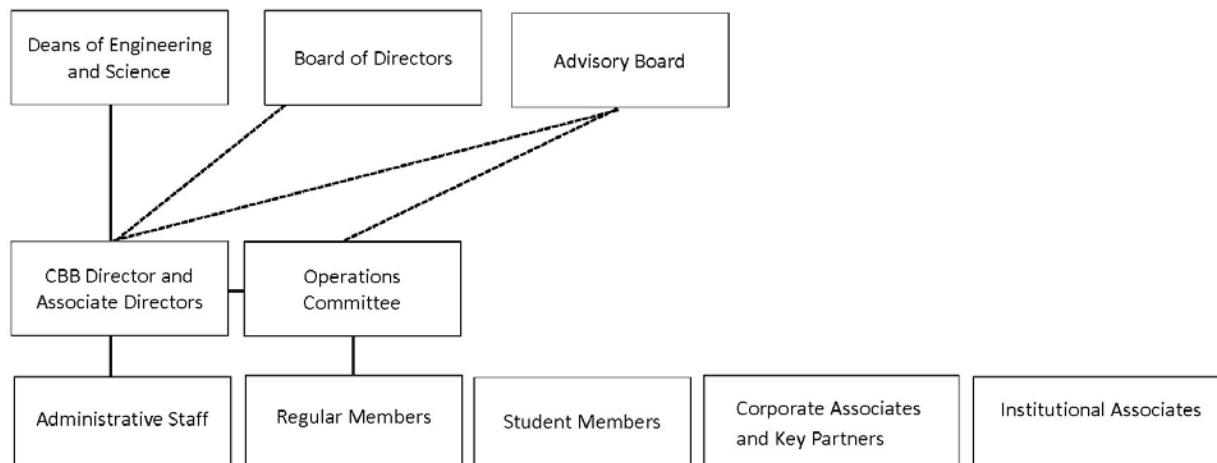


Figure 1. CBB Administrative Structure

Annual General Meeting

Once a year, the Centre will hold an annual meeting inviting all regular members to attend the meeting. The Centre may also choose to invite additional guests to attend the meeting.

Amendments to the Constitution

A two-thirds majority vote by the CBB membership is required to ratify amendments to the constitution.

TERMS OF REFERENCE

Established October 2011

Updated September 2016

- **Advisory Board**
- **Board of Directors**
- **Associate Directors**
- **Operations Committee**

Advisory Board

Terms of Reference

As a senate approved research Centre at the University of Waterloo, the Centre for Bioengineering and Biotechnology (CBB) relies upon the best and most up-to-date information, knowledge and advice to support its overall mission. The founding Advisory Board (AB) was established on June 26, 2014 as a means to obtain knowledge, objective advice and guidance from other academic institutions, industry and government in areas relevant to the Centre.

Membership

- The AB should be comprised of representatives from other academic institutions, industry and government reflecting the diversity of inter- and trans-disciplinary research the CBB fosters and supports.
- Members are selected for the excellence of their expertise and leadership in their respective fields.
- The size of the AB should be typically between eight (8) to fifteen (15) members.
- Advisory Board members are nominated by the Operations Committee and confirmed by the Board of Directors.
- The AB Chair is the Associate Vice President, University Research, University of Waterloo or his or her delegate.
- The CBB Director is an ex-officio member of the AB.

Mandate

- The AB's mandate is to provide advice and recommendations to the CBB Director, Associate Directors, and the CBB Operations Committee.
- AB members provide an ongoing exchange of information between industry and CBB, help promote CBB and communicate the Centre's activities to industry, government, the research community, the university and the public.

Meetings

- The AB should meet once or twice annually.
- One meeting per year should be held at the University of Waterloo and AB members are encouraged to attend in person, but the opportunity for attendance at the meeting by telephone or internet will be provided whenever possible.

- Advisory Board meetings are open to the Director and Associate Directors of CBB and the Operations Committee of CBB. CBB staff may also be present at the Advisory Board meetings to receive feedback and ideas, and ensure the operation of the meeting.
- Minutes from the Advisory Board meetings will be distributed to the Advisory Board and the Operations Committee within one month from the date of the meeting.

Terms

- The AB Founding Members were appointed for an initial period of three (3) years. The list of founding members is provided in the Appendix.
- At the end of the initial three year term, AB members may be re-appointed to two- or three-year terms.
- Appointments to the AB and subsequent renewals will be reviewed and approved by the CBB Operations Committee.
- New members may be invited to an initial term up to 3 years.
- Approximately one-third of AB seats should turn over each year.

Board of Directors

Terms of Reference

The Board of Directors of CBB is the governing body responsible for CBB. In this role, the Board of Directors provides fiduciary oversight for CBB and provides guidance to the CBB Director and Associate Directors on planning, direction, and staffing of CBB.

Membership

- The composition of the Board of Directors is specified in the CBB constitution.
- Board of Director members are nominated by the Operations Committee and recommended to the Director of CBB. Board of Directors members are selected to ensure fair and diverse representation from CBB's areas of interests. Board of Directors members are also expected to have held leadership positions in the University or their companies, and thereby be able to provide sound advice and guidance to CBB.
- The Chair of the Board of Directors is the Responsible Officer for CBB or his or her delegate.
- The Deans of Engineering and Science or his or her delegate are ex officio members of the Board of Directors of CBB.

Mandate

- The Board of Director's mandate is to provide guidance to CBB on policy, activities and budget planning.
- The Board of Directors has the authority to execute and monitor the affairs of CBB, subject to all applicable University policies, procedures and guidelines. This includes the ability to:
 - Enact rules and regulations for membership of the Board of Directors and the conduct of its affairs;
 - Recommend appointment of the Director and other leaders to the Responsible Officer;
 - Recommend appointment and removal of staff to the Responsible Officer;
 - Appoint and remove Members, and establish categories of membership and associated fees;
 - Plan and implement CBB's development;
 - Establish processes to manage and monitor the CBB's financial affairs;
 - Establish and enforce rules and regulations governing the CBB's activities, provided such rules and regulations are consistent with University policies, procedures and guidelines; and
 - Establish such committees as it deems necessary to discharge its responsibilities; this may include establishing advisory bodies comprised primarily of external Members for the purpose of providing strategic or scientific advice to the Board of Directors or the Director.

Meetings

- The Board of Directors should meet once a year and additionally if needed.
- Board of Directors meetings are open to all regular members of CBB and the CBB administrative assistant.
- Minutes will be taken at all meetings and will be available to all members of CBB.

Terms

- Board of Directors members are appointed for two (2) year terms that may be renewed if needed. Shorter terms are possible in order to accommodate sabbaticals or other lengthy absences from the University of Waterloo.

Associate Directors

Terms of Reference

The Associate Directors of CBB are responsible for assisting the CBB Director with the management and operation of CBB. In this role, Associate Directors provide vital feedback and guidance to the Director.

Appointment

- The Associate Directors are expected to represent larger membership patterns within CBB and should be selected to ensure a diversity of representation between the Associate Directors, and a breadth of CBB interests.
- The Associate Directors are nominated by the regular members of CBB. A nominating committee may be formed to solicit nominations and make a recommendation to the Director. The nominating committee must demonstrate that the input of CBB membership has been part of the process through either an open nomination process, or an interview process of regular members. In the case of nominating one Associate Director, this search may be limited to those members most relevant to expected Associate Director.
- The Associate Directors are appointed by the Director of CBB, on the recommendation of the nominating committee.
- The Associate Directors shall hold University of Waterloo faculty appointments.

Terms

- The Associate Directors terms are determined by the Director of CBB and are normally for a three (3) year period. An Associate Director's term may be extended or renewed by the Director of CBB with the support of the Operations Committee.
- In the event of an Associate Director's absence for any prolonged period, arrangements should be for the CBB Director to appoint an acting Associate Director for a period of no more than one year.

Operations Committee

Terms of Reference

The Operations Committee of CBB is responsible for planning and executing the activities of CBB. The Operations Committee is also responsible for ensuring that CBB provides interactions and functions that are useful to CBB members. The Operations Committee is comprised of members of CBB.

Membership

- The Operations Committee should be comprised of representatives from various departments and research directions represented by CBB and reflect the diversity of inter- and trans-disciplinary research the CBB fosters and supports.
- Student members of CBB are eligible to be members of the Operations Committee.
- The size of the Operations Committee may adjust to reflect diversity of interests and communities within CBB.
- Operations Committee members are nominated by their peers through an open process. The nominations are then reviewed by the current Operations Committee to ensure that the committee has retained a diversity of perspectives. In the case of multiple nominations, the Operations Committee may seek the input of the CBB membership to determine the best candidate for the Committee.
- The Chair of the Operations Committee is the Director of CBB or his or her delegate.
- The CBB Director and Associate Directors are ex-officio members of the Operations Committee.

Mandate

- The Operation Committee's mandate is to provide advice and recommendations to the CBB Director, Associate Directors, and CBB staff.
- Operations Committee members provide an ongoing exchange of information between their academic and research units and CBB, help promote CBB and communicate the Centre's activities to their departments, research groups and other colleagues at the University of Waterloo.

Meetings

- The Operations Committee should meet at least once a term.
- Members of the Operations Committee who are absent from two meetings in a year, may be asked to resign from the Operations Committee.
- Operations Committee meetings are open to all members of CBB and CBB staff.
- Minutes from the Operations Committee meetings will be distributed to the Operations Committee within one month of the meeting and non confidential summary of the minutes posted publicly.

Terms

- Operations Committee members are appointed for three (3) year terms that may be renewed. Shorter terms are possible in order to accommodate sabbaticals or other lengthy absences from the University of Waterloo.
- In any year, approximately one quarter to one third of the operations committee should turn over to new operations committee members.

E - Listing of seminars and events

Distinguished Lectures (5)

1. "The Next 3 Billion" Suneet Singh Tuli, BSc, CEO, Datawind Inc., November 11, 2014
2. "Tackling Grand Challenges in Global Health and Development" Peter Singer, PhD, CEO, Grand Challenges Canada, October 5, 2015
3. "Accelerating Academic Research into Commercial Impact" Charles L. Cooney, PhD, Professor, Chemical Engineering and Faculty Director Emeritus, Deshpande Center for Technological Innovation, MIT, November 6, 2015
4. "A Wide-Angle View of Vaccine R&D and Manufacturing" Donald F. Gerson, PhD, Co-Founder and CEO, PnuVax Inc., March 27, 2015
5. "Biosensors and nanomaterials: a scientist's journey from fundamental science to creating value to society" Cynthia Goh, PhD, Director, Impact Centre and Professor, Department of Chemistry, University of Toronto, September 30, 2015

Academic-Industry Networking Forums (3)

1. "Devices and Sensors Academic Industry Forum", University of Waterloo — Ontario Centres of Excellence, June 18, 2014
2. "Biomaterial & Biomanufacturing Academic Industry Forum", University of Waterloo — Ontario Centres of Excellence, January 19, 2016
3. "Greenhouse Gases Academic Industry Forum", University of Waterloo — Ontario Centres of Excellence, October 12, 2016

CBB Workshops (5)

1. "CIHR Info Session on open program changes and grant writing tips" Leslie Copp, University of Waterloo, January 8, 2014
2. "CBB Workshop: How to Start a Spinoff Company: Some Key Steps and Who Can Help" Benton Leong, Investor; Member, Selection Committee, Golden Triangle Angelnet, December 11, 2015
3. "Mitacs Programs and Funding Opportunities" Shaylene Nancekivell, Business Development Specialist, Waterloo Mitacs, April 7, 2016
4. "UWaterloo Intellectual Property" Eric Luvisotto, Technology Transfer Officer, University of Waterloo, Waterloo Commercialization Office, July 25, 2016
5. "UWaterloo Intellectual Property Part 2 Case Study" Eric Luvisotto, Technology Transfer Officer, University of Waterloo, Waterloo Commercialization Office, September 21, 2016

Conferences (2)

1. Biophysical Society of Canada Conference, University of Waterloo, June 17-19, 2015
2. Waterloo Region MED TECH 2016 Conference, Grand River Hospital Freeport Campus, May 25, 2016

Guest Lectures/Seminars (5)

1. "Ontario Life Sciences Sector — Challenges and Opportunities" Jason Field, PhD, Executive Director, Life Sciences Ontario, September 19-20, 2013
2. "Biofuels and Waste Treatment" and "Biotechnology: Innovations in Imaging" Panel Discussion and Presentations, September 29-October 1, 2014
3. "Fermentology: Innocente Brewery. From Academic to Fermentologist" Steve Innocente, PhD, Head Brewer and Owner, Innocente Brewing Company, November 6, 2015
4. "CBB Panel Discussion: Engaging Hospitals in Research Projects" June 17, 2016
5. "Harnessing natural biogeochemical cycles for waste treatment: examples of successful environmental biotechnologies" Dr. Elizabeth Edwards, Professor, Department of Chemical Engineering and Applied Chemistry; and Director, BioZone – Centre for Applied Bioscience and Bioengineering, University of Toronto, September 23, 2016

Biomedical Discussion Group Lectures (14)

1. "Translational studies of sodium nitrite supplementation to reverse arterial aging" and "Healthy ways to delay vascular aging" Douglas R. Seals, PhD, Department of Integrative Physiology, University of Colorado, September 11, 2013
2. "Bio-MEMS Seminar: "High-Throughput Analysis of Protein-Protein Interactions Using Droplet-based Microfluidics" Soo-Ik Chang, PhD, Professor of Biochemistry, Chungbuk National, October 24, 2013
3. "Seeing cells in the living eye: Pushing the limits of high-resolution retinal imaging" Jennifer Hunter, PhD, Assistant Professor, Departments of Ophthalmology, Biomedical Engineering, and Center for Visual Science, University of Rochester," October 24, 2013
4. "Heart Wall Myofibers are Arranged in Minimal Surfaces" Kaleem Siddiqi, PhD, Professor and William Dawson Scholar, School of Computer Science, McGill University, October 25, 2013
5. "FDA's role in regulating medical devices: premarket and scientific research programs" Yuan Fang, PhD, Regulatory Scientist, U.S. Food and Drug Administration (FDA), September 10, 2014
6. "Imaging Lipids in the Vulnerable Brain" Shawn Whitehead, PhD, Assistant Professor, Depts. Anatomy and Cell Biology; Clinical Neurological Sciences, Western University, November 27, 2014
7. "Exercise Training in Adverse Cardiac Remodeling" Dirk J. Duncker, PhD, Professor of Experimental Cardiology, Erasmus University, The Netherlands, April 2, 2015
8. "Persuasive Health Technology to Improve Health and Wellbeing" Olga Kulyk, PhD, Assistant Professor, Persuasive Health Technology Lab, Center for eHealth, University of Twente, Enschede, The Netherlands, May 27, 2015
9. "Zebra Mussel-inspired Electrically Conductive Polymer Nanofiber" Boxin Zhao, PhD, and Wei Zhang, Department of Chemical Engineering, University of Waterloo, June 11, 2015
10. "Mussel Power: Defining the Essentials for Translation to Technology" J. Herbert Waite, PhD, Professor of Biochemistry, Departments of Molecular Cell and Developmental Biology and Chemistry & Biochemistry, University of California, Santa Barbara (UCSB), August 13, 2015

11. "A tissue mechanist found in translation" Thomas Willett, PhD, Assistant Professor, Systems Design Engineering, University of Waterloo, November 19, 2015
12. "Ultrasound imaging innovations for live monitoring of complex flow dynamics" Alfred Yu, PhD, Associate Professor, Electrical and Computer Engineering, University of Waterloo, October 29, 2015
13. "Nanostructured based Lab-on-chips for optical and electrical detection" Sara Mahshid, Postdoc, Leslie Dan Faculty of Pharmacy, University of Toronto, April 14, 2016
14. "Image-based models of solid tumors behavior in diagnosis, treatment, and prediction" Dr. Madjid Soltani, Post Doctoral Fellow, Johns Hopkins University and Director, Computational Medicine Institute (CMI) at KNT University of Technology and Ministry of Health, Iran, August 17, 2016

F - Member awards and achievements

Canada Research Chairs (12)

- PU CHEN, Chemical Engineering; Canada Research Chair in Nano-Biomaterials
- C. PERRY CHOU, Chemical Engineering; Canada Research Chair in Novel Strategies for High-Level Recombinant Protein Production
- CLARK DICKERSON, Kinesiology; Shoulder Mechanics
Understanding the mechanics of the human shoulder. His research will improve our understanding of the fundamental causes of shoulder damage and prompt changes to our workplaces and daily lives that will protect shoulders and improve the lives of Canadians.
- BRIAN DIXON, Biology; Fish and Environmental Immunology
Understanding fish immunology and applying it to environmental problems such as climate change. His research will lead to increased knowledge and policies to preserve fisheries, threatened cold water species and aquaculture stocks.
- MARIANNA FOLDVARI, Pharmacy, Bionanotechnology and Nanomedicine
- FRANK GU, Chemical Engineering; Advanced Targeted Delivery Systems
Reducing eye injections by using nanoparticles. His research will lead to new ways to treat eye diseases.
- MING LI, Computer Science; Bioinformatics
Predicting protein structures. This research will make genome mapping, homology searches and determining protein structures more efficient by developing tools in bioinformatics.
- JOHN MCPHEE, Systems Design Engineering; Biomechatronic System Dynamics
System Dynamics: From Cars to Humans. His research will result in innovative mechatronic and biomechanical systems that will improve the performance of elderly, athletes and persons with disabilities.
- CAROLYN REN, Mechanical and Mechatronics Engineering; Lab-on-a-Chip Technology
A laboratory in the palm of your hand. This research will lead to hand-held devices for point-of-care diagnosis; reducing the costs with health care and environmental protection.
- ALEXANDER WONG, Systems Design Engineering; Medical Imaging Systems
Imaging technologies to detect cancer. His research will lead to the development of new medical imaging and analysis technologies for early detection of cancer.
- JOHN YEOW, Systems Design Engineering; Micro and Nanodevices
Treating diseases with micro and nanotechnologies. This research will lead to development of new medical instruments and devices for early diagnosis and therapy of diseases.
- JUSTIN WAN, Cheriton School of Computer Science; Scientific Computing
Visualizing the Ailing Brain and Body. His research is aimed at improving simulation techniques in computer-aided surgery and enhancing results in medical imaging diagnostics in order to lead to better patient outcomes and savings to the health-care systems

NSERC Industrial Research Chairs (3)

- PETER HUCK, Civil and Environmental Engineering; Water Treatment
Investigating the presence of known and emerging chemical and microbial contaminants in source waters; and the evolving technologies for the removal of these contaminants.

- JOHN MCPHEE, Systems Design Engineering; Mathematics-Based Modelling and Design
In collaboration with Maplesoft and Toyota they are investigating ways to develop math-based models and computer simulations, with a focus on automotive applications such as vehicle dynamics, powertrains and hybrid electric vehicles.
- SAFIEDDIN SAFAVI-NAEINI, Electrical and Computer Engineering; In Intelligent Integrated Radio/Antenna Systems and Novel Electromagnetic Media Technologies
In collaboration with BlackBerry to investigate the next generation of sensor networks, miniaturizing, human body interactions and computational designs and methodologies.

University Research Chairs (9)

- DUANE CRONIN, Mechanical and Mechatronics Engineering, 2016
- CHRIS BAUCH, Applied Mathematics, 2013
- PU CHEN, Chemical Engineering, 2015
- LYNDON JONES; Director, Centre for Contact Lens Research, Optometry and Vision Science, 2012
- BILL MCILROY, Department Chair, Kinesiology, 2011
- MICHAEL K.C. TAM, Chemical Engineering, 2011
- EHSAN TOYSERKANI, Mechanical and Mechatronics Engineering, 2015
- NORMAN ZHOU, Mechanical and Mechatronics Engineering, 2011
- SIVABAL SIVALOGNATHAN, Applied Mathematics, 2011

Royal Society of Canada Fellows (3)

- MING LI, Computer Science
- MURRAY MOO-YOUNG, Chemical Engineering
- JOHN THOMPSON, Biology

Individual Achievements

JONATHAN BAUGH, Chemistry

- 2011 Early Researcher Award

MICHAEL BEAZELY, Pharmacy

- 2014 Outstanding Faculty Mentor, Graduate Program
- 2014 Alumni of Influence, University of Saskatchewan, College of Pharmacy and Nutrition (named one of the top 100 influential Pharmacy alumni)

PHILIP BEESLEY, Architecture

- 2011 Canadian Pavilion Venice Biennale of Architecture Canada – Allied Arts Award

JONATHAN BLAY, Pharmacy

- 2016 Chartered Scientist of the Science Council (UK)
- 2015 Fellow of the Royal Society of Biology (FRSB)
- 2012 Honorary (Life) Membership of the Beatrice Hunter Cancer Research Institute
- 2012 Beatrice Hunter Cancer Research Institute (BHCRI) Award from the Board

CATHERINE BURNS, Systems Design Engineering,

- 2015 Fellow to the Human Factors and Ergonomics Society (HFES)
- 2013 University of Waterloo Outstanding Performance Award
- Faculty of Engineering Teaching Excellence Award
- Faculty of Engineering Research Excellence Award

MELANIE CAMPBELL, Physics and Astronomy

- 2015 Women of Distinction Award, Ontario Confederation of University Faculty Associations
- 2014 Canadian Association of Physicists L'institut National d'Optique Medal for Outstanding Achievement in Applied Photonics, Canadian Association of Physicists

TREVOR CHARLES, Biology

- 2015 Fellowship of Association of Biotechnology and Pharmacy (India)
- 2015 International Award of the Ninth DBN Science and Technology Awards (China)
- OGI/GC SPARK Award

JEFF CHEN, Physics and Astronomy

- 2015 Fellow, American Physical Society

PU CHEN, Chemical Engineering

- 2015 Fellow, Canadian Academy of Engineering
- 2015 University Research Chairs

ERIC CROISET, Chemical Engineering

- Faculty of Engineering Outstanding Performance and Distinguished Performance

DON COWAN, Computer Science

- 2011 ACM Distinguished Scientist

CLARK DICKERSON, Kinesiology

- 2014 NDI Doctorial Award Finalist, Canadian Society for Biomechanics
- 2014 University of Waterloo Outstanding Performance Award

BRIAN DIXON, Biology

- 2015 Canadian Society of Zoologists Robert Arnold Wardle Medal
- 2014 NSERC Synergy Award
- 2014 VROC Participation Award
- 2014 Virtual Researchers on Call Participation Award
- 2013 NSERC Synergy Award

BERNARD DUNCKER, Biology

- University of Waterloo Outstanding Performance Award 2013

JAMES FORREST, Physics and Astronomy

- 2013 Brockhouse Medal, Canadian Association of Physicists (CAP)

KELLY GRINDROD, Pharmacy

- 2014 Canadian Foundation for Pharmacy Wellspring Leadership Award
- 2014, 2013 Canadian Pharmacists Journal Best Paper of the Year
- 2011 CIHR Institute of Health Services and Policy Research Travel Award

FRANK GU, Chemical Engineering

- 2014 Early Researcher Award

LAURIE HOFFMAN-GOETZ, School of Public Health and Health Systems

- 2016 Award for Volunteer Achievement, Seniors Helping as Research Partners (SHARP), Service Awards for Geriatric Excellence
- 2015 Award of Excellence in Graduate Supervision, University of Waterloo
- 2014 Recognition from University of Waterloo, Office of the Vice-President, University Research for participation in the peer review process for CIHR
- 2014 Silver Quill Award for Journal Article
- 2011 Outstanding Performance Award, University of Waterloo

JOHN HONEK, Chemistry

- 2014 Canadian Society for Chemistry Bernard Belleau Award

BRIAN INGALLS, Applied Mathematics

- 2014 Centre for Theoretical Neuroscience Outstanding Performance Award

LYNDON JONES, Optometry

- 2016 30 Most Influential Global Contact Lens Researchers. Contact Lens Spectrum Journal's 30th anniversary celebration
- 2015 Springer Award and Lecture
- 2015 50 Most Influential in Optometry. Optometric Management Journal's 50th anniversary celebration
- 2015 International Optometrist of the Year. School of Optics and Optometry of Terrassa, Universitat Politècnica de Catalunya, Spain.
- 2014 The Glenn A. Fry Lecture Award. American Optometric Foundation
- 2014 Donald Korb Award. American Optometric Association (AOA) Contact Lens and Cornea Section (CLCS)
- 2013 Max Schapero Memorial Lecture. Cornea and Contact Lens Section of the American Academy of Optometry
- 2012 University of Waterloo, School of Optometry and Vision Science, "Woodruff Lecturer"

DANA KULIC, Electrical and Computer Engineering

- 2014 early researcher award

VASUDEVAN LAKSHMINARAYANAN, Optometry

- 2016 Gian Professor award, Govt. of India, Depts. of Physics and biomedical engineering, Indian Institute of Technology, Madras, India

- 2015 Best Paper Award, Optronix 2015, Vancouver, BC. IEEE Photonics meeting.
- 2013 Esther Hoffman Beller Medal, Optical Society of America

EDITH LAW, Computer Science

- CCC Challenges and Visions Track Best Paper Second Prize, 2013
- CHI Best Paper Honorable Mention, 2012

HYUNG-SOOL LEE, Civil and Environmental Engineering

- 2016 Early Researcher Award

RAYMONE LEGGE, Chemical Engineering

- Outstanding Performance Award, University of Waterloo
- Sandford Fleming Foundation Faculty of Engineering Teaching Excellence Award (twice)
- Award of Merit from the Canadian Society for Chemistry
- Excellence in Research Award with Dr. C. Barclay from the Research and Technology Branch of the Ontario Ministry of the Environment
- University of Waterloo Alumni Gold Medal
- Lionel Cinq Mars Award from the Canadian Botanical Association
- Invitation Fellowship from the Japan Society for the Promotion of Science

ZOYA LEONENKO, Physics and Astronomy

- 2012-13 Invited Professorship Award, Department of Physics, University of Burgundy, France
- 2007-2012, NSERC University Faculty Award

KAM TONG LEUNG, Chemistry

- 2014 Award of Excellence in Graduate Supervision

MING LI, Computer Science

- 2011 Killam Prize

JEUWEN LIU, Chemistry

- 2014 Canadian Society for Chemistry Fred Beamish Award
- 2011 Ontario Early Researcher Award

Brendan McConkey, Biology

- Early Researcher Award

JOHN MCPHEE, Systems Design Engineering

- 2014 NSERC Synergy Award for Innovation
- 2014 Fellow of the Canadian Society of Mechanical Engineers
- 2013 Best Paper Award from the American Society of Mechanical Engineers
- 2011 Fellow of the Canadian Academy of Engineers

ELIZABETH MEIERING, Chemistry

- 2016 Outstanding Performance Award, University of Waterloo

- 2014 Keynote Lecture in Symposium on Biophysical Chemistry, Canadian Society for Chemistry
- 2005-2012 University Research Chair, University of Waterloo
- 2012 Outstanding Performance Award, University of Waterloo

CHRISTINE MORESOLI, Chemical Engineering

- Faculty of Engineering Outstanding Performance and Distinguished Performance

SEAN PETERSON, Mechanical and Mechatronics Engineering

- 2014 Early Researcher Award

PASCAL POUPART, Computer Science

- 2014 Centre for Theoretical Neuroscience Outstanding Performance Award
- Early Researcher Award, Government of Ontario (2008-2011)

PRAVEEN NEKKAR RAO, Pharmacy

- 2016 Outstanding Faculty Mentor in the Graduate Program
- 2015 Early Researcher Award, Ministry of Research, Innovation and Science, Government of Ontario

DAVID ROSE, Biology

- Fellow, American Crystallographic Association

PAUL STOLEE, School of Public Health and Health Systems

- 2012 Evelyn Shapiro Mentoring Award, Canadian Association on Gerontology

ALEXANDER WONG, Systems Design Engineering

- 2016 Distinguished Performance Award, University of Waterloo, Canada
- 2015 Outstanding Performance Award, University of Waterloo, Canada
- 2015 Sandford Fleming Teaching Excellence Award, Sandford Fleming Foundation, Canada
- 2014 Norman Edmund Inspiration Award (with Shahid Haider), Edmund Optics, USA
- 2013 Canada Research Chair, Government of Canada, Canada
- 2012 Early Researcher Award, Ministry of Research and Innovation, Canada
- 2012 Outstanding Performance Award, University of Waterloo, Canada
- 2012 Engineering Faculty Research Award, University of Waterloo, Canada

Survey to CBB Faculty members - June 2016

“CBB Five year planning priorities”

Introduction to members:

CBB is nearing the end of its five year mandate. As part of our renewal process, we need to provide a plan for the next five years of CBB. Our operations committee has made several suggestions and we would like your feedback. In each case, let us know whether or not you support the idea. Some context is provided to help explain where things are coming from.

This survey should take less than five minutes. Thank you for your help. Your feedback will help us tune CBB to be an effective Centre for all of us.

Summary of observations with Director commentary:

- 36% CBB Faculty member response rate
- “Top 3” supported priorities:
 1. Company focus days 100% (response for the 5 year plan)
CBB should continue to host company focus days in its next term.
 2. International partnerships 94.4% (response for the 5 year plan)
Canada is a small country and to be competitive Canadian researchers must be competitive on a global stage. In the next few years there will be more opportunities for internationally supported research.
To achieve this priority, CBB should add international members to its Advisory Board. CBB members should be consulted to determine what international partners are the highest quality and present the most strategic possible partnerships. Representatives from these suggested partners will join the currently existing Advisory Board. In consultation with the board, an international engagement strategy will be developed to look for opportunities for joint research, joint funding, student exchange, and shared seminars.
 3. Government relations 88.9% (response for the 5 year plan)
Provincial and federal government relationships can be important in responding to opportunities and these groups can provide input into future opportunities. Presently CBB does not have anyone on its team with this expertise or set of relationships. CBB should seek to hire strength in this direction through either a Managing Director, or a Manager, Government Relations, depending on funding.
- There is further interest in:
 1. Pilot/Seed funding program 83.3% (response for the 5 year plan)
CBB should initiate a seed funding program for its members. The exact definition of the program should be defined by a program committee. The intention of the program should be to support early stage research that will lead to promising grant applications. A seed amount of 7-10k is suggested, enough to support a graduate student for 4-6 months.
 2. Communications 83.3% (response for the 5 year plan)
The need for stronger communications support has been identified by CBB members. CBB needs to communicate the work of its members internally and externally. UW Communications can provide some of this role, but having a person at CBB who could liaise

and help UW Communications as well as contribute additional communications for CBB in traditional and social media would be helpful. This role could be started with a part-time or co-op communications specialist, to understand the depth of the needs and expanded if needed.

3. More financial commitments from companies 75% (response for the 5 year plan)
CBB has maintained part time business development support, as well as worked closely with the office of research, and the corporate partnerships office. To continue our successful company relationships, we will need strategic outreach to companies that have already been reached by CBB to deepen relationships, as well as continuing relationships with our companies that are already familiar with CBB. The office of research has a strong network of corporate partnership managers that are dedicated to full time company outreach and it does not make sense for CBB to duplicate these activities. However, CBB has a stronger knowledge of member research activities and a better capability to host focus days and similar events. Focus days are a format that work very well for our members, as opposed to larger multi-company networking events which have not had as much support. This points to the importance of providing networking activities with deep interaction opportunities for our members.

CBB has met with Mike Szarka, Director, Corporate Partnerships and Evelyn Allen, Manager, Corporate Partnerships for Life Sciences. Our plan is to work closely with Mike and Evelyn to use their resources for broad outreach, then moving to deeper relationship building with CBB. CBB should consider a full-time Manager, Corporate Partnerships, if funding permits.

4. Peer grant review 66.7% (response for the 5 year plan)
CBB should pilot a peer grant review process. This process would allow researchers preparing grants to submit them to the CBB committee. The committee would review the grant and provide feedback to the researcher. This has been suggested to CBB several times. Some of the cautions are researcher commitment to submit grant drafts early, and CBB reviewer time and commitment to review. There may be some connections to the seed funding program whereby recipients of the seed funding program commit to submitting a proposal, possibly for review by the same peer review committee.
5. Large team grants 66.7% (response for the 5 year plan)
Continuing to seek large team grants is certainly a role of a Centre, and CBB must continually push its research activities in this direction. Our feedback on research support however still acknowledges that smaller grants are useful and help researchers to get started, so these activities can not be ignored. Deepening company relationships to the stage where the company is willing to make a significant investment in research is important and can take several years to establish. Some of the other activities such as peer grant review, and seed funding may also be helpful to increase the odds of Waterloo researchers obtaining larger grants.
6. Grant preparation activities 63.9% (response for the 5 year plan)

Questions and Responses:

1. CBB should continue to hold focused company networking days where one company meets with several researchers.

Context: CBB has facilitated over 106 company interactions in the last 4 years, many of these through “focus days” where a company comes to visit with researchers.(36 responses)

Yes 100%
No 0%

Yes 36
No 0

2. CBB should focus more on large team grant applications. (Examples are CFI, NCE, Strategic Network grants, NSERC Create grants)

Context: Most of the grants facilitated by CBB to date have been NSERC Engage and CRD grants.(36 responses)

Yes 66.7%
No 33.3%

Yes 24
No 12

3. CBB should increase its efforts to obtain financial commitments from companies to support research.

Context: Most of the company interactions supported by CBB to date have been networking or letters of support (non-financial).(36 responses)

Yes 75%
No 25%

Yes 27
No 9

4. CBB should organize peer grant review groups to help give feedback to researchers before they submit grant proposals.

Context: This is an activity that CBB does not currently do, but has been suggested several times by our members. We’d like to understand your interest and possible commitment.(36 responses)

Yes 66.7%
No 33.3%

Yes 24
No 12

5. Connecting to the last question, a model where each time I submitted a grant for review, I was expected to serve on the review of two other grants of my colleagues. Would you participate in this? (36 responses)

Yes 69.4%
No 30.6%

Yes 25
No 11

6. CBB should consider starting a seed funding program to enable pilot studies or pre-grant work. (These would be like funds of \$5k-\$10k, awarded through a small competition.)

Context: CBB does not currently have the budget to support this, but if we did in the future, would this be of interest to you?(36 responses)

Yes 83.3%
No 16.7%

Yes 30
No 6

7. CBB should help fund grant preparation activities (e.g. share grant writer costs with the office of research)

Context: CBB does not currently have the budget to support this, but if we did in the future, would this be of interest to you?(36 responses)

Yes 63.9%
No 36.1%

Yes 23
No 13

8. CBB should continue to develop strong international partnerships.

Context: CBB has successfully built two international partnerships, one with UTwente and one with Sorbonne Universities.(36 responses)

Yes 94.4%

Yes 34

No 5.6%

No 2

9. CBB should work to gain recognition and awareness with the Ontario provincial government and the Canadian federal government.

Context: Funding in health and medicine is largely influenced by government decision makers. Should CBB step up its efforts to gain recognition and influence with Canadian government bodies? This can influence budgets and strategic research areas.(36 responses)

Yes 88.9%

Yes 32

No 11.1%

No 4

10. CBB should increase its commitment to communications. (e.g. research communications, marketing research, getting research into the media, working with UW communications).

Context: CBB does not currently have the budget to support this, but if we did in the future, would this be of interest to you?(36 responses)

Yes 83.3%

No 16.7%

Yes 30

No 6

11. Please identify what you think are the top three priorities for CBB in the next five years. Place 1, 2 and 3 in what you see as the top 3 priorities.

	1	2	3	NA	Total
Academic Events	5	7	6	0	18
Networking events	19	7	5	1	29
Research support	8	9	4	0	21
Business development	3	9	3	1	16
Seed funding support in small grants to researchers	6	6	8	1	21
Grant writing support	3	5	7	2	17
International activities	8	4	1	1	14
National and Provincial activities	6	9	3	1	19
Communications	4	3	5	1	13

Please provide us with any additional comments: (6 responses)

It's time to have a change in the directorship appointments of CBB. They should not be run by the same people all the time in order to avoid being perceived as a dictatorship.

For some questions my answer was not a clear "yes or no". For example, working with Science and Engineering communication teams is good but expanding to do that work ourselves is not. So I entered "no" but still think communication is excellent. For the list above, I would like to include "academic events" just to continue to develop synergies.

Question 11 was hard to answer, since the ordering and wording of items in question 11 did not match the preceding 10 questions.

(can't undo click on unintended Seed funding line, above)

The questions should have allowed comments. Some cannot be justified with simply "Yes" or "No" and the replies could be easily misconstrued. Also, what are the credentials of a given responder? Unfortunately, not all voters are equal in this context. For example, those who were not involved significantly in CBB, and those with no expertise/experience in research centers are effectively unqualified for this survey.

Many of the questions should have had more options or a comment field. Question 11 was confusing and once a button was clicked you could only change it by clicking on another button in the same row.

H - Letters of support

Deans

- Dean of Engineering
- Dean of Science
- Dean of Applied Health Sciences
- Dean of Math

Biomedical Engineering Program

- Paul Fieguth, Department Chair, Systems Design Engineering

Faculty

Engineering Faculty

- Boxin Zhao, Chemical Engineering (early career faculty)
- Murray Moo-Young, Chemical Engineering
- Sean Peterson, Mechanical and Mechatronics Engineering (Lockheed Martin project)
- Armaghan Salehian, Mechanical and Mechatronics Engineering (Lockheed Martin project)
- Ning Jiang, Systems Design Engineering (early career faculty)
- Thomas Willett, Systems Design Engineering (early career faculty)

Science Faculty

- Zoya Leonenko, Physics and Astronomy

Math Faculty

- Brian Ingalls, Applied Mathematics

Applied Health Sciences Faculty

- Richard Hughson, Kinesiology

Companies

- Jason Dowd, Director, Product Development, Biopharmaceutical Division, Apotex
- Frank Cotter, VP Product Management, Enterprise Products, BlackBerry
- George Pinho, President, Christie Medical Holdings Inc.
- Fiona Fitzgerald, National Zone Leader, GE Healthcare Life Science, Canada
- Brian Foody, President and CEO, IOGEN Corporation
- Edward Allen, Chief Scientist, Corporate Engineering, Technology, and Operations, Lockheed Martin
- Tony D'Amore, VP, Product R&D – Global, Sanofi Pasteur

Hospitals

- Tina Mah, Vice President Planning, Performance Management and Research, Grand River Hospital
- Doug Dittmer, Medical Director, Rehab, Grand River Hospital, Freeport Campus

Schools

- Luis Garcia, Chair, Institute of Food Processing Technology and Trades and Apprenticeship (Millwright), Conestoga College
- Veronique Atger, Director of Research, Sorbonne Universités
- T.A.J. Toohan, Dean of Faculty Behavioural Management and Social Sciences, University of Twente

Other

- Marc Gibson, Science Lead, Velocity

August 19, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

I am pleased to endorse the renewal of the Centre for Bioengineering and Biotechnology (CBB). CBB serves as a champion for faculty members, researchers and students who participate in this key area of transformational research that is critical to the strategic interests of the University of Waterloo. Since its inception in 2011, CBB has distinguished itself for its dedication to its members and its commitment to developing important partnerships for the University of Waterloo.

Under the directorship of Dr. Catherine Burns, the university community has benefited from her stewardship and dedication to advancing the interests of the CBB membership. The Faculty of Engineering, with 74 faculty members actively participating in CBB initiatives, has received significant benefit. CBB has supported the Biomedical Discussion Group as well as fostering significant relationships with Grand River Hospital and the local community incubators. CBB also supports the Engineers in Medicine student group, which have allowed them to host several cross-faculty networking events. With Engineering developing a program in Biomedical Engineering, these interactions present very important opportunities for our students and our faculty.

The Centre provides ongoing support to researchers that has led to significant impact on the funding levels of the Engineering faculty. In the four years since CBB was founded, CBB has contributed over \$4 million in new research funding.

Research within biotechnology and the life sciences is a core theme within the University of Waterloo's Strategic Research Plan that transcends all faculties due to its multidisciplinary nature. Having a Centre like CBB allows Waterloo's research efforts in these fields to be more widely known in the context that it will strengthen the university reputation as a research powerhouse in these areas. CBB has played an important role in the last five years

and will play an even more important role for the university as it strives to facilitate these multi-faculty collaborations in its next five-year term.

The Faculty of Engineering strongly supports the renewal of CBB as a Centre at the University of Waterloo. Further, the Faculty of Engineering fully supports the recognition of CBB as a university level Centre, with budgetary support from the university. CBB has proven its capability to have a strong impact in a short time on a limited budget, suggesting that an increased level of support will be managed effectively and result in returns to the university as a whole. Until university level support can be confirmed, the Faculty of Engineering will continue its support of CBB at \$50,000/year.

Sincerely,



Dr. Richard Culham
Acting Dean of Engineering
University of Waterloo
culham@uwaterloo.ca

c.c. Dr. Anwar Hasan, Associate Dean of Research, Faculty of Engineering
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology

September 6, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

The Faculty of Science is happy to support the renewal of the Centre for Bioengineering and Biotechnology (CBB). Since its inception in 2011, CBB has distinguished itself for its dedication to its members and its commitment to developing important partnerships for the University of Waterloo. We encourage CBB to approach its next term with a focus on finding ways to serve as an effective catalyst for enhancing cross-disciplinary research initiatives and facilitating major research applications.

The Faculty of Science has particularly benefitted from CBB: 49 faculty members from Science are members of CBB and have participated actively. CBB has supported the Biomedical Discussion Group as well as sponsoring and providing significant administrative support for the first Meeting of the Canadian Biophysics Society in June 2015. CBB supports the iGEM and UW DNA student teams which have been very successful in their respective competitions. Additionally, CBB continues to build on its relationship with Velocity Science by showcasing a variety of Velocity science students at meetings and events including Medella and Suncayr.

Importantly, CBB has had a substantial and measurable impact on the funding levels of Science faculty members. In the four years since CBB was founded, CBB has played a key role in securing over \$700,000 in new research funding.

Biotechnology and the life sciences continue to be an area of growth for the Faculty of Science. Having a research centre like CBB allows Waterloo's research efforts in these areas to be more widely known. This is particularly important in the context of the University not often being recognized as a research powerhouse in these disciplines. The reality however is that these areas are quite strong at Waterloo and will continue to grow in the future. CBB has played an important role in the last five years and will play an even stronger role for the University of Waterloo in the next five years as it looks to expand its opportunities for CBB members locally and globally.



The Faculty of Science strongly supports the renewal of CBB as a Centre at the University of Waterloo. It also strongly supports CBB's recognition as a University level Centre, with budgetary support from the University. CBB has proven its capability of having a strong impact in a short time on a limited budget, suggesting that an increased level of support will be managed effectively and result in tangible returns to the University. Until University level support can be confirmed, the Faculty of Science will continue its support of CBB at \$25,000/year for the next five-year term.

Sincerely,



Robert P. Lemieux
Dean of Science

c.c. Dr. Bernard Duncker, Associate Dean of Research, Faculty of Science
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology





August 31, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

On behalf of the Faculty of Applied Health Sciences (AHS), I wish to indicate support for the renewal of The Centre for Bioengineering and Biotechnology (CBB) as a Centre at the University of Waterloo. I further support the recognition of CBB as a University Level Centre. Over the last five years, CBB has demonstrated its' commitment and has added value in leveraging important research partnerships for UW.

Currently, 14 faculty members from AHS are associated with CBB. Two significant joint research projects have transpired through the Centre. Richard Hughson, a Kinesiology department faculty member, is working in collaboration with Mechanical and Mechatronics Engineering, and Electrical and Computer Engineering, on a four-year research project with Lockheed Martin. It has amounted to over \$1 million in industry funding and over \$250,000 in overhead to the UW. This project has also resulted in a spinoff company with further Federal and Provincial funding under review.

The second significant project is the recent partnership with the University of Twente in the Netherlands. This partnership has resulted in a MOU between both universities, and the School of Public Health and Health Systems. Faculty members (Helen Chen, Ian McKillop, Paul Stolee, Joon Lee) are working on submitting other health-related research projects in collaboration with Pharmacy, Computer Science, Systems Design Engineering, and Mechanical and Mechatronics Engineering departments and schools.

I am confident that there will be significant opportunities for many other AHS faculty members to participate in activities through CBB and for the development of more cross-faculty research collaborations over the next five-year term.

Life sciences and biotechnology research is quite strong at UW and these areas of research in particular will continue to intensify within the Faculty. A Centre like CBB allows UW's research strength in these areas to become more widely known. CBB will play an important role for the University over the next five years as it looks to expand opportunities for its' members locally and globally.

The Centre for Bioengineering and Biotechnology has proven its' capability to have a strong impact in a short time while on a limited budget, suggesting that an increased level of support consistent with University Research Centre status, will be managed effectively and will result in returns to UW as a whole. AHS looks forward to deepening the relationships it has with the Centre and creating new ones, as they move forward in applying for University level recognition.

Sincerely,



James W.E. Rush, PhD
Professor and Dean
Faculty of Applied Health Sciences
jwerush@uwaterloo.ca



Sept. 21, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

The Faculty of Math is pleased to support the renewal of the Centre for Bioengineering and Biotechnology (CBB) as a Centre at the University of Waterloo.

Over the past 4 years, as part of its multidisciplinary areas of bioengineering, biotechnology and biomedicine, CBB involved several members of the faculty of mathematics, in its efforts to develop research collaborations and partnerships. For instance, in 2015, CBB supported the Southern Ontario Synthetic Biology Academic-Industrial Cluster meeting hosted by Brian Ingalls in Applied Mathematics which enabled his group to make several connections between researchers at UW and the local agri-tech community. Also in this past year, CBB received two IRPG-EU awards with the Office of Research that have brought together several faculty from across campus to work on international partnership collaborations. Jesse Hoey and Edith Law (Computer Science), and ten other faculty are working with the University of Twente, The Netherlands, to submit a Horizons 20/20 grant application in the area of "Data Driven Persuasive Health Technology". Another instance is the participation of Sivabal Sivaloganathan (Applied Mathematics) in a Waterloo team that will be travelling to France this fall to build on the Sorbonne Universités relationship in the area of "Innovative Health Engineering". Both international relationships have resulted in two MOU agreements that will aid in increasing the academic research and student exchange opportunities between the universities.

The Faculty of Math believes that CBB will continue to play a significant role for the University as it strives to facilitate multi-faculty research collaborations and external collaborations. We look forward to strengthening our relationships with CBB and its members over their next five-year term.

Sincerely,



Dr. Stephen M. Watt
Dean of Math
University of Waterloo
deanmath@uwaterloo.ca

c.c. Dr. Raouf Boutaba, Associate Dean of Research, Faculty of Math
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



Prof. Catherine Burns, Director
Centre for Bioengineering and Biotechnology
Systems Design Engineering
University of Waterloo

Dear Dr. Burns,

I am writing to express my support for the CBB and the work which it has undertaken during your time as director.

By far the most important role which the CBB has played is to assist in research networking for new faculty in the Biomedical area. This has been particularly important for Systems Design Engineering since the launch of our new Biomedical Engineering undergraduate program two years ago, as the launch of that program is associated with a relatively large number of Biomedical tenure-track hires. Because of the relatively interdisciplinary breadth of the Biomedical program,

- Biodevices
- Biomechanics / human movement
- Biosignals / Bioimaging / signal analysis and inference,

our hires have had a similar breadth of research expertise and goals, however such a breadth is really much more than what Systems Design, a relatively small department, can hope to offer on its own, with critical mass in each area. As a result, the networking and connections which the CBB offers allows such a critical mass to be developed, creating a much fuller and richer research environment than what our department would have offered.

To be specific, the CBB has helped substantially in the following ways:

- They widely advertise new biomedically-related tenure-track positions, reaching audiences through their network that the department might not reach in its own ads.
- They have developed connections with a number of companies, connections which are of importance for new faculty, particularly those who may have studied outside of Canada and who would like to grow their local network.



- They have created a variety of opportunities for new faculty, including a Pitch Workshop, international visits, Pizza with the Profs, and commercialization assessments.

What CBB has offered is to speak on behalf of the Biomedical research area as a unified voice, rather than a larger number of individual researchers in multiple faculties. In particular, the CBB has made much more progress in building relationships with local hospitals, a relationship which is long overdue, but which has long been challenging since the hospitals are frankly not interested in the overhead of dealing with a large number of individual researchers.

What really characterises the Biomedical area is interdisciplinarity, with substantial work in absolutely every faculty on campus, necessitating some central organization to provide a common context, meeting place, and voice for the many different but interrelated Biomedical activities taking place. The CBB has played this role very well indeed, catalyzing opportunities and bringing together researchers with complementary interests, but who would otherwise not have met.

I absolutely and strongly support the work of the CBB and look forward to its continued presence.

Sincerely,



Paul Fieguth
Professor and Chair
Systems Design Engineering
University of Waterloo

<https://uwaterloo.ca/systems-design-engineering>

<https://uwaterloo.ca/vision-image-processing-lab/people-profiles/paul-fieguth-0>



September 5, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

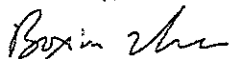
I am writing to support the renewal of the Centre of Bioengineering and Biotechnology (CBB) and highlight the important role of CBB on promoting biotechnology research and building connections between academia and industries.

I have been a professor at the University of Waterloo since 2008, and have been a member of CBB since 2012. My home department is the department of chemical engineering. My research is in the area of surface science and bionanomaterials, relating to CBB's priority area of Biomaterials & Biomanufacturing Innovations.

CBB has played an important role to my research; I have participated multiple CBB-organized events, e.g. seminars, workshop and information sessions related to my research area. These events helped connect my research to industrial needs so as to build connections and partnerships. To name a few, CBB organized the Biomaterial and Biomanufacturing Academic-Industry Forum networking event on January 19, 2016 in which both myself and my industrial partner Aereus Shielding Tech have been invited to present our collaborative research. This event not only enhanced our existing partnerships but also provided opportunities to create new connections with other companies and faculty members. In this event, I met a young faculty member from SYDE, who has same research interests in the development bio-inspired materials but from a different perspective. We are currently working together to write up proposals towards higher-impact collaborative research. CBB co-hosted seminars with our chemical engineering department, e.g., the invitation of world-class marine biochemist Prof Herb Waite from UCSB to speak on the Mussel Power: Defining the Essentials for Translation to Technology. Other CBB events I have participated include the industrial session with Johnson & Johnson, Waterloo-Bordeaux Workshop in 2014, and the Aerospace Defence Forum co-hosted with Office of Research in 2016. I found these events very informative and instrumental to build connections, and create new partnerships.

In summary, the CBB is valuable and has played important roles in helping many faculty members like myself to promote bio-rated research and help build constructive connections with academia and industries. Hence, I fully support the renewal of CBB.

Sincerely,



Boxin Zhao,
Associate professor
Department of Chemical engineering
University of Waterloo

c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



Chemical Engineering
Faculty of Engineering

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

519 888 4567
Fax: 519 746 4979

August 2, 2016

Dr George Dixon,
Vice-president, Research
University of Waterloo

Dear Dr Dixon,

This letter is written in support of the application of the *Centre for Bioengineering and Biotechnology* (CBB) for its renewal as a research centre in the University of Waterloo (UW), and to be approved as a "university research centre".

I became a member of CBB at its inception about four years ago, and three years ago I also became one of the two internal UW members of the 10-membership of its Advisory Board. With these positions, I have had a good opportunity to observe the operation, accomplishments, and potential of the centre.

Started only four years ago, CBB has already demonstrated its important value to the university with its promotion, facilitation and management in the generation of new research grants, publications, conference presentations, workshops, seminars, engagements externally with industry and government, and significant other influences beyond. Strategically based on multidisciplinary bio-innovations, the CBB membership has developed established and emerging world-class research groups. UW should treasure the CBB accomplishments and support it appropriately. To become a more internationally-recognised centre, CBB needs financial infrastructure assistance. With only 1.2 staff institutional assistance, CBB is clearly "punching above its weight" in the relevant university space. Given that our prime minister explicitly observed (at the recent Davos World Economic Forum) that "biotech...is an important economic driver for Canada", CBB should be encouraged to go even further internationally.

CBB has enabled new transformative research where the life sciences interact with the engineering sciences in its two thrust areas of "biomedical systems and device technologies", and "biomaterials and biomanufacturing innovations". In this arena, the traditional university departmental barriers between disciplines are effectively overcome. CBB has the fairly unique opportunity among Canadian universities in having the largest Science and Engineering Faculties with the most extensive strengths in bioengineering and biotechnology among its 120-plus internal multi-Faculty membership. CBB has mobilized the campus-wide relevant talents under one umbrella, thereby creating perhaps the largest research centre at the university. Given the interdisciplinary expertise, CBB has a holistic rather than the usual academic focused narrow approach to the global pressing concerns about health and the environment. Accordingly, the combined research consortium addresses the interconnections between human wellness and ecosystems health. Collectively, CBB pursues preventive and curative solutions to problems in illness, pollution, energy security and employment with innovations for biomedical

engineering, bio-devices, food processing, pharmaceutical manufacturing, pathogen detection, clean biofuels, waste treatment, and more, all impacting on climate change issues.

As a CBB research member *per se*, my connection with CBB has resulted in enhanced research activities which were initiated through various networking with others in the centre and external relationships. For example, my renewed NSERC five-year Discovery grant awarded last year (which is directed to bioreactor- production of biomedical biopolymers) was based on ideas emanated from various discussions with other centre members and introductions to industry and government representatives. Another example relevance is the award of a NSERC Engage grant (with me as a co-investigator for alkaloids production by microbial fermentation processes). Additionally, a NSERC Strategic grant (with me as a co-investigator for renewable biofuel manufacturing) was inspired through the centre brainstorming sessions primarily arranged by CBB. The transformative research activities have generated several publications, invited conference presentations and three patent applications. Importantly I note that other CBB members have had and are experiencing similar benefits resulting from the centre promotion and facilitation of synergistic research collaborations. I believe that these initiatives and achievements would likely not occur without the existence of CBB.

In conclusion, I believe that the documented positive impact of CBB on UW justifies for its renewal as a university-level research centre. With proper institutional encouragement, CBB will be able to escalate its impact in future on the world stage in the internationally-recognized strategic area of bioengineering and biotechnology. Given his Davos pronouncement, our prime minister also would be proud of us.

Sincerely,



Murray Moo-Young, PhD, PEng, FAIMBE, FRSC

Distinguished professor emeritus

mooyoung@uwaterloo.ca



August 29, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

I am writing this letter to express my enthusiastic support for the renewal of the Centre for Bioengineering and Biotechnology. I am currently an Associate Professor in the Mechanical and Mechatronics Engineering department, having joined the University of Waterloo in June 2009 as an Assistant Professor. I joined CBB in 2012 in an effort to broaden the exposure of my research to Canadian industrial partners and to facilitate collaborations with other researchers interested in biomedical engineering. CBB has done a wonderful job of centralizing and broadcasting the bio-related research capabilities at UW, which were not necessarily apparent either internally or externally due to the lack of (at that time) a bioengineering program or medical school.

Joining CBB has been one of the best decisions I have made since joining UW. Shortly after joining CBB, I was rewarded with an invitation to join a research team that CBB was putting together in response to a request for proposal from the Chief Scientist's Office of Lockheed Martin (LM). The proposal was funded and the "Second Heart" project started in September 2012. The project, currently in its 4th year, has brought in over \$1M in industrial funding from LM and \$254k from the Ontario Centres of Excellence (we are currently awaiting the results of an NSERC CRD application that will hopefully bring in an additional \$330k). The research project, with the assistance of CBB, has recently spun out a start-up company (Pression Inc.) to transfer our technology from the laboratory to the market. CBB has played a critical role in the life of this research program, having pulled together the initial research team from its pool of members, spearheading the initial proposal development, acting as the point of contact with LM for extensions, coordinating semi-annual on campus team meetings with industrial liaisons, and providing administrative and strategic support. Without CBB providing the outward face of the bioengineering capabilities at UW and facilitating collaborations internally, one of my most successful research programs would not have materialized.

Over the past few years, the Canadian government in general and the Ontario government in particular have recognized the importance of a global presence in the growing health technology and medical device sectors. This is evidenced by the growing number of research fund opportunities in these spaces (*e.g.*, Health Technology Fund, CIHR initiatives, the MedDev Commercialization Centre, the booming medical device startup community). UW seems to have identified this as well, with the recent launch of the biomedical engineering program, support for CBB, and the number of faculty members with research in the area. In order to fully capitalize on this growing research and entrepreneurial area, I argue that it's prudent to not only renew CBB, but to double down on the investment and provide additional resources to CBB in order to expand their capabilities. I have been very pleased with the support provided to me by CBB, particularly given their limited resources, human and financial. I believe that CBB would benefit from additional resources that would, in turn, lead to greater service to UW faculty members. For example, with additional dedicated human and financial resources, CBB may be

able to better engage with local and regional hospitals to improve the access of UW faculty members to clinical collaboration. It would also provide greater capacity for connecting researchers with biomed companies, assist in technology transfer, and provide connections for graduating students interested in joining the biomedical sector.

In summary, CBB has had an enormously positive impact on my research career. I am fully supportive of their renewal and believe that the University should consider increased support/investment in CBB. I would like to see CBB rival WIN in capabilities. Biomedical research at UW is rapidly expanding and improving our support and visibility will be a strong step towards realizing the University and provincial goals of making Ontario a major player in health technology and medical device development.

Sincerely,

A handwritten signature in black ink, appearing to read "Sean Peterson", with a long horizontal flourish extending to the right.

Sean D. Peterson, Ph.D., P.Eng.
Associate Professor
Mechanical and Mechatronics Engineering

c.c. Dr. Pearl Sullivan, Dean of Engineering
Dr. Anwar Hassan, Associate Dean, Research and External Partnerships
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology

August 16th, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Memo: Support letter for CBB renewal

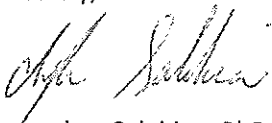
Dear Dr. Dixon:

I am an Associate Professor in the Mechanical and Mechatronics Engineering department at the University of Waterloo and have been with the department since April 2008. My area of research pertains to obtaining smart materials solution for sensing and actuation for medical and industrial applications. I have performed scientific research with the CBB under several contracts and grants with various funding agencies such as Lockheed Martin, USA. I have been a regular participant for the events organized by the CBB with potential collaborators and industry partners such as Lockheed Martin, Grand River Hospital and Blackberry.

CBB has been of tremendous help for me in connecting with potential research partners within the academic and industrial community, and has helped me establish an important part of my research for bioengineering applications to develop actuation mechanisms for lower extremities to help patients with various arterial diseases. In particular, CBB has been quite supportive of faculty members of gender minorities and has been very effective in helping them with networking opportunities.

I am hoping that this information will help CBB receive significant consideration for their renewal. If you have any questions or require any additional information, please do not hesitate to contact me at salehian@uwaterloo.ca, or call me at my extension at 38531.

Sincerely,



Armaghan Salehian, PhD, PEng, Associate Professor,
Mechanical and Mechatronics Engineering Department

c.c. Dr. Pearl Sullivan, Dean of Engineering
Dr. Anwar Hasan, Associate Dean, Research, Faculty of Engineering
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology
Dr. Richard Culham, Acting Dean of Engineering and Associate Dean, International





Sep. 8, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

I am writing this letter to support the upcoming renewal of the Center for Bioengineering and Biotechnology (CBB).

I am an assistant professor at the Department of Systems Design Engineering. My research focuses on human-machine interfaces for neurorehabilitation and non-invasive neurotechnologies, such as Brain-Computer Interfaces and Muscle-Robot Interfaces.

Before joining the University, CBB is in fact one of the reasons that attracted me to Waterloo, turning down two faculty position offers, including a tenured position in Denmark. I joined CBB immediately after I started my position May 2016. Since then, I have received tremendous support from CBB, which came in different forms, as small as covering the cost business cards, as large as joint research proposals and co-supervised graduate students with other CBB members. Through the network events organized by CBB, such as workshops, biomedical discussion group, and pizza with the Prof., I got acquainted with other researchers on campus with common research interests and complementary expertise, as well as clinicians from the Grand River Hospital. These interactions, made possible by CBB, led to joint-grants with other CBB members (Dr. Kofman, Dr. McPhee, Dr. Chen, and Dr. McKillop) that are currently supporting two graduate students and two co-op students. Two additional grant proposals have been submitted, one NSERC-RTI and one Pilot Project Grant from Canadian Parkinson Society. I also participated two International Partnership Grants with the University of Twente and the University of Sorbonne, with potential joint-research projects and grants. CBB also assisted me and Dr. Chen in getting in contact with MedDev Commercialization Centre (MDCC) for the commercialization opportunities and pathways of the outcome from our joint-research project.

My relatively short but extremely fruitful experiences with CBB indicate that it is indeed a catalyst for advancing bioengineering and biotechnology research and innovation at the University of Waterloo. It helped me to establish my research group and an engaging research collaboration network at the University within a relative short time. Therefore, I strongly support the renewal of CBB, and looking forward to more involvement with CBB activities.

Sincerely,

Dr. Ning Jiang
Assistant Professor
Systems Design Engineering

CC:

Dr. Anwar Hasan, Associate Dean of Research, Faculty of Engineering
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



August 30th, 2015

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

RE: Support for the renewal of the Centre for Bioengineering and Biotechnology

I am writing to extend my strongest support for renewal of the Centre for Bioengineering and Biotechnology (CBB) at the University of Waterloo. Being a new faculty member (July 2nd, 2015 start) in the Biomedical Engineering Program in Systems Design Engineering and a multi-disciplinary researcher with interests spanning biomechanics, biomaterials, bioprinting and biodesign, I joined the CBB as soon as I arrived.

The CBB has played an important role in my first fourteen months as an assistant professor at Waterloo. They have provided means of presenting my work to the Waterloo population and others, connecting with colleagues and potential academic and industrial collaborators and partners, both locally (Grand River Hospital) and internationally (Sorbonne Universites). I look forward to leveraging the CBB network to develop my first industrial partnerships in the short term.

As a new faculty member with intentions of contributing to the leadership of the Biomedical Engineering program, it is my opinion that we need the CBB, especially for our research growth success. I see the CBB as a very important resource for biomedical engineering research at Waterloo as the Biomedical Engineering program grows in stature and develops graduate student training.

Sincerely,

Thomas Willett, PhD, Assistant Professor, Systems Design Engineering

c.c. Dr. Pearl Sullivan, Dean of Engineering
Dr. Anwar Hasan, Associate Dean, Research and External Partnerships
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



Thursday, 1 September 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

I am writing to express my strong and enthusiastic support for the renewal of the Centre for Bioengineering and Biotechnology (CBB) as an approved research centre at the University of Waterloo.

I joined the University of Waterloo in 2007 as faculty member of both the Department of Physics and Astronomy, and the Department of Biology. My research focuses on the biophysical aspects of neurodegenerative disorders to find causes and treatments for common, yet debilitating, age-related diseases, one of the key theme areas of CBB. Joining the Centre in 2011 has helped me professionally in many aspects. CCB provides exceptional networking and partnership-building opportunities within government, academic and industrial sectors, as well as funding opportunities.

From the beginning, I was very impressed with the organization and structure of the Centre, which has grown to an impressive size of over 120 UW faculty members. The vision of the Centre's Director, Catherine Burns, and the dedication of the administrative team must be acknowledged for all CBB has provided over the past five years. CBB not only provides exceptional help to all faculty members, it also accepts and supports our initiatives and helps us with many events that we organize. This is demonstrated by the success of major events held within the last year, namely the First Annual Meeting of the Biophysical Society of Canada (BSC) held in June 2015, joint with Bilateral Workshop with University of Bristol that I organized with the help of CBB and WIN. This event hosted over 130 national and international participants and provided invaluable domestic, international and industrial connections. The Biophysical Society of Canada is an active, growing society now thanks to the excellent start that we achieved with the help of CBB.

In addition to this role, CBB has enriched the academic environments of the many graduate students in this field. In March 2016, CBB helped organize a very successful International Biophysics Week Celebration Workshop in the QNC. The event allowed students and professors to showcase their exciting research in biophysics and related areas, and allowed them to network with others in this field, leading to new friendships and collaborative opportunities. The workshop also introduced the discipline to current UW undergraduate

students, who have since expressed keen interest in graduate studies at UW. This event provided an excellent way to attract and recruit top-quality students in biophysics.

In summary, CBB has without a doubt helped raise the profile of UW as a world-leader in biological and biotechnological research. It will promote research collaborations not only in Canada but also around the world, helping to find much-needed solutions to global challenges. Renewing the Centre will allow for its continued promotion of the field, and it will continue to provide valuable contacts with top-ranked academic institutions, industry and corporate relations, and important government agencies.

I believe the University of Waterloo has been well served by CBB, and I highly support the renewal of its mandate.

Sincerely,



Zoya Leonenko
Professor
Department of Physics and Astronomy,
Department of Biology,
Waterloo Institute for Nanotechnology
Center for Bioengineering and Biotechnology
University of Waterloo
200 University Ave West
Waterloo, Ontario, N2L 3G1
Phone: 1-519-888-4567, ext 38273 (of) 38495 (lab)
Fax: 1-519-746-8115
zleonenk@uwaterloo.ca
<https://uwaterloo.ca/leonenko-research-group/>

c.c. Dr. Robert Lemieux, Dean, Faculty of Science
Dr. Bernard Duncker, Associate Dean of Research, Faculty of Science
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



August 30, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

It is my great pleasure to write in support of the Centre for Bioengineering and Biotechnology's (CBB) request for renewal. I have been a member of the CBB since it was formed, and have benefitted significantly from its activities.

As a member of the Department of Applied Mathematics who works in Biotech, I very often reach outside of the Math faculty to find support for my research. The CBB provides an ideal conduit for such interdisciplinary outreach, regularly connecting me to research opportunities across campus and beyond.

Over the years I have participated in a range of CBB events, from the ongoing Biomedical discussion groups, to National Biotechnology week symposia, to targeted workshops with industrial contacts and researchers overseas.

The CBB's support was critical to my own organization of an on-campus meeting of the Southern Ontario Synthetic Biology Academic-Industrial Cluster in 2014. That meeting focused on application to agriculture, and was very successful in making connections between researchers at UW and the local agritech community.

CBB plays an important role for Waterloo researchers who are working in the interdisciplinary area of biotech. I strongly support the institute's request for renewal, which will allow researchers like me to enjoy their continued support.

Sincerely,

Brian Ingalls
Associate Professor
Department of Applied Mathematics
University of Waterloo

c.c. Stephen Watt, Dean, Faculty of Mathematics
Raouf Boutaba, Associate Dean Research, Faculty of Mathematics
Catherine Burns, Director, Centre for Bioengineering and Biotechnology



Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

August 9, 2016

Dear Dr. Dixon:

I am very happy to submit this letter with my complete support for the renewal of the Centre for Bioengineering and Biotechnology.

As a faculty member in Applied Health Sciences, I have long had an engineering orientation to my life sciences research (e.g. control theory applications to study of oxygen uptake and blood flow kinetics and methods for analysis of heart rate variability). Since its inception, the CBB provided an opportunity to interact with engineers and other health science researchers with similar interests.

Most recently, I have two major interactions with colleagues and students in the Faculty of Engineering who are also members of CBB. One aspect is related to image processing of ultrasound where an Engineering student has developed software to analyze arterial walls. This is a very important research tool in my aging and my spaceflight research programs. Interestingly, the Engineering student is attempting to take the software he has developed, while supported by my Canadian Space Agency funding, and establish a company that will sell the software to other researchers around the world. The second is as a co-investigator on a project (Second Heart) which has been supported by contract funding from Lockheed Martin that was negotiated through the CBB. This contract funding has supported a post-doctoral position and a Master's student in my laboratory in addition to supporting colleagues and their students in the Faculty of Engineering. This research has also resulted in establishment of a company that aims to market a novel device that alters leg blood flow.

For the future, connections enabled in part by CBB have allowed me to initiate discussions with medical colleagues at Freeport Hospital that could lead to thesis work for my Master's student and potentially to a new medical device that will monitor and assess brain oxygenation in rehabilitation patients.

My research has benefited greatly from interactions with colleagues in CBB and I look forward to the University of Waterloo's continued support for this excellent Centre.

Sincerely,

Richard L. Hughson, Ph.D.
Professor
Schlegel Research Chair in Vascular Aging and Brain Health

c.c. Prof. James Rush
Prof. Richard Staines
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology

APOTEX

ADVANCING GENERICS

To whom it may concern,

April 6, 2016

This letter is to confirm the support of Apotex Inc. for the University of Waterloo Centre for Bioengineering and Biotechnology (CBB), which arranges meetings between industry and academia. These connections to research facilitate the innovation that modern pharmaceutical product development depends.

As a result of the connections, an initial Engage Grant was engaged. The idea for the Engage project was a direct result of one of the CBB meetings with Apotex Inc. These meetings permitted Apotex to identify suitable academic partners that may be able to assist in developing methodology for comparing complex biologics.

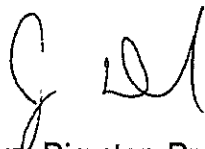
The Engage grant project entitled "Quantitative biochemical response profiling as a methodology for comparing biosimilar compounds", is led by Dr. Brendan McConkey at the University of Waterloo. This project will investigate the use of proteomics technologies for assessment and characterization of the effects of bioactive compounds, and in particular may provide a method for comparing biosimilars and originator pharmaceuticals.

Apotex Inc. is the largest Canadian-owned pharmaceutical company, and produces more than 300 generic pharmaceuticals which, in Canada, are used to fill over 89 million prescriptions a year. The Canadian operations of the Apotex Group of Companies have over 6,000 employees. Extensive investments in Canadian facilities include over 3 million square feet in manufacturing and R&D facilities in Richmond Hill, Toronto, Etobicoke, Brantford, Windsor and Winnipeg. The success of Apotex has also enabled it to diversify into a number of other health-related areas, including fine chemicals, non-prescription and private label medicines, and disposable plastics for medical use. The worldwide sales of the Apotex Group of companies exceed \$2 billion (Canadian \$) per year.

This project is expected to have direct commercial benefit for Apotex within a time-frame of one to five years. The proposed methodology, if effective, will provide strong support for the equivalence of effect of biosimilars and originator compounds in the Canadian market, and thus will reduce the time required for regulatory approval of biosimilars. This in turn can increase the availability of lower-cost alternatives to branded pharmaceuticals, reducing health care costs for Canadians.

Over the longer term, success will breed success, and Apotex has the vision of deeper interactions with CBB, the University of Waterloo and the connections with health, university and industrial sectors in order to drive innovation. This will translate into employment for students, larger project funding for researchers and products that improve the health and well-being of Canadians.

Sincerely,



Jason Dowd, Director, Product Development, Biopharmaceutical Division



Tuesday September 5, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Letter of Support for CBB

As a member of the CBB Advisory Board, I have observed the progress of CBB over the past four years. Healthcare is a key vertical for BlackBerry and UofW CBB is an excellent resource. I'm very impressed with how the Center brings together a myriad of different disciplines within the University and it's excellent and close working relationships with industry from healthcare providers to pharmaceutical and medical equipment providers. They connect innovative ideas with the community, market need and resources, including government funding sources. Their collaborative approach benefits communities, patients and citizens.

We've interacted with the CBB in a number of areas, including being a keynote speaker at the Waterloo Region MedTech Conference organized by Grand River Hospital and CBB in May and introducing CBB members and affiliated companies to other groups within BlackBerry, as an example:

- Professor Karim Karim and his spinoff company, KA Imaging, were introduced to QNX regarding IoT and BlackBerry regarding enhanced fingerprint scanning.

We welcome the opportunity to engage CBB with new and existing joint customers in the enterprise mobility space. Such areas could include working together with common customers/healthcare providers and/or research grants, as an example:

- Working on a proposal for funding from the Ontario Government's Health Technology Fund organized by the Office of the Chief Health Innovation Strategist, whereby we're looking to include CBB as a "third-party" researcher. It was extremely efficient working with CBB as they identified excellent resources within days of a phone call.

Frank Cotter,
VP Product Management, Enterprise Products

LETTER OF SUPPORT:

Centre for Bioengineering and Biotechnology (CBB)

April 13, 2016

Christie Medical supports the renewal of the CBB at the University of Waterloo and the proposal to become a university-level centre.

The CBB has created an ecosystem whereby industry and researchers can interact. It enables industry to more easily access university researchers to help solve product development problems and likewise enables university researchers to find commercial conduits for research projects. Our company is an example of how the CBB is beneficial. We first approached the CBB looking for new medical imaging ideas to grow our innovation pipeline. Through the CBB we were able to meet researchers working on projects in our field of interest. In particular, we became interested in a new x-ray imaging detection technique developed by Dr. Karim Karim. In the process of working with Dr. Karim we eventually became a founding investor in his company to help commercialize the technology.

The need for innovation in Canada is more important now that it has even been before. In the medical field in particular, aging populations are putting a strain on the medical system. New technologies are required to address needs for lower cost care and more efficient care. Telemedicine, self-monitoring products, and minimally invasive surgeries are a few examples of technology innovations now occurring in the medical industry. The CBB plays a key role in driving this innovation by helping companies seek and bring new innovative ideas from the university setting to the market. The Christie Medical example demonstrates how important it is to have a centre like the CBB at the University of Waterloo.

With innovation also comes a need for specialized talent especially in the medical field. By working with companies the CBB creates exposure for the university's staff and students to industry. This enables the CBB to prepare qualified students who can enter industry ready to help drive innovative ideas from the product development stages to commercial application.

Over the next several years, Christie Medical plans on expanding its imaging product lines. We see the CBB as a valuable centre for sourcing new ideas, solving scientific problems and a resource for new talent as we grow our company.

George Pinho

President

Christie Medical Holdings, Inc.



GE Healthcare
Life Sciences

March 26th, 2016

Shirley Fenton, MA, BES (Hon)
Business Development Director,
Centre for Bioengineering and Biotechnology
University of Waterloo.

Dear Ms. Fenton,

It is our pleasure to provide this letter of interest to support the renewal of the Centre for Bioengineering and Biotechnology (CBB).

GE Healthcare (GEHC) provides transformational medical technologies and services that are shaping a new age of patient care. In particular, our *Life Sciences* division delivers breakthroughs in drug discovery, biopharmaceutical manufacturing and the latest in cellular technologies, so scientists and specialists around the world discover new ways to predict, diagnose and treat disease.

Since inception, the Advisory Board has guided and supported the Centre. Over the course of several meetings, members from a variety of industries and government organizations, including GE have worked with CBB researchers to establish areas of mutual interest and channel the scientific innovations through to our research and development teams.

Our interests are aligned in many areas but specific examples include GEHC sponsorship of the CBB Bioinnovations Seminars. The first speaker was the international BioProcessing expert; Dr. Charles L. Cooney. His talk around Accelerating Academic Research into Commercial Research is a particular area of focus for our Life Science division and generated a lot of discussion. Another example of a high value-adding event was the Biomaterial and Biomanufacturing Academic-Industry Forum. This event was well organized and executed and allowed us contact with both young innovators and other potential collaborators. The Centre creates unique opportunities for Commercialization and knowledge-sharing.

As a practice, GEHC cannot commit cash or in-kind to potential projects at this time. However, if and when specific project opportunities align with our internal technology gaps, we would welcome an opportunity to engage in discussions directly with CBB scientists.

In conclusion, GE Healthcare Life Sciences is very pleased to support this application.

A handwritten signature in black ink, appearing to read 'Fiona Fitzgerald', written over a white background.

Fiona Fitzgerald
National Zone Leader
GE Healthcare Life Science, Canada
fiona.fitzgerald@ge.com
Tel : 5149196700



September 28, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario N2L 3G1

Dear Dr. Dixon:

Re: Support for the Renewal of CBB

Iogen Corporation is pleased to provide a letter of support for the renewal of the Centre for Bioengineering and Biotechnology ("CBB").

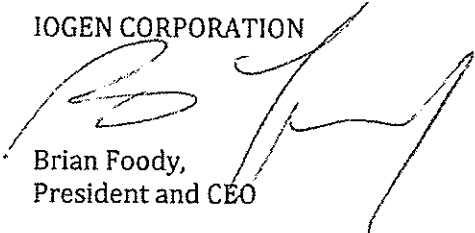
Iogen is a renewable energy company. We are developing next generation biofuels to replace gasoline and diesel with products that are renewable, have ultra-low greenhouse gas emissions and are made from the vast quantities of household and agricultural residues that go to waste every year.

We are one of North America's top five registered producers of renewable compressed natural gas for powering CNG trucks, buses and cars. We are also partnering with major energy companies to make ethanol from sugar cane residue and partially renewable gasoline from landfill wastes.

As a founding member of the Advisory Board for CBB, I have been impressed with the quality of the work and the commitment of the people at CBB. CBB offers a model for the best of how universities can reach out to the broader community, including both businesses and universities. I strongly recommend that Waterloo continues this important initiative.

Sincerely,

IOGEN CORPORATION



Brian Foody,
President and CEO

Cc: Dr. Catherine Burns
Director, Centre for Bioengineering and Biotechnology
University of Waterloo

Dr. Ned Allen
Chief Scientist

31 August 2016

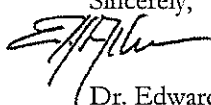
Re: Letter of Support for Centre for Bioengineering and Biotechnology

Dear Dr. George Dixon,

Lockheed Martin is pleased to support the renewal of the Centre for Bioengineering and Biotechnology (CBB) at the University of Waterloo and the proposal to become a university-level center. In 2012, we approached CBB to explore the design and feasibility of a mobile system, referred to as "Second Heart", intended to provide workload reduction on the heart and cardiac system for athletes and people with regular and sustained periods of exercise such as marching soldiers or package delivery personnel. The initial proposal for the "Second Heart" project was led by Dr. Catherine Burns, CBB Director, who assembled an expert multidisciplinary team of researchers to provide research services to Lockheed Martin in support of its investigation of the design and use of "Second Heart". CBB was instrumental to the success of the "Second Heart" initiative by building a team with the core competencies, skills and domain knowledge to execute this project successfully and managing the project as it matured which included reporting to Lockheed Martin management and coordinating visits for company representatives and international research teams.

Lockheed Martin's investment of \$1.1 million into the research project over 4 years is a testament to the expertise and resources provided by CBB. This academic and private sector partnership facilitated by CBB has produced transformational research that benefits the lives of everyday Canadians and Lockheed Martin's business and core customers. Beyond the team curation, CBB provides industry the opportunity to develop partnerships with CBB members and granting agencies. The Lockheed Martin/CBB partnership has produced concrete results leading to continued research supported by large government grants, including a successful OCE VIP II grant and an NSERC CRD proposal currently under review. Lockheed Martin's business model for this kind of new product development is to spin out a new business from the university once the research achieves sufficient maturity. A spin-out company has been launched, with the assistance of Communitech and UW Velocity incubators, to transition the technology developed within the research project into a commercial product. The proposed new spin out business will be a Canadian-based company and provide direct economic impact to the province and country alike. It should be noted that in addition to the military application of the technology for improving the endurance of both our country's soldiers, there is a likely benefit of this technology for post-surgical applications, and for those with chronic disease effecting blood flow to extremities such as diabetes. This spin out company also could have an immediate impact to the Canadian healthcare system, reducing costs of long term care and improving outcomes for patients.

Lockheed Martin is very pleased to support CBB's renewal and promotion application. We see CBB's value as a national and international partnership builder and the facilitator of ground breaking research that drives innovation across multiple industries and economic sectors within Canada and abroad.

Sincerely,


Dr. Edward H "Ned" Allen
Chief Scientist, Corporate Engineering, Technology, and Operations
Lockheed Martin

April 1, 2016

Professor Catherine Burns, Director
Centre for Bioengineering and Biotechnology
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1 Canada

Dear Professor Burns,

Sanofi Pasteur is a global company involved in the biotechnology industry with a significant interest in the production of biopharmaceuticals in Canada and globally.

Sanofi Pasteur is pleased to provide a letter of support for the Centre for Biotechnology and Bioengineering (CBB) at the University of Waterloo. The centre brings together a variety of disciplines from the University of Waterloo with the capacity for making significant contributions to the commercial development and production of novel bio-products in support of potential prophylactic and therapeutic vaccines. We have entered into several successful collaborative projects with the CBB over the past several years and remain confident that this center continues to have a significant impact on the Canadian and global healthcare industry.

The value of CBB is in the opportunities for Industry to develop partnerships with the CBB and granting agencies for specific projects in the areas of bioengineering and biotechnology. Our company recognizes that the training aspect of the CBB will be of benefit by increasing the size of the pool of highly trained personnel with technical skills that match the needs of our organization. We intend to continue our ongoing important interaction with CBB, including potential research collaborations and student employment, as possible.

In summary, we believe that the CBB will continue to provide a significant benefit to the Canadian biotechnology industry by supporting research, contributing to the development of scientific talent, and enhancing the reputation of Canada in the international biotechnology arena.

Tony D'Amore, Ph.D. MBA

VP, Product R&D - Global

TEL : +1 (416) 667-2745 - CELL : +1 (416) 301-5554 - Building 95 Room 308
1755 Steeles Avenue West, Toronto, Ontario, M2R 3T4, Canada

September 8, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Support for the Renewal of CBB

I am pleased to provide this letter of support which strongly endorses the renewal application for the Centre of Bioengineering and Biotechnology (CBB) as a University of Waterloo research centre.

Every day, we at Grand River Hospital (GRH) strive to provide exceptional care to our patients, in order to do this, we strongly believe in the support for ongoing research within our organization. As such, GRH has positioned strategically and operationally to partner with the University of Waterloo to ensure both organizations benefit from experience, skilled, and enthusiastic clinicians and researchers who are keen to work alongside each other in areas of research to discover and advance care that will optimize outcomes for patients.

To that end, GRH has been pleased to partner with CBB in a number of valuable endeavors. For example, the first inaugural Waterloo Region MED TECH Conference, ongoing monthly Pizza with the Profs sessions at our Freeport campus, ongoing discussions related to the concept of a Global Centre for Community-Based Medical Innovation with the initial hub at Grand River Freeport Campus, and a well-attended "Workshop on Engaging Hospitals in Research Projects".

Seeing the value in CBB's contribution to our organization, a number of our staff and physicians at GRH have been supported and encouraged to participate at the leadership for CBB. Gary Higgs, Integrated Chief Information Officer has been a member of CBB's Advisory Board since its inception in 2014. As well, Dr. Doug Dittmer, Medical Director has been a member of the Board of Directors since January 2015.

GRH has benefited from the research that has been undertaken at its organization from CBB members including research conducted by Drs. Johnathan Blay, Helen Chen, Kelly Grindrod, Dana Kulic, Bill McIlroy, Ian McKillop, Paul Stolee, and Shawn Wettig. As well, a number of CBB members have volunteered to participate on working groups at our organization to advance care related to falls prevention and wearable device strategies, an area that GRH has placed significant focused attention on over the past 18 months.

Moving forward, we expect to maintain our strong partnership with CBB and the University of Waterloo by continuing to collaborate with researchers, students, and industry partners. This collaboration will continue to invest in building an ecosystem of research, innovation, and commercialization in the advanced bioengineering and biotechnology space. CBB is uniquely positioned to help advance research and innovation within advanced bioengineering and biotechnology. GRH will continue to partner and collaborate with researchers and students helping stimulate innovation through access to the healthcare environment.

If you have any questions about our commitment for the ongoing support of the CBB at the University of Waterloo, please feel free to contact me.

Sincerely,

A handwritten signature in black ink, appearing to be 'Tina M. Mah', written in a cursive style.

Tina M. Mah, PhD
Vice President Planning, Performance Management and Research

cc. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo



August 26, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Support for the Renewal of CBB

I am pleased to provide this letter of support and strongly endorse the renewal of CBB.

I have been involved with CBB for several years and have found the relationship to be extremely valuable to the work we do here at Freeport Hospital, a campus of Grand River Hospital. It all began when an engineer, Dana Kulic, called me to ask if she could collaborate on a project that she was working on. Not only did it provide an opportunity for clinicians to observe how engineers work, but it provided valuable insight for her to improve her medical device. I then met Don Cowan, Bill McIlroy, Pearl Sullivan, and Catherine Burns through CBB and the rest is history. Some of them met with our CEO, Malcolm Maxwell, and this helped the hospital understand what a valuable partner the University of Waterloo would be in medical research. This helped in a small way to the formal launch of the Research Partnership between the UW and GRH in March 2015.

Since then, I personally have been involved with a number of professors, who through CBB, have presented at Grand Rounds at the Hospital and our informal "Pizza with a Prof" which has less formality than Grand Rounds but allows engineers and kinesiologists to bounce their ideas off of our therapists, nurses, and doctors. This has proved to be invaluable to our staff.

We have started to collaborate on major research grants, the most recent for a CFI grant. Our plans include collaborating on a major region wide med tech hub, which we believe will be the only one of its kind in Canada. In May of this year, we held the first Waterloo Regional Med Tech Conference, and CBB was a major partner in hosting this along with Communitech and Blackberry. We plan to host this again next year and the help provided to us by Shirley Fenton and her colleagues at CBB was invaluable. In

fact I don't think we could have hosted a conference that was sold out (over 100 people, start-ups, and industry attended) without their help.

We are now in the process of joining ranks with a group from CBB in applying for a major grant from the Ministry of Health Innovation Group. Mr. Bill Charnetski, the head of that Ministry department, has visited Freeport and has said that what we are doing here in collaboration with the University is on his radar. We don't have to be a major teaching hospital to be working in collaboration with UW to apply for these grants.

The importance of the research and development of products in areas crucial to our organization cannot be understated. The hospital needs help not only in innovation with medical devices but also in our processes. We know a little bit about lean theory at the hospital but we are not industrial engineers. Access to these individuals will help us be a better hospital to serve the Region and the province.

Through meet and greet nights I have come to meet at least 30 professors at the university, most of whom are affiliated with CBB. This is partly because CBB has taken steps to build academic-healthcare-industry relationships with ourselves and others (enabled by CBB collaborative efforts, outreach, scholarly lectures, networking events and other programs).

In terms of collaborations that I have worked on with CBB, the most noteworthy has been to found the Global Centre for Community-Based Medical Innovation. This is the dream of having an incubator at Freeport Hospital where Waterloo students can be imbedded in our hospital and observe the way we do things in a way to better understand clinical problems with patients. Other collaborative efforts have included as mentioned the Waterloo Region MED TECH conference, Grand Rounds at the hospital, Pizza with the Profs, Dr. Charlie Cooney Bioinnovations Seminar where I met Prof. Cooney from MIT and have tried to emulate how they set up their hub at MIT, and a Workshop on How to Start a Spinoff Company.

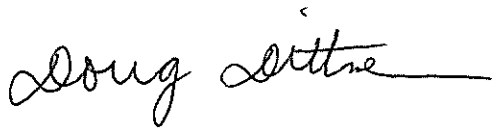
As a member of the Board of Directors for Centre of Bioengineering and Biotechnology (CBB), I have seen the development and growth of CBB. The value of CBB, the research it facilitates and the need for this in our community is not only important for our region, but the potential underscores its importance in Canada and/or the world. Through its efforts, CBB has helped researchers, students, new entrepreneurs, start-ups and healthcare organizations with their research, collaborations and possible partnerships. CBB is helping to link healthcare organizations with students and I look forward to working with Business Development – Co-operative Education in bringing biomedical engineering students to Freeport/GRH. We value the access to research experts and students enabled by CBB. Working with CBB makes it easier for us to find the researchers/collaborators/partners/highly qualified personnel/co-op students we need for our initiatives. I've worked with several CBB researchers (Don Cowan, Dana Kulic, Bill McIlroy, John McPhee, Rich Hughson, Lora Giangregorio, Jonathan Kaufmann, amongst others).

The vision of a thriving medical community here at GRH's Freeport site working side by side with engineers, kinesiologists, computer scientists, social innovators and business has been embraced by the Waterloo community including Laurier University, Conestoga College, Communitech, the Velocity Center and Mayor Berry Vrbancovic. Over the next 5 years I envision that we will secure a grant supporting a 10,000 sq. foot research building here at Freeport, and that building will be populated by grad students

working side by side with health researchers and industry. I envision more international conferences on med tech (co-sponsored by CBB), and as a result of this activity, more medical researchers will be attracted to Waterloo-Wellington. That equates to better healthcare for the citizenry and pride for the people working at GRH. I envision us being the best rehabilitation hospital in the province, and later in Canada.

In plain and simple words, Mr. Charnetski said to me at Queen's Park in June, that we have to stop thinking about this, and just do it. CBB in collaboration with GRH will help us build the hospital of the future.

Sincerely,

A handwritten signature in black ink that reads "Doug Dittmer". The signature is written in a cursive style with a long horizontal flourish at the end.

Doug Dittmer MD, FRCPC

Medical Director, Rehab

Freeport/Grand River Hospitals

c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo

August 25, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Re: Conestoga College's Support for the Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

I am the Chair of the Institute of Food Processing Technology and Trades and Apprenticeship (Millwright) at Conestoga College and I am also a member of the CBB Advisory Board since 2014.

Over the last two years, Conestoga College and CBB have strengthened a collaborative relationship that aims at further developing leading edge technologies for the food and beverage processing industry. CBB has played an important role by connecting their researchers with Conestoga to collaboratively develop project proposals for applied research in different areas. To date, CBB-Conestoga projects have been included in formal proposals for funding in several areas such as food safety (a collaboration with Bill Anderson on novel antibacterial coatings for contact and non-contact surfaces) and beverage quality (a collaboration with Christine Moresoli on the use of fluorescence technology for the fining of wine).

At Conestoga College we believe in collaboration as a fundamental piece for a successful environment, be it academia, the food and beverage industry, or even better, a combination of both. By connecting CBB researchers with our industry partners, we will be able to take important steps toward a more competitive food and beverage processing industry in Ontario and Canada.



In the next few months, CBB and Conestoga researchers will be undertaking projects that should be a stepping stone to a larger, more formal collaboration structure to be developed in five to ten years. CBB researchers have developed technologies that have a high potential for commercialization. Through our applied research programs and with the support of our industry partners, Conestoga will assist in bringing such technologies to market. Working with CBB is an asset for Conestoga and we look forward to an even stronger level of collaboration in the years to come.

Based on all of the above, we strongly support CBB's renewal application and request to move to a university level funded centre. The approval of both will go a long way toward the consolidation of CBB as a leading research organization in Bioengineering and Biotechnology.

Sincerely,

Luis Garcia
Chair – Institute of Food Processing Technology
and Trades and Apprenticeship (Millwright)
lgarcia@conestogac.on.ca

c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1
Canada

Letter of support for the support for the renewal of CBB

Paris
26/08/2016

Dear Dr. Dixon:

I am writing to you in order to express our support for the renewal of the UWaterloo Centre for Bioengineering and Biotechnology (CBB).

As Director of Research at the Sorbonne Universités, I am responsible for coordinating and implementing the research strategy of our alliance with a particular focus of enhancing potential for interdisciplinary cooperation and innovation of our member institution aiming at tackling global challenges. Considering the shared values and complementarity of University of Waterloo and Sorbonne Universities and with respect to the renewal of the Centre for Bioengineering and Biotechnology I thus strongly support the latter.

The cooperation between CBB and the Institute of Engineering in Health of Sorbonne Universités (IUIS) has been initiated following the setup of a strategic partnership between University of Waterloo and Sorbonne Universités signed by Presidents Feridun Hamdullahpur and Thierry Tuot on Nov 30th 2015 in Paris. Following reciprocal visits in June and September 2015, the scope of the agreement included in particular joint activities in the field of transformational interdisciplinary research, amongst which namely in the area of health engineering, bioengineering and bio-economy building on the setup on both sides of dedicated interdisciplinary structures, the CBB on the UWaterloo, and the Sorbonne Universités IUIS on the other side.

The first major event in the framework of our cooperation was the first University of Waterloo – Sorbonne Universités Seminar “Crystallizing transdisciplinary innovation in Health Engineering” in May 2016 held in Waterloo. At this occasion, a delegation of ten laboratory directors and researchers with different disciplinary backgrounds and implicated in the IUIS exchanged with their CBB counterparts and industry representatives on themes ranging from promoting healthy living and aging (Quantifying and Modelling Health and Life) to improving healthcare (medical diagnostics, patient experience). This meeting supported by external funding from the French Embassy in Canada got excellent feedback on both sides as it provided an opportunity for the crystallization of concrete scientific collaborations, academic exchanges and innovation actions between the two partners in the area of Innovative Health Engineering Technologies.

A second edition to take place in Paris is planned in November 2016 and has already benefited from financial support of the International Research Partnership Grant (IRPG) in April 2016.

The collaboration has so far already been very productive and inspiring as it not only showed potential for disciplinary bilateral but also for interdisciplinary international cooperation. There is clear value for researchers from both sides for enabling quality research, both in terms of facilities, innovative spirit as well as in terms of disciplinary cross-fertilization. The themes of CBB and IUIS are challenges that are those of society and industry as showcased in particular by the H2020 research agenda, the French agenda for active aging and the silver economy.

Over the next 5 years, we now aim at structuring this cooperation further, both in research and education as well as in the field of cooperation with industry. Therefore, we have already started negotiations for the setup of a Joint PhD framework agreement and the feasibility of international study tracks in particular at the Bachelor's and Master's levels. Giving opportunity for visiting researchers to stay at CBB and vice versa has also been discussed.

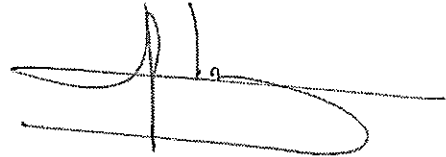
The interdisciplinary scope and facility setup, as well as the connection with industry made working with CBB an excellent choice for Sorbonne Universités which has already been proved by the rich follow-up activities between UWaterloo, UPMC and UTC in particular, including visits, seminars and joint project proposals that could be submitted as soon as this fall already including topics such as e-health, electronics, applied mathematics and bioinformatics.

For all these reasons I would like to acknowledge the results already achieved by CBB during the first 5-year period and strongly support its renewal.

Sincerely,


SORBONNE
UNIVERSITÉS

www.sorbonne-universites.fr
Véronique Atger, Director of Research



c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology,
University of Waterloo

UNIVERSITY OF TWENTE.



Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario
Canada N2L 3G1

FACULTY OF BEHAVIOURAL MANAGEMENT AND SOCIAL SCIENCES

FROM
Elize Schiweck
T 053-489 4486
e.schiweck@utwente.nl

DATE
31 August 2016
YOUR REFERENCE
BMS-PGT-UP-16.067

PAGE
1 of 2
ATTACHMENTS

DEPARTMENT
Psychology, Health & Technology

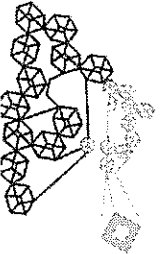
COPY TO
Dr. Catherine Burns, Director, Centre
for Bioengineering and Biotechnology,
University of Waterloo

SUBJECT

Re: Support the Renewal of CBB

Dear Dr. Dixon,

As Head of Internationalization at the University of Twente, I support the renewal of the Centre for Bioengineering and Biotechnology (CBB).



The University of Twente (UT), in particular the Centre for eHealth and Wellbeing Research has a productive and strong collaboration with the University of Waterloo (UW) and CBB since 2008. This collaboration was recognized and strengthened when a University of Waterloo International Research Partnership - EU Grant (IRPG) between The Centre of Bioengineering and Biotechnology and UT was awarded in November 2015 to pursue data-driven persuasive technology and formalized via a Memorandum of Understanding, between University of Twente and University of Waterloo, May 2016. UT and CBB aim to establish an international, transatlantic infrastructure for excellent research for data and patient-centered science to improve health care and social services, to write proposals and to generate new plans to fund data driven persuasive health technology in cooperation with health institutions and industrial companies, to strengthen the transatlantic liaisons between science-business-healthcare.

The collaboration between CBB and the Centre for eHealth and Wellbeing Research has created one of the world's largest international, transatlantic research teams in the field of data driven persuasive technology. The partnership has resulted in a joint workshop in June 2016 at the University of Twente and one is planned for this fall at the University of Waterloo to undertake joint international research projects. CBB and UT submitted a transatlantic proposal T-AP, funded through the European Union's seventh framework programme, to engage transatlantic dialogue and collaboration. The CBB-UT proposal aims to dig into Big Data to understand and model social behaviors in high risk contexts.

In the past five years, UT-students, one at the Masters level and one at the PhD level, have visited Waterloo as visiting scholars for 2-3 month periods. During UT's Summer course, Curious U, two PhD students from Waterloo visited the University of Twente and the Centre for eHealth and Wellbeing Research.

Dr. van Gemert-Pijnen has made several visits and given invited seminars at Waterloo. Dr. Kulyk from the University of Twente visited Waterloo and gave an invited talk in May 2015 during the Dutch Education Mission and Liberation celebrations. Dr. Burns and Dr. van Gemert-Pijnen have co-authored one paper together and Dr. Kulyk is serving as a consultant on the PhD work of one of Dr. Burns' graduate students. Dr. van Gemert-Pijnen holds an adjunct appointment in the School of Optometry at the University of Waterloo, to collaborate on usability of interface design. This beneficial collaboration demonstrated that the research relationship could be expanded to take advantage of upcoming opportunities in health technology, big data, data analytics and the Internet of Things (IoT).

CBB and UT complement each other's strength combining engineering and computer science expertise with social sciences expertise. Jointly, the partners have strong track records in the areas of computer science, human interaction with sensors and automation, data science technology including big data, data analytics, IoT and persuasive technology. Both have a strong track record in applying this research to health care. The resulting, unique powerhouse in the world will be attractive to funding organizations both in Canada, such as NSERC, and EU Horizon 2020 and Marie Skłodowska-Curie Actions Program. It is anticipated that there may be significant joint funding opportunities available now or in the near future to create a platform for international exchange of research and to establish an international, transatlantic research Centre for Persuasive Technology & Smart Society. The MOU facilitates the exchange of personnel and students and research results. We want to explore the possibility to create a model for a joint graduate program.

The cooperation between CBB and UT will boost innovations in health care, because in particular the Canadian –Dutch healthcare systems are comparable. CBB can provide the knowledge and experiences with disease management; UT can provide insights and knowledge about homecare and self-management. CBB and UT together can provide the knowledge to create *safe, smart self-organizing communities, dealing with aging and improving welfare of citizens with different cultural backgrounds*.

CBB and UT are working together in *reducing antibiotic resistance*. The Public Health Agency of Canada and the Dutch government have a proactive policy in fighting infections due to misuse of antibiotics in medical and veterinary domain. We do so by creating a high quality surveillance system, providing data driven persuasive feedback for public health and institutional health. We will work with several data sets including data from the Canadian Integrated program for antimicrobial resistance surveillance (CIPARS) and from CARRS system and Hospital Surveillance systems (Dutch medical centers) and Geospatial data (mobility of people) to develop methods to connect big data sets that have been otherwise studied in isolation from each other. The methods developed provide *GEOHEALTH data analytics*, an emergent field for research exchange.

In the next 5 years, we want to strive with CBB to have a very productive collaboration resulting in:

- A plan for the development of *transatlantic Centre for Persuasive Technology & Smart Society Network*. This Centre would enable international student exchange, development of joint masters/degrees and research on new concepts for self-control and safety that contribute to a vital and healthy society. The Centre is embedded in a strong collaboration between technology, behavioural and social sciences (3TU) and with ongoing relationship with UW in system design and bioengineering.
- A knowledge translation plan. The partnership should establish an accessible communication channel, such as a website. As well, a five year plan will be established for research publication at conferences, workshops or symposia, contingent on the partnership's success in obtaining funding. As an example, the international conference on Persuasive Technology for 2017 is being held in Amsterdam. This presents a unique opportunity for partner participants to both attend and disseminate research at the conferences, as well as communicate directly with each other. This is an example of the kind of strategic leveraging for knowledge translation that will be discussed.
- A plan for personnel exchange of researchers CBB and UT.
- A draft Cooperation Agreement that captures aspects of a sustainable communication, confidentiality, publications, costs, IP rights, etc.
- A 'liaison officer' at Waterloo and Twente responsible for the collaboration will be appointed to guarantee and to enable a sustainable cooperation.
- The Centre for Persuasive Technology & Smart Society Network facilitate the exchange of research and education, and foster the ~~Canada-Dutch collaboration~~ in the medical and healthcare domain.

Sincerely,

Professor Dr. T.A.J. Toonen
Dean of Faculty Behavioural Management and Social Sciences
University of Twente

P.O. Box 217, 7500 AE Enschede
The Netherlands
www.utwente.nl



August 24, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Support for the renewal of CBB funding

As the Science Lead for the Velocity entrepreneurship program, I am responsible for managing a community of early-stage science companies emerging from the University of Waterloo. This has attracted membership from students across all six of our faculties, as well as the involvement of graduates from other outstanding academic institutions here in Ontario and abroad. Owing to our strong contingent of medical device and health-related companies in Velocity Science, we routinely work with the CBB and fully endorse the renewal of their funding to continue our collaborations which translate the research discoveries of Waterloo faculty and students into world-class technologies.


The interaction between Velocity and CBB reaches from the highest-level of our operations down to the day-to-day interaction between our startups and CBB faculty members. In 2015/16, CBB supported Velocity when we played host to the Ontario Bioscience Innovation Organization (OBIO), a Toronto-based advocacy group working to build a stronger entrepreneurial and investment ecosystem for the benefit of Ontario and Canada, whose goal was to establish links into regional centres of innovation and build awareness for the \$9 trillion opportunity that health and biomedical science could represent in Canada. On another occasion, Velocity supported CBB in their startup showcase and pitch completion, and I was personally delighted to participate in that event as a panelist and judge, helping to share my experience from Velocity with CBB faculty members and graduate students considering launching their own companies. From that event, Velocity Science recruited a new team to our program, H2NanO, demonstrating the importance of working together to strengthen the overall entrepreneurial ecosystem at Waterloo. H2NanO is also an excellent example of the research and commercialization interactions between CBB and Velocity, as one of H2NanO's cofounders is Prof Frank Gu, a CBB researcher. Many of our companies work with CBB researchers, including the first Velocity Science startup, Medella Health, who are making glucose-sensing contact lens and clinical near-patient diagnostics. This research and its commercialization have been supported by many experts from CBB in the Faculties of Science and Engineering, including Profs. Vivek Maheshwari and Maud Gorbet, respectively, and Prof Lyndon Jones from the School of Optometry and Vision Science. Without the interaction between these multidisciplinary teams, the necessary critical mass of training and experience would be much more difficult to assemble, which again highlights the need for centres such as CBB to serve as a focal point for individuals with complementary skillsets who might otherwise not have the opportunity or venue to interact and collaborate to translate research into our economy.

With the recent expansion of the Velocity Garage incubator to include wet lab space for later-stage science startups, part of a renovation that has made Velocity the largest free incubator in the world, I

expect that our program will only increasingly engage with CBB. In particular, I have recently been increasingly approached by faculty members seeking to commercialize their technology through entrepreneurship, and I anticipate an even greater adoption of startups by principal investigators, their graduate students, and recent alumni. The relationships CBB helps Velocity companies to build and support will also increasingly foster the vision of a Toronto-Waterloo Tech Corridor, which will see our thriving entrepreneurial spirit benefit from greater access to capital and networks based in Toronto.

Between the startup community and infrastructure being led by Velocity, and the network of world-leading bioscience researchers assembled through CBB, Kitchener-Waterloo is poised to be at the forefront of the rapidly expanding medical device and related economy that is increasingly being driving by the intersection of outstanding science, engineering and clinical sciences that CBB embodies.

Sincerely,

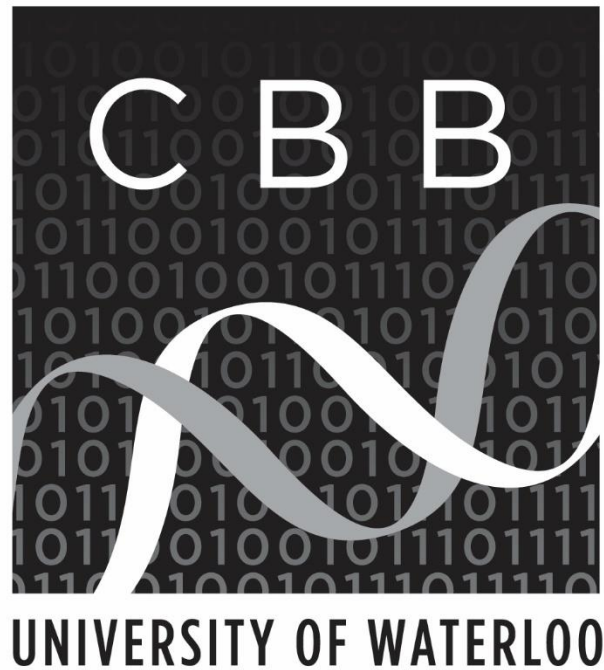
A handwritten signature in black ink, appearing to read 'Marc Gibson', with a stylized flourish at the end.

Dr. Marc Gibson, Science Lead, Velocity

c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo

DRAFT

This constitution has adjusted the governing bodies and reporting structure to the requirements of a university level centre. Formal ratification of the constitution would occur following the approval. CBB currently operates on a constitution approved by SGRC October 2016.



Centre for Bioengineering and Biotechnology (CBB)

University of Waterloo

East Campus 4, Room 2001

cbb.uwaterloo.ca

STRUCTURE AND CONSTITUTION

Established October 2011

Revised September 2016



Mission of CBB

The Centre for Bioengineering and Biotechnology (CBB) at the University of Waterloo was formed in 2011 to promote research and education in the application of engineering and applied sciences principles and techniques to address human health, environmental and industrial challenges. The Centre promotes synergy among its researchers, provides efficient access to shared central services such as equipment and technical support for research, and serves as a focal point for research interaction with industry, hospitals and other external organizations. As a Centre at the University of Waterloo, CBB is governed by Policy #44. As a university entity, CBB is governed by all University of Waterloo procedures and policies.

3.1. Membership in CBB

There are two types of regular members in CBB, *Regular Members* and *Student Members*. Membership as Regular Members is open and virtually automatic for those faculty members at the University of Waterloo who are primarily concerned with research in biotechnology and bioengineering. Membership of faculty members from diverse perspectives is encouraged and these memberships will be decided by approval of the Director or one of the Associate Directors. Again, these memberships are highly encouraged and expected to be virtually automatic. Membership of student members is also highly encouraged and will be granted upon the endorsement of a regular member of the Centre.

There are three other forms of CBB membership. *Institutional associates* are representatives of entities such as hospitals, professional schools, research institutes and government bodies. *Corporate associates* are firms or agencies active in the research, development, or application of CBB research. Membership entitles them to obtain notices of seminars, VIP invitations to research symposia, and research results updates. A third category recognizes *Key partners* who are noted for their extraordinary contribution to the Centre in one or a combination of financial support, facility support, or educational support.

3.2. Role of Groups

Synergy is the major motivating factor for CBB. Intellectual synergy is facilitated by the open individual membership in CBB and its promotion of a healthy research environment. Part of this process is the free association of researchers in groups of a transitory nature, where the close collaboration extends over rather limited time frames such as the conduct of a single project or the creation of one paper. In other circumstances, the “organizational synergy” required to acquire and manage laboratories with large specialized requirements for hardware and technical support results in the emergence of more formal entities such as research groups.

The mandate of CBB is admittedly broad and as such there is a need for research groups in specific topic areas. For groups primarily concerned with research in a specific topic area and that wish to have formal recognition and designation of such, a formal entity within CBB is possible. Such groups are called Working Groups of CBB. Working groups can be proposed at

any time and their status renewed by the Operations Committee. Working groups should be reviewed intermittently to make sure the group is still active, relevant and defined properly.. A listing of working groups can be found on the CBB website.

There is a clear need to coordinate the activities and interactions of the groups, as formal entities, in areas such as the cooperative acquisition, administration, maintenance and allocation of laboratory resources. Further, CBB can provide efficient access to many services by eliminating duplication. Such services might be document preparation, report distribution, advice on grant applications and proposals, and a public relations interface both on and off the campus.

Should the Centre reach a point where it can offer funding or grants to its members, a formal proposal process will be established whereby members apply formally for funding and proposals are reviewed by a selection committee.

Other research groups within the University should have access to CBB services, negotiable with the Director of CBB and the appropriate CBB researchers where relevant.

3.3. Governance

Responsible Officer

The responsible officer for CBB is the Vice President of University Research (VPUR) or his/her delegate.

Governing Body

The Governing Body of CBB is the **Board of Directors** who provide guidance to CBB on policy, activities and budget planning.

The membership in the Board comprises senior members of the community whose responsibilities involve CBB members in a major way.

The composition is:

- Dean of Engineering or a delegate
- Dean of Science or a delegate
- Director of CBB
- Associate Director (Engineering)
- Associate Director (Science)
- Three representatives from the CBB Key Partners, Corporate Associates, or Institutional Associates.
- Six representatives from CBB regular members.

The appointment of members to the Board of Directors is governed by the Board of Directors Terms of Reference. Normally, the Chair of the Board will be the Dean of Engineering. The Deans of Engineering and Science are *ex officio* voting members of the Board of Directors. A quorum shall consist of a majority of the regular members.

The Board of Directors meets at least once per year and additionally if needed. Board meetings will be announced at least one month in advance with an agenda indicating all decision items and background material. Board meetings are open to all members of CBB. Minutes will be taken at all meetings and will be available to all members of CBB.

The Director of CBB is responsible to the Board of Directors for the operational management of CBB, preparation of its annual budget, supervision of staff members and guiding the research and outreach agenda, consistent with policies established by the Board and with input from the Centre's membership.

The Board of Directors has the authority to execute and monitor the affairs of CBB, subject to all applicable University policies, procedures and guidelines. This includes the ability to:

- Enact rules and regulations for membership of the Board of Directors and the conduct of its affairs;
- Recommend appointment of the Director and other leaders to the Responsible Officer;
- Recommend appointment and removal of staff to the Responsible Officer;
- Appoint and remove Members, and establish categories of membership and associated fees;
- Plan and implement CBB's development;
- Establish processes to manage and monitor the CBB's financial affairs;
- Establish and enforce rules and regulations governing the CBB's activities, provided such rules and regulations are consistent with University policies, procedures and guidelines; and
- Establish such committees as it deems necessary to discharge its responsibilities; this may include establishing advisory bodies comprised primarily of external Members for the purpose of providing strategic or scientific advice to the Board of Directors or the Director.

Director

1. The Director is appointed by the Responsible Officer on the recommendation of the Governing Body. In making its recommendation, the Governing Body will seek the views of CBB's members.
2. The Director shall hold a University of Waterloo faculty appointment.
3. The Director's term is determined by the Responsible Officer and is normally for a five year period. A Director's term may be extended or renewed by the Responsible Officer with the support of the Governing Body.

4. If permitted by the Governing Body, the Director may delegate some of his/her responsibilities to one of more Associate Directors and/or one or more staff members.
5. The Director is responsible for
 - a. overseeing CBB's operations and managing its budget;
 - b. supervising staff members;
 - c. establishing working groups or committees to provide appropriate guidance and advice in support of his/her responsibilities;
 - d. preparing an Annual Report to the Governing Body; and
 - e. discharging all responsibilities set out in the constitution or charter, and as directed by the Governing Body.
6. The Director's performance is reviewed annually by the Responsible Officer. With prior knowledge of the Director, the Responsible Officer will seek confidential input from the Governing Body, Members of the CBB and its staff by any means s/he deems appropriate.
7. In the event of the Director's absence for any prolonged period, arrangements should be made for the Responsible Officer to appoint an Acting Director for a period of no more than one year.
8. If the office of Director becomes unexpectedly vacant, the Responsible Officer will appoint, after appropriate consultation, an interim Director and initiate the process of filling the vacancy.
9. A Director may only be removed from office for cause, which is to be understood in relation to the duties of the Director as described herein. Causes for removal include negligence, incompetence, unprofessional conduct, and inability to maintain the confidence of the Members. The procedures governing removal for cause shall be those set out in section 4 of [Policy 40 – The Chair](#), except that all references to the "Chair" shall mean the Director and references to the "Dean" shall mean the Responsible Officer.

Other Positions and Committees

Associate Directors

The Director will be assisted by two Associate Directors, one from the Faculty of Engineering and one from the Faculty of Science who will be responsible for the detailed direction and support of the Centre's research activities, including research-related workshops, seminars, and public talks. Associate Directors are appointed to their roles as Associate Directors consistent with the Associate Directors Terms of Reference.

Administrative Assistant

An administrative assistant manages the Centre’s operations, provides organizational and logistical support, and serves as the initial point of contact between the Centre and internal and external individuals and organizations.

Operations Committee

The operations committee provides guidance on the day to day operations of CBB and ensures that CBB meets the needs of its members. A minimum of five regular member representatives of the CBB membership plus the Associate Directors comprise the Operations Committee. The Director shall seek advice from the Operations Committee about initiatives involving CBB members. Members are appointed to the Operations Committee consistent with the Operations Committee Terms of Reference.

Advisory Board

The CBB advisory board is comprised of leaders in industry, academia or other institutions who may be able to provide guidance to CBB. Members are appointed to the advisory board consistent with the Advisory Board Terms of Reference.

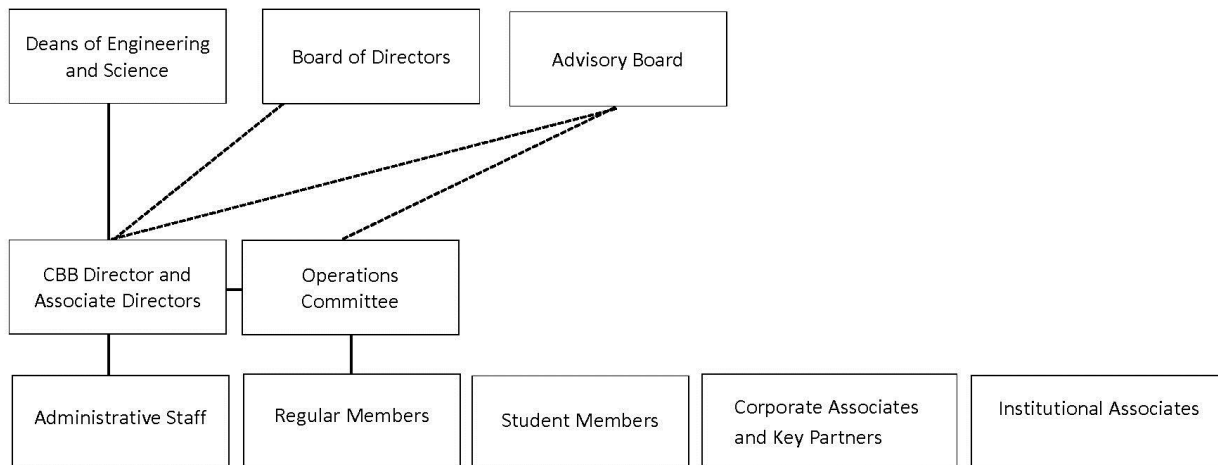


Figure 1. CBB Administrative Structure

Annual General Meeting

Once a year, the Centre will hold an annual meeting inviting all regular members to attend the meeting. The Centre may also choose to invite additional guests to attend the meeting.

Amendments to the Constitution

A two-thirds majority vote by the CBB membership is required to ratify amendments to the constitution.

TERMS OF REFERENCE

- Advisory Board
- Board of Directors
- Associate Directors
- Operations Committee

Advisory Board Terms of Reference

As a senate approved research Centre at the University of Waterloo, the Centre for Bioengineering and Biotechnology (CBB) relies upon the best and most up-to-date information, knowledge and advice to support its overall mission. The founding Advisory Board (AB) was established on June 26, 2014 as a means to obtain knowledge, objective advice and guidance from other academic institutions, industry and government in areas relevant to the Centre.

Membership

- The AB should be comprised of representatives from other academic institutions, industry and government reflecting the diversity of inter- and trans-disciplinary research the CBB fosters and supports.
- Members are selected for the excellence of their expertise and leadership in their respective fields.
- The size of the AB should be typically between eight (8) to fifteen (15) members.
- Advisory Board members are nominated by the Operations Committee and confirmed by the Board of Directors.
- The AB Chair is the Associate Vice President, University Research, University of Waterloo or his or her delegate.
- The CBB Director is an ex-officio member of the AB.

Mandate

- The AB's mandate is to provide advice and recommendations to the CBB Director, Associate Directors, and the CBB Operations Committee. The Advisory Board has no decision-making authority in the CBB.
- AB members provide an ongoing exchange of information between industry and CBB, help promote CBB and communicate the Centre's activities to industry, government, the research community, the university and the public.

Meetings

- The AB should meet once or twice annually.
- One meeting per year should be held at the University of Waterloo and AB members are encouraged to attend in person, but the opportunity for attendance at the meeting by telephone or internet will be provided whenever possible.
- Advisory Board meetings are open to the Director and Associate Directors of CBB and the Operations Committee of CBB. CBB staff may also be present at the Advisory Board meetings to receive feedback and ideas, and ensure the operation of the meeting.

- Minutes from the Advisory Board meetings will be distributed to the Advisory Board and the Operations Committee within one month from the date of the meeting.

Terms

- The AB Founding Members were appointed for an initial period of three (3) years. The list of founding members is provided in the Appendix.
- At the end of the initial three year term, AB members may be re-appointed to two- or three-year terms.
- Appointments to the AB and subsequent renewals will be reviewed and approved by the CBB Operations Committee.
- New members may be invited to an initial term up to 3 years.
- Approximately one-third of AB seats should turn over each year.

Appendix: Founding Advisory Board Members

Ex-officio	Burns	Catherine	Dr.	Director, Centre for Bioengineering and Biotechnology	University of Waterloo
Member	Cotter	Frank	Dr.	VP, Mobile Computing	BlackBerry
Member	D'Amore	Tony	Dr.	VP, Product R&D - Global	Sanofi Pasteur
Member	Dowd	Jason	Dr.	Director, Product Development, Biopharmaceuticals	Apotex
Member	Fitzgerald	Fiona	Ms.	Zone Leader, Life Sciences Canada	GE Healthcare
Member	Foody	Brian	Mr.	President and CEO	IOGEN
Member	Garcia	Luis	Mr.	Chair, Institute of Food Processing Technology	Conestoga College
Member	Gerson	Donald	Dr.	President and CEO	PnuVax SL Biopharmaceuticals, Inc.
Member	Higgs	Gary	Mr.	Integrated Chief Information Officer	St. Mary's and Grand River Hospitals
Member	Karlsson	Tim	Mr.	Director, Emerging Technologies Directorate	Industry Canada
Member	Moo-Young	Murray	Dr.	Distinguished Professor Emeritus, Chemical Engineering	University of Waterloo
Member	Pinho	George	Dr.	President	Christie Medical Division
Member & Board Chair	Thompson	John	Dr.	Associate Vice-President Research, University Research	University of Waterloo

Board of Directors Terms of Reference

The Board of Directors of CBB is the governing body responsible for CBB. In this role, the Board of Directors provides fiduciary oversight for CBB and provides guidance to the CBB Director and Associate Directors on planning, direction, and staffing of CBB.

Membership

- The composition of the Board of Directors is specified in the CBB constitution.
- Board of Director members are nominated by the CBB membership and recommended to the Director of CBB. Board of Directors members are selected to ensure fair and diverse representation from CBB's areas of interests. Board of Directors members are also expected to have held leadership positions in the University or their companies, and thereby be able to provide sound advice and guidance to CBB.
- The Chair of the Board of Directors is the Responsible Officer for CBB or his or her delegate.
- The Deans of Engineering and Science or his or her delegate are ex officio members of the Board of Directors of CBB.

Mandate

- The Board of Director's mandate is to provide guidance to CBB on policy, activities and budget planning.
- The Board of Directors has the authority to execute and monitor the affairs of CBB, subject to all applicable University policies, procedures and guidelines. This includes the ability to:
 - Enact rules and regulations for membership of the Board of Directors and the conduct of its affairs;
 - Recommend appointment of the Director and other leaders to the Responsible Officer;
 - Recommend appointment and removal of staff to the Responsible Officer;
 - Appoint and remove Members, and establish categories of membership and associated fees;
 - Plan and implement CBB's development;
 - Establish processes to manage and monitor the CBB's financial affairs;
 - Establish and enforce rules and regulations governing the CBB's activities, provided such rules and regulations are consistent with University policies, procedures and guidelines; and
 - Establish such committees as it deems necessary to discharge its responsibilities; this may include establishing advisory bodies comprised primarily of external Members for the purpose of providing strategic or scientific advice to the Board of Directors or the Director.

Meetings

- The Board of Directors should meet once a year and additionally if needed.
- Board of Directors meetings are open to all regular members of CBB and the CBB administrative assistant.
- Quorum for a board meeting must be 50% + 1 made up of regular UW faculty members.
- Minutes will be taken at all meetings and will be available to all members of CBB.

Terms

- Board of Directors members are appointed for two (2) year terms that may be renewed if needed. Shorter terms are possible in order to accommodate sabbaticals or other lengthy absences from the University of Waterloo.

Associate Directors Terms of Reference

The Associate Directors of CBB are responsible for assisting the CBB Director with the management and operation of CBB. In this role, Associate Directors provide vital feedback and guidance to the Director.

Appointment

- The Associate Directors are expected to represent larger membership patterns within CBB and should be selected to ensure a diversity of representation between the Associate Directors, and a breadth of CBB interests.
- The Associate Directors are nominated by the regular members of CBB. A nominating committee may be formed to solicit nominations and make a recommendation to the Director. The nominating committee must demonstrate that the input of CBB membership has been part of the process through either an open nomination process, or an interview process of regular members. In the case of nominating one Associate Director, this search may be limited to those members most relevant to expected Associate Director.
- The Associate Directors are appointed by the Director of CBB, on the recommendation of the nominating committee.
- The Associate Directors shall hold University of Waterloo faculty appointments.

Terms

- The Associate Directors terms are determined by the Director of CBB and are normally for a three (3) year period. An Associate Director's term may be extended or renewed by the Director of CBB with the support of the Operations Committee.
- In the event of an Associate Director's absence for any prolonged period, arrangements should be for the CBB Director to appoint an acting Associate Director for a period of no more than one year.

Operations Committee Terms of Reference

The Operations Committee of CBB is responsible for planning and executing the activities of CBB. The Operations Committee is also responsible for ensuring that CBB provides interactions and functions that are useful to CBB members. The Operations Committee is comprised of members of CBB.

Membership

- The Operations Committee should be comprised of representatives from various departments and research directions represented by CBB and reflect the diversity of inter- and trans-disciplinary research the CBB fosters and supports.
- Student members of CBB are eligible to be members of the Operations Committee.
- The size of the Operations Committee may adjust to reflect diversity of interests and communities within CBB.
- Operations Committee members are nominated by their peers through an open process. The nominations are then reviewed by the current Operations Committee to ensure that the committee has retained a diversity of perspectives. In the case of multiple nominations, the Operations Committee may seek the input of the CBB membership to determine the best candidate for the Committee.
- The Chair of the Operations Committee is the Director of CBB or his or her delegate.
- The CBB Director and Associate Directors are ex-officio members of the Operations Committee.

Mandate

- The Operation Committee's mandate is to provide advice and recommendations to the CBB Director, Associate Directors, and CBB staff.
- Operations Committee members provide an ongoing exchange of information between their academic and research units and CBB, help promote CBB and communicate the Centre's activities to their departments, research groups and other colleagues at the University of Waterloo.

Meetings

- The Operations Committee should meet at least once a term.
- Members of the Operations Committee who are absent from two meetings in a year, may be asked to resign from the Operations Committee.
- Operations Committee meetings are open to all members of CBB and CBB staff.
- Minutes from the Operations Committee meetings will be distributed to the Operations Committee within one month of the meeting and non confidential summary of the minutes posted publicly.

Terms

- Operations Committee members are appointed for three (3) year terms that may be renewed. Shorter terms are possible in order to accommodate sabbaticals or other lengthy absences from the University of Waterloo.
- In any year, approximately one quarter to one third of the operations committee should turn over to new operations committee members.

C. Governing Boards

C.1 Board of Directors

- Dean of Engineering – Pearl Sullivan or delegate Anwar Hasan
- Dean of Science – Robert Lemieux or delegate Bernard Duncker
- Director of CBB – Catherine Burns, Systems Design Engineering
- Associate Director Engineering – Karim Karim, Electrical and Computer Engineering
- Associate Director Science – Trevor Charles, Biology

2 Representatives from CBB Partners (Industrial)

- Doug Dittmer, Grand River Hospital – Freeport Campus (Jan 15-19, renewed 2017)
- Andrey Lomako, Teledyne DALSA (Jan 15-18, renewed 2017)

6 Representatives from CBB Members (Faculty)

- Andrea Edginton, School of pharmacy (Jan 17-19)
- Eric Croiset, Chemical Engineering (Jan 15-19, renewed 2017)
- Sue Horton, School of Public Health and Health Systems (Jan 16-18)
- Carolyn Ren, Mechanical and Mechatronics Engineering (Jan 16-18)
- Chris Backhouse, Electrical and Computer Engineering (Jan 16-18)
- Elizabeth Meiring, Chemistry (Jan 16-18)

Past Board Members (Faculty):

- Jan Huissoon, Mechanical and Mechatronics Engineering (Jan 15-17)
- David Rose - BIO/SCI (Jan 14-16)
- Jonathan Blay - PHARM/SCI (Jan 14-16)
- Paul Fieguth - SYDE/ENG (Jan 14-16)
- Manoj Sachdev - ECE/ENG (Jan 13-15)
- John Honek – CHEM/SCI (Jan 13-15 + 1YR renewal ending Jan 16)
- Barbara Riley – AHS/SPHHS (Jan 13-15)
- David Edwards – Pharmacy/SCI (Jan 13-14)
- Lyndon Jones – Optometry/SCI (Jan 13-14)
- Murray Moo-Young – CHEM ENG/ENG (Jan 13-14)

Past Board Members (Industry):

- Tyler Whale, Ontario Agri Food Technologies (Jan 15-17)
- Aldo Badano, US FDA (Jan 13-15)
- George Pinho, Christie Medical (Jan 13-15)

The Terms of Reference for the Board of Directors is in Appendix D: Constitution

C.2 Advisory Board

- Catherine Burns, Ex-officio, Director, Centre for Bioengineering and Biotechnology, University of Waterloo
- John Thompson, Board Chair, Associate Vice-President Research, University Research, University of Waterloo
- Tony D'Amore, VP, Product R&D - Global Sanofi Pasteur (Mar 14-Apr 18, renewed 2017)
- Jason Dowd, Director, Product Development, Biopharmaceuticals Apotex (Mar 14-Apr 19, renewed 2017)
- Fiona Fitzgerald, Zone Leader, Life Sciences Canada GE Healthcare (Mar 14-Apr 19, renewed 2017)
- Luis Garcia, Chair, Institute of Food Processing Technology Conestoga College (Mar 14-Apr 18, renewed 2017)
- Gary Higgs, Integrated Chief Information Officer St. Mary's and Grand River Hospitals (Mar 14-Apr 19, renewed 2017)
- Murray Moo-Young, Distinguished Professor Emeritus, Chemical Engineering University of Waterloo (Mar 14-Apr 18, renewed 2017)
- George Pinho, President Christie Medical Division (Mar 14-Apr 18, renewed 2017)
- Gail Garland, President and CEO, Ontario Bioscience Innovation Organization (OBIO) Apr 17-20)
- Barbara Paldus, CEO and Co-Founder, Finesse Solutions (Apr 17-20)

Past Advisory Board:

- Donald Gerson, President and CEO PnuVax SL Biopharmaceuticals, Inc. (Mar 14-Apr 17)
- Brian Foody, President and CEO IOGEN (Mar 14-Apr 17)
- Frank Cotter, VP, Mobile Computing, BlackBerry (Mar 14-Apr 17)
- Tim Karlsson, Director, Emerging Technologies Directorate, Industry Canada (Mar 14-Jun 15)

The Terms of Reference for the Advisory Board is in Appendix D: Constitution

C.3 Operations Committee

- Catherine Burns, CBB Director, Centre for Bioengineering and Biotechnology, Systems Design Engineering (Mar 12-present)
- Karim Karim, CBB Associate Director, Electrical and Computer Engineering (Mar 12-present)
- Trevor Charles, CBB Associate Director, Biology (Mar 12-present)
- Melanie Campbell, Physics and Astronomy (May 15-present)
- John Yeow, Systems Design Engineering (May 15-present)
- Marc Aucoin, Chemical Engineering (May 15-present)
- Brendan McConkey, Biology (Mar 12-present)
- Safieddin Safavi-Naeini, Electrical and Computer Engineering (Mar 12-present)
- Mei Lin Chen, Graduate Student Member-Systems Design Engineering (Jan 17-18)

Past Operations Committee Members:

- Frank Gu, Chemical Engineering (Mar 12-Apr 15)

The Terms of Reference for the Operations Committee is in Appendix D: Constitution



August 19, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

I am pleased to endorse the renewal of the Centre for Bioengineering and Biotechnology (CBB). CBB serves as a champion for faculty members, researchers and students who participate in this key area of transformational research that is critical to the strategic interests of the University of Waterloo. Since its inception in 2011, CBB has distinguished itself for its dedication to its members and its commitment to developing important partnerships for the University of Waterloo.

Under the directorship of Dr. Catherine Burns, the university community has benefited from her stewardship and dedication to advancing the interests of the CBB membership. The Faculty of Engineering, with 74 faculty members actively participating in CBB initiatives, has received significant benefit. CBB has supported the Biomedical Discussion Group as well as fostering significant relationships with Grand River Hospital and the local community incubators. CBB also supports the Engineers in Medicine student group, which have allowed them to host several cross-faculty networking events. With Engineering developing a program in Biomedical Engineering, these interactions present very important opportunities for our students and our faculty.

The Centre provides ongoing support to researchers that has led to significant impact on the funding levels of the Engineering faculty. In the four years since CBB was founded, CBB has contributed over \$4 million in new research funding.

Research within biotechnology and the life sciences is a core theme within the University of Waterloo's Strategic Research Plan that transcends all faculties due to its multidisciplinary nature. Having a Centre like CBB allows Waterloo's research efforts in these fields to be more widely known in the context that it will strengthen the university reputation as a research powerhouse in these areas. CBB has played an important role in the last five years

and will play an even more important role for the university as it strives to facilitate these multi-faculty collaborations in its next five-year term.

The Faculty of Engineering strongly supports the renewal of CBB as a Centre at the University of Waterloo. Further, the Faculty of Engineering fully supports the recognition of CBB as a university level Centre, with budgetary support from the university. CBB has proven its capability to have a strong impact in a short time on a limited budget, suggesting that an increased level of support will be managed effectively and result in returns to the university as a whole. Until university level support can be confirmed, the Faculty of Engineering will continue its support of CBB at \$50,000/year.

Sincerely,



Dr. Richard Culham
Acting Dean of Engineering
University of Waterloo
culham@uwaterloo.ca

c.c. Dr. Anwar Hasan, Associate Dean of Research, Faculty of Engineering
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology

September 6, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

The Faculty of Science is happy to support the renewal of the Centre for Bioengineering and Biotechnology (CBB). Since its inception in 2011, CBB has distinguished itself for its dedication to its members and its commitment to developing important partnerships for the University of Waterloo. We encourage CBB to approach its next term with a focus on finding ways to serve as an effective catalyst for enhancing cross-disciplinary research initiatives and facilitating major research applications.

The Faculty of Science has particularly benefitted from CBB: 49 faculty members from Science are members of CBB and have participated actively. CBB has supported the Biomedical Discussion Group as well as sponsoring and providing significant administrative support for the first Meeting of the Canadian Biophysics Society in June 2015. CBB supports the iGEM and UW DNA student teams which have been very successful in their respective competitions. Additionally, CBB continues to build on its relationship with Velocity Science by showcasing a variety of Velocity science students at meetings and events including Medella and Suncayr.

Importantly, CBB has had a substantial and measurable impact on the funding levels of Science faculty members. In the four years since CBB was founded, CBB has played a key role in securing over \$700,000 in new research funding.

Biotechnology and the life sciences continue to be an area of growth for the Faculty of Science. Having a research centre like CBB allows Waterloo's research efforts in these areas to be more widely known. This is particularly important in the context of the University not often being recognized as a research powerhouse in these disciplines. The reality however is that these areas are quite strong at Waterloo and will continue to grow in the future. CBB has played an important role in the last five years and will play an even stronger role for the University of Waterloo in the next five years as it looks to expand its opportunities for CBB members locally and globally.



The Faculty of Science strongly supports the renewal of CBB as a Centre at the University of Waterloo. It also strongly supports CBB's recognition as a University level Centre, with budgetary support from the University. CBB has proven its capability of having a strong impact in a short time on a limited budget, suggesting that an increased level of support will be managed effectively and result in tangible returns to the University. Until University level support can be confirmed, the Faculty of Science will continue its support of CBB at \$25,000/year for the next five-year term.

Sincerely,



Robert P. Lemieux
Dean of Science

c.c. Dr. Bernard Duncker, Associate Dean of Research, Faculty of Science
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology





August 31, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

On behalf of the Faculty of Applied Health Sciences (AHS), I wish to indicate support for the renewal of The Centre for Bioengineering and Biotechnology (CBB) as a Centre at the University of Waterloo. I further support the recognition of CBB as a University Level Centre. Over the last five years, CBB has demonstrated its' commitment and has added value in leveraging important research partnerships for UW.

Currently, 14 faculty members from AHS are associated with CBB. Two significant joint research projects have transpired through the Centre. Richard Hughson, a Kinesiology department faculty member, is working in collaboration with Mechanical and Mechatronics Engineering, and Electrical and Computer Engineering, on a four-year research project with Lockheed Martin. It has amounted to over \$1 million in industry funding and over \$250,000 in overhead to the UW. This project has also resulted in a spinoff company with further Federal and Provincial funding under review.

The second significant project is the recent partnership with the University of Twente in the Netherlands. This partnership has resulted in a MOU between both universities, and the School of Public Health and Health Systems. Faculty members (Helen Chen, Ian McKillop, Paul Stolee, Joon Lee) are working on submitting other health-related research projects in collaboration with Pharmacy, Computer Science, Systems Design Engineering, and Mechanical and Mechatronics Engineering departments and schools.

I am confident that there will be significant opportunities for many other AHS faculty members to participate in activities through CBB and for the development of more cross-faculty research collaborations over the next five-year term.

Life sciences and biotechnology research is quite strong at UW and these areas of research in particular will continue to intensify within the Faculty. A Centre like CBB allows UW's research strength in these areas to become more widely known. CBB will play an important role for the University over the next five years as it looks to expand opportunities for its' members locally and globally.

The Centre for Bioengineering and Biotechnology has proven its' capability to have a strong impact in a short time while on a limited budget, suggesting that an increased level of support consistent with University Research Centre status, will be managed effectively and will result in returns to UW as a whole. AHS looks forward to deepening the relationships it has with the Centre and creating new ones, as they move forward in applying for University level recognition.

Sincerely,



James W.E. Rush, PhD
Professor and Dean
Faculty of Applied Health Sciences
jwerush@uwaterloo.ca



Sept. 21, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

RE: Renewal of the Centre for Bioengineering and Biotechnology (CBB)

Dear Dr. Dixon:

The Faculty of Math is pleased to support the renewal of the Centre for Bioengineering and Biotechnology (CBB) as a Centre at the University of Waterloo.

Over the past 4 years, as part of its multidisciplinary areas of bioengineering, biotechnology and biomedicine, CBB involved several members of the faculty of mathematics, in its efforts to develop research collaborations and partnerships. For instance, in 2015, CBB supported the Southern Ontario Synthetic Biology Academic-Industrial Cluster meeting hosted by Brian Ingalls in Applied Mathematics which enabled his group to make several connections between researchers at UW and the local agri-tech community. Also in this past year, CBB received two IRPG-EU awards with the Office of Research that have brought together several faculty from across campus to work on international partnership collaborations. Jesse Hoey and Edith Law (Computer Science), and ten other faculty are working with the University of Twente, The Netherlands, to submit a Horizons 20/20 grant application in the area of "Data Driven Persuasive Health Technology". Another instance is the participation of Sivabal Sivaloganathan (Applied Mathematics) in a Waterloo team that will be travelling to France this fall to build on the Sorbonne Universités relationship in the area of "Innovative Health Engineering". Both international relationships have resulted in two MOU agreements that will aid in increasing the academic research and student exchange opportunities between the universities.

The Faculty of Math believes that CBB will continue to play a significant role for the University as it strives to facilitate multi-faculty research collaborations and external collaborations. We look forward to strengthening our relationships with CBB and its members over their next five-year term.

Sincerely,



Dr. Stephen M. Watt
Dean of Math
University of Waterloo
deanmath@uwaterloo.ca

c.c. Dr. Raouf Boutaba, Associate Dean of Research, Faculty of Math
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology



September 8, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Support for the Renewal of CBB

I am pleased to provide this letter of support which strongly endorses the renewal application for the Centre of Bioengineering and Biotechnology (CBB) as a University of Waterloo research centre.

Every day, we at Grand River Hospital (GRH) strive to provide exceptional care to our patients, in order to do this, we strongly believe in the support for ongoing research within our organization. As such, GRH has positioned strategically and operationally to partner with the University of Waterloo to ensure both organizations benefit from experience, skilled, and enthusiastic clinicians and researchers who are keen to work alongside each other in areas of research to discover and advance care that will optimize outcomes for patients.

To that end, GRH has been pleased to partner with CBB in a number of valuable endeavors. For example, the first inaugural Waterloo Region MED TECH Conference, ongoing monthly Pizza with the Profs sessions at our Freeport campus, ongoing discussions related to the concept of a Global Centre for Community-Based Medical Innovation with the initial hub at Grand River Freeport Campus, and a well-attended "Workshop on Engaging Hospitals in Research Projects".

Seeing the value in CBB's contribution to our organization, a number of our staff and physicians at GRH have been supported and encouraged to participate at the leadership for CBB. Gary Higgs, Integrated Chief Information Officer has been a member of CBB's Advisory Board since its inception in 2014. As well, Dr. Doug Dittmer, Medical Director has been a member of the Board of Directors since January 2015.

GRH has benefited from the research that has been undertaken at its organization from CBB members including research conducted by Drs. Johnathan Blay, Helen Chen, Kelly Grindrod, Dana Kulic, Bill McIlroy, Ian McKillop, Paul Stolee, and Shawn Wettig. As well, a number of CBB members have volunteered to participate on working groups at our organization to advance care related to falls prevention and wearable device strategies, an area that GRH has placed significant focused attention on over the past 18 months.

Moving forward, we expect to maintain our strong partnership with CBB and the University of Waterloo by continuing to collaborate with researchers, students, and industry partners. This collaboration will continue to invest in building an ecosystem of research, innovation, and commercialization in the advanced bioengineering and biotechnology space. CBB is uniquely positioned to help advance research and innovation within advanced bioengineering and biotechnology. GRH will continue to partner and collaborate with researchers and students helping stimulate innovation through access to the healthcare environment.

If you have any questions about our commitment for the ongoing support of the CBB at the University of Waterloo, please feel free to contact me.

Sincerely,

A handwritten signature in black ink, appearing to be 'Tina M. Mah', written in a cursive style.

Tina M. Mah, PhD
Vice President Planning, Performance Management and Research

cc. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo



August 26, 2016

Dr. George Dixon
Vice President, University Research
University of Waterloo
200 University Avenue West
Waterloo, Ontario, N2L 3G1

Dear Dr. Dixon:

Re: Support for the Renewal of CBB

I am pleased to provide this letter of support and strongly endorse the renewal of CBB.

I have been involved with CBB for several years and have found the relationship to be extremely valuable to the work we do here at Freeport Hospital, a campus of Grand River Hospital. It all began when an engineer, Dana Kulic, called me to ask if she could collaborate on a project that she was working on. Not only did it provide an opportunity for clinicians to observe how engineers work, but it provided valuable insight for her to improve her medical device. I then met Don Cowan, Bill McIlroy, Pearl Sullivan, and Catherine Burns through CBB and the rest is history. Some of them met with our CEO, Malcolm Maxwell, and this helped the hospital understand what a valuable partner the University of Waterloo would be in medical research. This helped in a small way to the formal launch of the Research Partnership between the UW and GRH in March 2015.

Since then, I personally have been involved with a number of professors, who through CBB, have presented at Grand Rounds at the Hospital and our informal "Pizza with a Prof" which has less formality than Grand Rounds but allows engineers and kinesiologists to bounce their ideas off of our therapists, nurses, and doctors. This has proved to be invaluable to our staff.

We have started to collaborate on major research grants, the most recent for a CFI grant. Our plans include collaborating on a major region wide med tech hub, which we believe will be the only one of its kind in Canada. In May of this year, we held the first Waterloo Regional Med Tech Conference, and CBB was a major partner in hosting this along with Communitech and Blackberry. We plan to host this again next year and the help provided to us by Shirley Fenton and her colleagues at CBB was invaluable. In

fact I don't think we could have hosted a conference that was sold out (over 100 people, start-ups, and industry attended) without their help.

We are now in the process of joining ranks with a group from CBB in applying for a major grant from the Ministry of Health Innovation Group. Mr. Bill Charnetski, the head of that Ministry department, has visited Freeport and has said that what we are doing here in collaboration with the University is on his radar. We don't have to be a major teaching hospital to be working in collaboration with UW to apply for these grants.

The importance of the research and development of products in areas crucial to our organization cannot be understated. The hospital needs help not only in innovation with medical devices but also in our processes. We know a little bit about lean theory at the hospital but we are not industrial engineers. Access to these individuals will help us be a better hospital to serve the Region and the province.

Through meet and greet nights I have come to meet at least 30 professors at the university, most of whom are affiliated with CBB. This is partly because CBB has taken steps to build academic-healthcare-industry relationships with ourselves and others (enabled by CBB collaborative efforts, outreach, scholarly lectures, networking events and other programs).

In terms of collaborations that I have worked on with CBB, the most noteworthy has been to found the Global Centre for Community-Based Medical Innovation. This is the dream of having an incubator at Freeport Hospital where Waterloo students can be imbedded in our hospital and observe the way we do things in a way to better understand clinical problems with patients. Other collaborative efforts have included as mentioned the Waterloo Region MED TECH conference, Grand Rounds at the hospital, Pizza with the Profs, Dr. Charlie Cooney Bioinnovations Seminar where I met Prof. Cooney from MIT and have tried to emulate how they set up their hub at MIT, and a Workshop on How to Start a Spinoff Company.

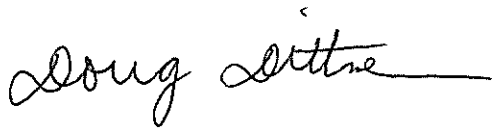
As a member of the Board of Directors for Centre of Bioengineering and Biotechnology (CBB), I have seen the development and growth of CBB. The value of CBB, the research it facilitates and the need for this in our community is not only important for our region, but the potential underscores its importance in Canada and/or the world. Through its efforts, CBB has helped researchers, students, new entrepreneurs, start-ups and healthcare organizations with their research, collaborations and possible partnerships. CBB is helping to link healthcare organizations with students and I look forward to working with Business Development – Co-operative Education in bringing biomedical engineering students to Freeport/GRH. We value the access to research experts and students enabled by CBB. Working with CBB makes it easier for us to find the researchers/collaborators/partners/highly qualified personnel/co-op students we need for our initiatives. I've worked with several CBB researchers (Don Cowan, Dana Kulic, Bill McIlroy, John McPhee, Rich Hughson, Lora Giangregorio, Jonathan Kaufmann, amongst others).

The vision of a thriving medical community here at GRH's Freeport site working side by side with engineers, kinesiologists, computer scientists, social innovators and business has been embraced by the Waterloo community including Laurier University, Conestoga College, Communitech, the Velocity Center and Mayor Berry Vrbanovic. Over the next 5 years I envision that we will secure a grant supporting a 10,000 sq. foot research building here at Freeport, and that building will be populated by grad students

working side by side with health researchers and industry. I envision more international conferences on med tech (co-sponsored by CBB), and as a result of this activity, more medical researchers will be attracted to Waterloo-Wellington. That equates to better healthcare for the citizenry and pride for the people working at GRH. I envision us being the best rehabilitation hospital in the province, and later in Canada.

In plain and simple words, Mr. Charnetski said to me at Queen's Park in June, that we have to stop thinking about this, and just do it. CBB in collaboration with GRH will help us build the hospital of the future.

Sincerely,

A handwritten signature in black ink that reads "Doug Dittmer". The signature is written in a cursive style with a long horizontal flourish at the end.

Doug Dittmer MD, FRCPC

Medical Director, Rehab

Freeport/Grand River Hospitals

c.c. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology, University of Waterloo

Memorandum

To: **Members**
 Senate Graduate and Research Council

From: **Julie Joza**
 Acting Chief Ethics Officer
 Office of Research Ethics

Date: **April 24, 2017**

Subject: **New and Continuing Membership to Research Ethics Committees**

The following information on new and continuing members for the **Clinical Research Ethics Committee** is provided for review and consideration by the Senate Graduate and Research Council:

Clinical Research Ethics Committee (CREC)

Sabbatical leaves and members taking on acting roles:

Andrea Edginton, CREC chair, will be on sabbatical from September 1, 2017 to August 31, 2018. Andrea will step away from her chair role for the first 7 months of her 12 month sabbatical.

Valerie Hoag, CREC alternate legal member, will become the acting CREC chair from September 1, 2017 to March 31, 2018 to replace Andrea Edginton as chair of the committee.

Elizabeth (Beth) Irving, CREC vice-chair and ocular science member, will be taking sabbatical from September 1, 2017 to August 31, 2018. Beth will step away from her vice-chair role for the entire 12 month sabbatical.

Kelly Grindrod, current CREC member and pharmacy representative, will become the acting CREC vice-chair from September 1, 2017 to August 31, 2018. Kelly will also fill the role of pharmaceuticals/drug pharmacokinetics representative during the 7 months Andrea Edginton is away from her role on the committee.

Deborah Jones, Interim Director of the School of Optometry and Vision Science, will become the CREC ocular science member from September 1, 2017 to August 31, 2018. Please refer to the attached letter of interest and CV.

Renewing members:

Shekar Pandey, will renew his term for 3 years as the CREC clinician with expertise in cardiology and clinical trials from October 1, 2017 to September 30, 2020. Please refer to the attached CV.

Marsha Mann, will renew her term for 2 years as the CREC community member from October 1, 2017 to September 30, 2019. Please refer to the attached CV.

I would like to express my interest in the (sabbatical coverage) position as a member of the Clinical Research Ethics Committee (CREC), for the period September 1st 2017 to August 31st 2018.

I have experience of conducting clinical research for over 30 years. I have experience in the UK through both an optometric practice and also at a contact lens manufacturing company. I have been a faculty member at the School of Optometry & Vision Science since Sept 1998. Since moving to Waterloo I have conducted clinical research through the Centre for Contact Lens Research and within the School of Optometry & Vision Science. I have been responsible for all aspects of a clinical research project, through the initial protocol writing, applying for Ethics approval including submission of ORE 101, ORE 104, ORE 105, examination of study participants, notification of adverse events and development of research reports.

Due to my experience listed above, I am very familiar with what is involved in clinical research and feel that I would be able to contribute positively to the committee.

CURRICULUM VITAE

Deborah Annette Jones

CURRICULUM VITAE

Deborah Annette Jones

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1 Background Details

Business Address School of Optometry & Vision Science
University of Waterloo
Waterloo
Ontario, Canada, N2L 3G1

Tel (519) 888 4567 xt 35934
Fax (519) 884 8769
Email: dajones@uwaterloo.ca

2 University Education

- Sept 1983 - May 1986 The City University, London, UK
Honours Degree Course in Optometry & Vision Science.
BSc (Hons) Class 2; Division 1

3 Professional Qualifications

- March 2009 100-hour Therapeutic Course (Ontario)
- October 2003 General certificate of registration – Ontario College of Optometrists
- October 1998 Academic certificate of registration – Ontario College of Optometrists
- December 1995 Fellowship of the American Academy of Optometry (FAAO)
- October 1993 Diplomate in Contact Lens Practice (DipCLP) of the British College of Optometrists
- October 1992 Fellowship of the British College of Optometrists (FCOptom) by examination in modules in Contact Lenses and Paediatrics
- September 1987 Membership of the British College of Optometrists (MCOptom)

4 Employment History

4.1 *Current Positions Held*

1. From July 1st 2016: Interim Director, School of Optometry & Vision Science

Duties include:

- Development activities– meeting donors and potential donors; external meetings (eg AAO)
- Event planning – in particular 50th anniversary planning
- Senior admin tasks/meetings
- Budget planning
- Curriculum
- Strategic planning
- Chair of Administrative Council
- Representing the school at ad hoc meetings with CAO, OAO and College of Optometrists of Ontario
- Supervision of School Administrator

2. From January 2013: Clinical Professor, School of Optometry and Vision Science

Duties include:

- Teaching
 - clinic supervision
 - laboratory teaching
 - didactic teaching
- Service
 - administration
- Scholarship

3. From June 2011: Clinical Scientist, Centre for Contact Lens Research, UW

- Communication with funding sources/sponsors
- Development of study outlines and protocols for clinical studies
- Communication with Office of Research
 - Ethics submission
 - Adverse events queries
- Liaison with other CCLR staff before and during a clinical study
- Examination of participants on clinical studies
- Development of study reports
- Presentation of study results
 - Abstract development and submission to conferences
 - Development of slides or posters
 - Presentation of posters and papers
 - Development of manuscripts for submission to journals

4. From May 2010: Continuing Education (CE) Chair, School of Optometry & Vision Science
 - Organization of annual 3-day CE meeting
 - Organization of CE events
 - Program development
5. From April 2009: Ontario Association of Optometrists Eye See-Eye Learn working party
 - Implementation of pilot project for children's eye care in Hamilton September 2009
 - Expansion to other centres within Ontario
 - Ongoing improvement of program

4.2 Previous Positions Held

1. January 2016 to June 2016: Acting Director, School of Optometry & Vision Science
Duties as per Interim Director (see above)
2. April 2013 to Dec 2015: Associate Director Academics & Deputy Director, School of Optometry & Vision Science:

Duties included:

- Acting Director in Director's absence
 - Organization of faculty teaching schedule
 - Organization of TA schedule for teaching labs
 - Master of Ceremonies at various optometry events
 - e.g. awards evening, white coat ceremony
 - Chairing various committees
 - e.g. Space Committee, Faculty Council
 - Attending meetings with professional bodies
 - e.g. Ontario Association of Optometrists, College of Optometrists of Ontario
 - Orientation of new faculty
 - Supervision of Laboratory demonstrators
3. July 2011 to April 2013: Interim Associate Director, Academics and Research, School of Optometry & Vision Science, UW

Duties as above
 4. March 2011 to January 2013: Co-Chair Children's Vision Initiative Working Group – Canadian Association of Optometrists
 5. July 1999 to September 2015: Clinic Head – Paediatric & Special Needs Clinic, School of Optometry & Vision Science, UW

Duties included:

- Working with pediatric clinic staff and responding to queries promptly
- Meeting with interns experiencing difficulty in clinic rotation

- Imparting information relating to clinic to other supervisors/staff e.g. equipment additions/losses etc.
- Attending clinic committee meetings
- Making decisions related to patient scheduling
- Ensuring appropriate intern coverage for specific clinic activities
- Handling patient enquiries related to the paediatric and special needs clinic
- Handling professional enquiries from optometric/medical colleagues
- Managing patient complaints

6. October 1998 to December 2012: Lecturer, School of Optometry & Vision Science, UW

Duties included:

- Teaching (clinic supervision, laboratory teaching and didactic teaching)
- Service
- Scholarship

7. July 2003 to June 2010: Clinic Director, School of Optometry & Vision Science, UW

Duties included:

- Involvement in the general administration of the School of Optometry
- Overseeing the day to day operations of the School of Optometry Clinic
- Coordination of clinical interns in on-site and offsite clinical rotations
- Supervision of clinic staff
- Supervision of optical dispensary
- Chairing clinic committee meetings
- Serving on School Advisory Committees on Appointments (SACA) for clinical appointments
- Coordinating clinic scheduling to provide patient care, student education and appropriate supervision
- Liaison with clinic heads to implement changes within the clinic
- Reporting to faculty on a regular basis on the clinic operations
- Forward planning for clinic operations

8. July 2000 to July 2003: Assistant Clinic Director, School of Optometry & Vision Science, UW

Duties included:

- Providing support and assistance to the Clinic Director
- Being the “optometrist in charge” in the Clinic Directors absence
- Working with the Clinic Director on policies pertaining to the clinic
- Specific projects as required (such as clinic policy development)

9. October 1998 to July 2000: Research Associate, CCLR, School of Optometry & Vision Science, UW

Duties included:

- Direct Communication with funding sources
- Development of protocols for clinical studies
- Communication with Office of Research
- Liaison with other CCLR staff before and during a clinical study
- Examination of participants on clinical studies

- Development of study reports
 - Presentation of study results
10. May 1996 to April 1998: Secretary of the North West Kent & South East London Association of Optometrists, UK
- Duties included:
- Development of a Continuing Education policy for registered optometrists in the North Kent area
 - Liaising between ophthalmology and optometry for models of ophthalmic care for patients in the North Kent area
11. January 1994 to April 1998: Honorary Secretary and Vice-Chairman of North West Kent & South East London Local Optical Committee (LOC)
- Duties included:
- Liaising with the local Health Authority regarding political optical matters
 - Development of policy decisions regarding the training of optometrists in shared care schemes
12. April 1993 to April 1998: Optometric co-ordinator of Shared Care Projects with Bexley Health Authority
- Duties included:
- Development and initiation of shared-care projects between local ophthalmology units and local optometrists. Successful implementation of paediatric and diabetic projects.
13. October 1991 to May 1998: Sessional optometrist to the Ophthalmology Department at Queen Mary's Hospital, Sidcup, Kent
- Duties included:
- refraction and refractive management of pre- and post-cataract patients
 - refraction and refractive management of all paediatric patients attending the ophthalmology department
 - coordination of care for amblyopic patients with orthoptists and ophthalmologists
 - Refraction education to ophthalmology residents
 - Vision screening training for Health Visitors
14. January 1990 to May 1998: Optometrist at Collett & Jones Optometric practice. Sidcup & Eltham, UK
- Practice statistics,
 - 1990 employee count 9, annual turnover \$500,000
 - 1998 employee count 24, annual turnover \$2,500,000
 - Appointed as partner in January 1992: responsibilities included:
 - Staff management
 - hiring and firing staff members
 - staffing of the two practices
 - staff training
 - Marketing
 - Chief financial officer

- budget planning and allocation
- accounts management
- preparation of financial statements
- The practice won a number of National Awards
 - 1997 "UK Contact Lens Practice of the Year" in the "Optician" journal Eye-Care Awards
 - 1996 "UK Contact Lens Practice of the Year" in the "Optician" journal Eye-Care Awards
 - 1995 "UK Eye-Care Practice of the Year" in the "Optician" journal Eye-Care Awards
 - short-listed to the final three in the "UK Contact Lens Practice of the Year" in 1995, "UK Eye-Care Practice of the Year" in 1997 and "UK Marketing Initiatives" in 1996.
- The practice was used as a resource of subjects for 25 clinical studies for the contact lens industry
 - These included studies initiated from outside agencies and also following protocols written by clinicians within the practice

15. July 1988 to April 1996: Continuing Education coordinator for the North West Kent & South East London Association of Optometrists

Duties included:

- Organisation of CE courses for optometrists within the North West Kent area.

16. January 1990 to May 1995: Clinical Consultant to Madden & Layman Contact Lens Group, Hastings, UK

Duties included:

- Coordination and execution of clinical trials on bifocal contact lenses, novel soft lenses and new RGP lens designs and materials
- Production of reports on clinical trial outcomes

17. October 1987 to October 1988: Clinical Tutor in the orthoptics (binocular vision) department at the Institute of Optometry, London, UK

Duties included:

- assessment and management of patients within the Institute's tertiary binocular vision referral centre
- supervision of trainee optometrists
- running tutorial courses for trainee/inexperienced optometrists

18. October 1988 to December 1989: Clinical Tutor in the children's visual assessment department at the Institute of Optometry, London UK

Duties included:

- assessment and management of patients within the Institute's tertiary paediatric referral centre
- supervision of trainee optometrists
- tutorial courses for trainee/inexperienced optometrists.

19. October 1987 to December 1991: Voluntary sessional optometrist in the contact lens department at the Institute of Optometry, London UK

Duties included:

- assessment and management of patients within the Institute's tertiary contact lens referral centre

- supervision of trainee optometrists
 - tutorial courses for trainee/inexperienced optometrists.
20. October 1987 to December 1989: Managing optometrist in private practice with R Woodfall Opticians, Purley, UK
- Duties included:
- Provision of primary eye care and contact lens care,
 - Supervision of pre-registration trainee optometrists
 - General practice management duties
21. Sept 1986 to Sept 1987: Pre- Registration student at R Woodfall Ophthalmic Opticians, Norwood, London UK
- Experience included:
- Provision of primary eye care in a contemporary optometric practice
 - Contact lens fitting and follow-up care at Moorfields Eye Hospital contact lens department
 - Observation and tutorial sessions in ocular pathology at Guy's Hospital, London
 - Refractive technique and orthoptic (binocular vision) management at the London Refraction Hospital
22. Jun 1986 to Aug 1986: Mission work in Kenya with "Sight by Wings".

5 Current Professional Memberships

- Member of OAO (Ontario Association of Optometrists). Since October 1998.
- Member of the College of Optometrists of Ontario – General Certificate of Registration to practice optometry in Ontario. Since October 1998.
- Fellow of the AAO (American Academy of Optometry). December 1995.
- Member of BCLA (British Contact Lens Association). Since June 1988.
- Fellow of the BCO (British College of Optometrists) – full licence to practice optometry in the UK. Since Sept 1987.
- Member of the British AOP (Association of Optometrists). Since Sept 1987.

6 Awards

6.1 Academic / Professional Awards

- a) University of Waterloo, School of Optometry Distinguished Clinical Teacher Award for 2002-2003, April 2003. This single award is voted for by the students within the School of Optometry and honours excellence in clinical teaching during the academic year.
- b) University of Waterloo, School of Optometry Distinguished Clinical Teacher Award for 2000-2001, April

2001. This single award is voted for by the students within the School of Optometry and honours excellence in clinical teaching during the academic year.

- c) *Optician* magazine's "*Contact Lens Practice of the Year*" in Sept 1997. This single, annual award was awarded to the practice voted by a panel of judges to provide the best contact lens service to its patients in the UK.
- d) *Optician* magazine's "*Contact Lens Practice of the Year*" in Sept 1996. This single, annual award was awarded to the practice voted by a panel of judges to provide the best contact lens service to its patients in the UK.
- e) *Optician* magazine's "*UK Eye-Care Practice of the Year*" in Sept 1995. This single, annual award was awarded to the practice voted by a panel of judges to provide the best overall clinical expertise and service to its patients in the UK.

6.2 Conference Awards

- a) Second place in the poster competition at Bausch & Lomb European Research Symposium, Seville, Spain, October 1996 (A clinical comparison of three polyhexanide-preserved multi-purpose contact lens solutions. L Jones, **D Jones** & M Houlford).
- b) Third place in the poster competition at the British Contact Lens Association Conference, Birmingham, England, May 1996 (A clinical comparison of three polyhexanide-preserved multi-purpose contact lens solutions. L Jones, **D Jones** & M Houlford).
- c) Second place in the poster competition at Bausch & Lomb European Research Symposium, Lisbon, Portugal, October 1994 (The time dependent effect of hydrogen peroxide neutralisation on the fitting characteristics of group IV disposable lenses. L Jones, I Davies & **D Jones**).
- d) First place in the poster competition at Bausch & Lomb European Research Symposium, Lisbon, Portugal, October 1994 (Every picture tells a story. **D Jones** & L Jones).
- e) First place in the photographic competition at Bausch & Lomb European Research Symposium, Sorrento, Italy, October 1990 (Photographic analysis of peripheral dimple-veil).

7 Scholarship

7.1 *Grants Awarded*

All amounts quoted are in Canadian Dollars.

Title	Year	Authors	Granting agency	Amount
Implementation of novel computerized software to enhance lens design during ophthalmic dispensing	2010	W Bobier, P Shaw, D Jones , L Christian, T McMahon.	American Optometric Foundation/Essilor Optical Technology Grant	20,000
A new stress-free treatment for binocular vision deficits in children	2009	W Bobier, T Simpson, D Jones, R Hess.	Canadian Optometric Education Trust Fund	1,500
Child Vision awareness study. Exploring vision in children aged four to six	2005	L Ng, D Jones , S Leat	Canadian Optometric Education Trust Fund	1,700
Developing an understanding of the role played by information technology on the current and future practice of optometry	2004	I McKillop, P Stolee, D Jones , JG Strong	JW Graham Trust	47,500
A comparison of cup-to-disc ratio measurement using a cross section with the OCT and clinical observation	2001	P Hrynchak, T Simpson, D Jones	Canadian Optometric Education Trust Fund	4,000
Comparison of visual acuity measurements of amblyopic children and children with low vision with the Cardiff acuity cards and Kay logmar test	2001	D Jones , C Westall	Canadian Optometric Education Trust Fund	2,500
Visual acuity assessment of the pre-school child: Can the Kay picture test be used as an accurate and repeatable measure of acuity for the pre-school child?	2000	D Jones , C Westall	Canadian Optometric Education Trust Fund	2,000
The production of an enhanced grading scale for determination of ocular hyperemia	2000	D Jones , T Simpson.	Canadian Optometric Education Trust Fund	2,500
The enhancement of clinical grading systems to grade ocular appearance	1999	T Simpson, D Jones	Canadian Optometric Education Trust Fund	2, 500
Matching grant	1999	T Simpson , L Jones, D Jones, M Senchyna & E	Ontario Research Development Challenge Fund	385,000

		Irving		
New Opportunities Grant	1998	T Simpson, L Jones, D Jones, M Senchyna & E Irving	Canada Foundation for Innovation, New Opportunities Grant	385,000
University Start-up funds	1998	D Jones	UW	10,000

7.2 Unsuccessful grant applications

1. Application to Ontario Centres of Excellence (OCE) - “DREAM Vision Test” (Diabetic Retinopathy Evaluation and Management). **D Jones**, A Stanberry, D Jones. Requested \$100,000.
2. Application to Ontario Centres of Excellence (OCE) – LANO project – tearful biomarkers. **D Jones**, C Phan, L Jones Requested \$100,000.
3. COETF application: The use of cycloplegic agents by optometrists. **D Jones**, C Chiarelli. Requested \$4800.

7.3 Industry Contracts Awarded

NOTE: For all Industry contracts with the CCLR, the CCLR Director is the PI for all contracts. The role of the Lead Investigator includes:

- Development of study protocol
- ORE application process
- Liaison with study sponsor
- Training of study personal
- Examination of research participants
- General oversight if study
- Management of protocol deviations and adverse events
- Report writing and presentation of study results where applicable

All amounts quoted are in Canadian Dollars.

Project title and brief description	Site	Role	Amount (\$ CN)	Project Period
CHIVE - comparison of myopia control contact lenses	CCLR	Lead Investigator	\$ 126,280	May 2016 – Nov 2016
FALCON – prevalence of myopia in Canadian children	CCLR	Co-lead Investigator	\$ 66,275	Jan 2015 – Dec 2015
ORILLIA. A multicentre dispensing clinical evaluation of MiSight lenses	CCLR	Lead Investigator	\$ 252,000	Nov 2012 – Dec 2015
ORILLIA 2. Extension of Orillia for 2 further years	CCLR	Lead Investigator	\$ 150,000	Dec 2015 – Dec 2018
COPPER – fitting children with contact lenses	CCLR	Lead Investigator	\$ 595,000	Jan 2010 – Dec 2010
ACT – Toric lens study	CCLR	Co-	\$ 59,738	1999

		investigator		
CAT – Toric lens study	CCLR	Co-investigator	\$ 70,840	1998
WHAM – multifocal study	CCLR	Co-investigator	\$ 38,588	1998
CR1101 – disposable contact lenses	Private practice	Co-investigator	\$ 30,000	1997
CR 1223 – disposable contact lenses	Private practice	Co-investigator	\$ 7,000	1997
EYE-DROP – rewetting drop study	Private practice	Co-investigator	\$ 27,000	1997
RGP surface treatment project	Private practice	Co-investigator	\$ 13,000	1995
Project Biocompatible	Private practice	Co-investigator	\$ 13,000	1995
Project G11 vs G1V – disposable contact lenses	Private practice	Co-investigator	\$ 10,000	1995
Aspheric RGP study	Private practice	Co-investigator	\$ 10,000	1994

7.4 *Development of Intellectual Property*

Development of a Validated Bulbar Redness (VBR) Scale. M Schulze, **D Jones**, T Simpson. This project was previously published (Schulze MM, Jones DA, et al.: The development of validated bulbar redness grading scales. *Optom Vis Sci* 2007; 84;10: 976-83) and subsequently commercialised. To date, there have been 15 executed agreements for the VBR scale and it has been used in clinical studies worldwide.

7.5 *Publications & Presentations*

7.5.1 *Refereed Publications*

1. A sixteen year survey of Canadian contact lens prescribing. **D Jones**, C Woods, L Jones, N Efron, Morgan P. *Contact Lens Anterior Eye* 2016: 39(6) 402-410
2. Contact lens fitting and training in a child and youth population. L Paquette, **D Jones**, C Woods, Nandakumar K. *Contact Lens Anterior Eye* 2015;38(6): 419-23
3. The benefit of comprehensive eye examinations for pre-schoolers. **D Jones**, C Chiarelli, B Robinson, K MacDonald. *Canadian Journal of Optometry* 2012: 74(1):14-21
4. Contact lens prescribing in Canada 2011. **D Jones**. C Woods, N Efron, P Morgan. *Canadian Journal of Optometry* 2012: 74(2): 35-37
5. The prevalence and impact of high myopia. *Eye and Contact Lens*. **D Jones**, D Luensmann. *Eye and Contact Lens* 2012: 38(3):188-196
6. Soft toric contact lens prescribing in different countries. N Efron, PB Morgan, M Helland, M Itoi, **D Jones**, JJ Nichols, E van der Worp, CA Woods. *Contact Lens Anterior Eye* 2011; 34(1): 36-38
7. Global trends in prescribing contact lenses for extended wear. PB Morgan, N Efron, M Helland, M Itoi, **D Jones**, JJ Nichols, E van der Worp, CA Woods. *Contact Lens Anterior Eye* 2011; 34(1): 32-35.
8. “Eye-T”: Information technology adoption and use in Canada’s optometry practices. P Stolee, I McKillop, J Macmurray, JGStrong, **D Jones**, J Hildebrand. *Optometry* 2011: 82(3) 166-174
9. Demographics of international contact lens prescribing. PB Morgan, N Efron, M Helland, M Itoi, **D**

- Jones, JJ Nichols, E van der Worp, CA Woods.** Contact Lens Anterior Eye 2010; 33(1): 27-29.
10. International rigid contact lens prescribing. N Efron, PB Morgan, M Helland, M Itoi, **D Jones**, JJ Nichols, E van der Worp, CA Woods. Contact Lens Anterior Eye 2010; 33(3): 141-143.
 11. Twenty first century trends in silicone hydrogel contact lens fitting: An international perspective. PB Morgan, N Efron, M Helland, M Itoi, **D Jones**, JJ Nichols, E van der Worp, CA Woods. Contact Lens Anterior Eye 2010; 33(4): 196-198.
 12. Daily disposable contact lens prescribing around the world. N Efron, PB Morgan, M Helland, M Itoi, **D Jones**, JJ Nichols, E van der Worp, CA Woods. Contact Lens Anterior Eye 2010; 33(5): 225-227.
 13. Student indebtedness amongst graduates from Canadian Optometry Schools. E Bitton, **D Jones**. Canadian Journal of Optometry 2009; 71 (March): 33-38
 14. User perceptions of a paperless clinical evaluation system for optometry students and clinicians. M Shinouda, **D Jones**, M Spafford. Optometric Education 2009; 34:3 104-109.
 15. A seven year survey of contact lens prescribing habits of Canadian optometrists. C Woods, **D Jones**, L Jones, P Morgan. Optom Vis Sci 2007; 84(6):505-510.
 16. The development of validated bulbar redness grading scales. M Schulze, **D Jones**, T Simpson. Optom Vis Sci 2007; 84(10) :976-983.
 17. Senior optometry students' experiences with information technology in optometric practice. J Hildebrand, P Stolee, I McKillop, **D Jones**, JG Strong. Optometric Education 2007; 33: 19-23.
 18. Contact Lens Prescribing in Canada in 2006. **D Jones**, C Woods. Canadian Journal of Optometry, November 2006: 68(6).
 19. Parent's awareness of vision care issues in children aged four to six. L Ng, **D Jones**, S Leat. Canadian Journal of Optometry, January 2006; 68(1).
 20. A comparison of cup-to-disc ratio measurement in normal subjects using optical coherence tomography image analysis of the optic nerve head and stereo fundus biomicroscopy. PK Hrynychak, N Hutchings, **D Jones**, T Simpson. Ophthalmic Physiol Opt 2004; 24(6): 543-50.
 21. Visual acuity measurement: A comparison of two tests for measuring children's vision. **D Jones**, C Westall, K Averbeck, M Abdollell, Ophthalmic Physiol Opt 2003 23:541-546
 22. A comparison of cup-to-disc ratio evaluation in normal subjects using stereo biomicroscopy and digital imaging of the optic nerve head. P Hrynychak, N Hutchings, **D Jones**, T Simpson. Optom Vis Sci 2002; 79 (12s): 90
 23. Non-inflammatory corneal complications of contact lens wear. L Jones, **D Jones**. Contact Lens & Anterior Eye 2001; 24 (2): 73 – 79.
 24. A clinical comparison of three polyhexanide-preserved multi-purpose contact lens solutions. L Jones, **D Jones**, M Houlford. Contact Lens Anterior Eye 1997; 20: 23-30.
 25. Reactive or proactive contact lens fitting - does it make a difference? L Jones, **D Jones**, C Langley, M Houlford. J BCLA 1996; 19 (2): 41-43.
 26. The time dependent effect of hydrogen peroxide neutralisation on the fitting characteristics of group IV disposable lenses. L Jones, I Davies, **D Jones**. J BCLA 1993; 16(4): 135-140.

7.5.2 Non-Refereed Publications

1. Global trends in myopia management: A review. **D Jones**. contactlensupdate.com. November 2016
2. International contact lens prescribing in 2015. P Morgan, N Efron, C Woods, **D Jones** et al. Contact Lens Spectrum 2016; 31(1) 24-29
3. International contact lens prescribing in 2014. P Morgan, N Efron, C Woods, **D Jones** et al. Contact Lens Spectrum 2015; 30(1) 28-33
4. International contact lens prescribing in 2013. P Morgan, N Efron, C Woods, **D Jones**, et al. Contact Lens Spectrum 2014; 29(1) 30-35

5. International contact lens prescribing in 2011. P Morgan, N Efron, C Woods, **D Jones**, et al. *Contact Lens Spectrum* 2012; 27(1) 26-31
6. International Contact Lens Prescribing in 2010. Morgan, P., Efron N., Woods, C., **Jones, D.**, et al. *Contact Lens Spectrum* 2011; 24(2)30-36
7. International Contact Lens Prescribing in 2008. P Morgan, N Efron, C Woods, **D Jones** et al. *Contact Lens Spectrum* 2009; 23(2): 28-32.
8. International Contact Lens Prescribing in 2007. P Morgan, N Efron, C Woods, **D Jones** et al. *Contact Lens Spectrum* 2008; 22(1) 36-41.
9. International Contact Lens Prescribing in 2006. P Morgan, N Efron, C Woods, **D Jones** et al. *CL Spectrum* January 2007; 21(1) 34-38.
10. International Contact Lens Prescribing in 2005. P Morgan, N Efron, C Woods, **D Jones** et al. *CL Spectrum* January 2006; 21(1) 35-39.
11. What contact lenses are fitted today (and tomorrow). P Morgan, N Efron, C Woods, **D Jones**. *Global Contact* 2006 42:12-15.
12. International Contact Lens Prescribing in 2004. P Morgan, N Efron, C Woods, **D Jones** et al. *CL Spectrum* January 2005; 20(1) 34-37.
13. International Contact Lens Prescribing in 2003:P Morgan, N Efron, C Woods, **D Jones**, I. Tranoudis, M Itoi, E van der Worp, M Helland, A Yeo Chee Hong, J T. Barr, *CL Spectrum* 2004; (1): 34-37.
14. International Contact Lens Prescribing in 2002. P Morgan, N Efron, C Woods, **D Jones**, Y Tranoudis, E van der Worp, M Helland, A Yeo Chee Hong, J Barr, G Bailey. *CL Spectrum* 2003;17 (1): 40-43.
15. International Contact Lens Prescribing: P Morgan, N Efron, C Woods, **D Jones**, Y Tranoudis, E van der Worp, M Helland, *CL Spectrum* 2002;17 (1): 42-45.
16. Response to clinical case on Choroidal Melanoma. *Practical Optometry*, July 1999.
17. The subjective response of 100 consecutive patients to 1-day disposable lenses. L Jones, **D Jones**, C Langley, M Houlford *Optician* 1995; 211 (5536): 28-32.
18. The comparative performance of two aspheric rigid gas permeable lens designs. L Jones, **D Jones**, C Langley. *Optician* 1995; 210 (5526): 28-36.
19. Three and nine O'clock corneal staining. L Jones, **D Jones**. *Optician* 1995; 210 (5526): 20-22.
20. Blepharitis. L Jones, **D Jones**. *Optician* 1995; 210 (5522): 32-33.
21. RGP lens binding (adherence). L Jones, **D Jones**. *Optician* 1995; 210 (5517): 28-29.
22. SMILE staining and dehydration. L Jones, **D Jones**. *Optician* 1995; 210 (5513): 24-25.
23. Dimple-veil staining. L Jones, **D Jones**. *Optician* 1995; 210 (5509): 32.
24. Superior epithelial arcuate lesions. L Jones, **D Jones**. *Optician* 1995; 209 (5500): 32-33. 1995.
25. Corneal staining assessment. L Jones, **D Jones**. *Optician* 1995; 209 (5496): 30-32.
26. Meibomian gland dysfunction. L Jones, **D Jones**. *Optician* 1995; 209 (5491): 30-31.
27. Persecon 92E: design and clinical performance. L Jones, **D Jones**. *Optician* 1991; 203 (5333): 16-23.
28. Contact lens case histories at the IOO. L Jones, **D Nixon**, C Woods. *Optician* 1989; 198 (5215): 23-24 and 198 (5220): 29-32.

7.5.3 Books & Book Chapters

1. *Slit Lamp Biomicroscopy*. L Jones & D Jones. Chapter 1 in “*The Cornea*”, by Nathan Efron. Butterworth-Heinemann, Oxford, UK. ISBN 0 7506 4798 1. Published April 2001.
2. *Common Contact Lens Complications: Recognition and Management*. L Jones & D Jones. A textbook aimed principally at optometry students and practitioners with basic contact lens knowledge. Butterworth-Heinemann, Oxford, UK. ISBN 0 7506 3542 8. Published April 2000.

7.5.4 *Refereed Conference Presentations*

- 1) Myopia prevalence in Canadian school children. M Yang, D Luensmann, D Fonn, J Woods, K Gordan, L Jones, **D Jones**. American Academy of Optometry. Anaheim. (2016). Presented as a poster
- 2) Clinical evaluation of a dual-focus myopia control 1 day soft contact lens – 2 year results P Chamberlain, N Logan, **D Jones**, J Gonzalez-Mejome, S Saw, G Young. American Academy of Optometry. Anaheim. (2016). Presented as a paper
- 3) The acceptability of contact lens wear to children and teenagers. **D Jones**, L Paquette, K Nandakumar, C Woods. British Contact Lens Association conference. Manchester UK. (2012). Presented as a paper
- 4) Ease of Contact Lens Fitting and Training in a Child and Youth Population. **D Jones**, L Paquette, M Despres, K Nandakumar, C Woods., British Contact Lens Association. Manchester UK. (2012). Presented as a poster
- 5) Ease of contact lens fitting and training in a child and youth population. L Paquette, **D Jones**, M Despres, K Nadakumar, C Woods, Optom Vision Science 2011: 88 E-abstract 115833. American Academy of Optometry. Boston. (2011). Presented as a poster.
- 6) Institutional and Gender Differences in Students Indebtedness attending Canadian Optometry Schools. C Gemme, A St Jean, E Bitton, **D Jones**. Optometry and Vision Science E-abstract 95436. American Academy of Optometry. Orlando, Florida. (2009). Presented as a poster.
- 7) User perceptions of a paperless clinical evaluation system for optometry students and instructors. M Shinouda, **D Jones**, M Spafford. Optometry and Vision Science E-abstract 85102. American Academy of Optometry, Anaheim, California. (2008). Presented as a poster.
- 8) Student Indebtedness amongst Canadian optometry Students. E Bitton, **D Jones**, Optometry and Vision Science E-abstract 075274. American Academy of Optometry. Tampa, Florida. (2007). Presented as a poster
- 9) The Use of Silicone Hydrogel Lenses by Canadian Optometrists 2000-2006. **D Jones**, C Woods, L Jones, P Morgan. Optometry and Vision Science E-abstract 065282. American Academy of Optometry, Denver. (2006). Presented as a poster
- 10) The Use of O² Optix in custom in a case of pediatric aphakia. **D Jones**, L Jones. Contact Lens and Anterior Eye 2008. 31(5): pg 246 British Contact Lens Conference, Birmingham, UK. (2008) Presented as a poster
- 11) The Use of O² Optix in custom in a case of pediatric aphakia. **D Jones**, L Jones. Optometry and Vision Science E abstract 075149. American Academy of Optometry, Tampa, Florida. (2007). Presented as a poster
- 12) International Contact Lens Prescribing in 2002. P Morgan, N Efron, C Woods, **D Jones**, Y Tranoudis, E van der Worp, H van Utrecht, M Helland, A Yeo Chwee Hong, J Barr, G Bailey. Optometry and Vision Science 2002; 79 (12s): 4 American Academy of Optometry. San Diego. (2002). Presented as a Poster
- 13) A comparison of Two Visual Acuity Tests in Pediatric Patients with Amblyopia. **D Jones**, C Westall, M Enssle. Optom Vis Sci 2002; 79 (12s):231. American Academy of Optometry, San Diego. (2002). Presented as a Poster
- 14) A comparison of cup-to-disc ratio evaluation in normal subjects using stereo biomicroscopy and a digital image of the optic nerve head. P Hrynychak, T Simpson, **D Jones**, N Hutchings. Optom Vis Sci 2001; 78 (12s): 65. American Academy of Optometry, San Diego (2001). Presented as a poster
- 15) The Application of Clinical Grading Scales by Trained and non- Trained Observers. **D Jones**, M Schulze, T Simpson. Contact Lens & Anterior Eye. British Contact Lens Association. Brighton, UK (2001). Presented as a poster
- 16) Recording of contact lens complications using digital image technology. **D Jones**, L Jones, K Dumbleton & N Pritchard. Contact Lens & Anterior Eye 2000; 23(4): 160.. British Contact Lens Association. Birmingham, UK. (2000). Presented as a poster

- 17) Production of an enhanced grading scale for determination of ocular hyperemia. M Schulze, **D Jones** & T Simpson. *Optometry and Vision Science* 2000; 77 (12s): 184. American Academy of Optometry. Orlando.(2000). Presented as a poster
- 18) A comparison of two logMAR based crowded visual acuity tests for the assessment of vision in children. K Averbeck, **D Jones**, C Westall. *Optometry and Vision Science* 2000; 77 (12s): 280. American Academy of Optometry. Orlando (2000). Presented as a poster.
- 19) The subjective satisfaction of presbyopes wearing disposable/frequent replacement lenses: a comparison of monovision versus reading over-spectacles. **D Jones**, L Jones & T Simpson. *Contact Lens & Anterior Eye* 1999; 22: 162.. British Contact Lens Association Conference. Birmingham UK. (1999). Presented as a poster.
- 20) Multi-purpose solution effects on the clinical performance and spoilage of daily-wear monthly planned replacement contact lenses. L Jones, **D Jones**, V Franklin, S Tonge & B Tighe. *Contact Lens & Anterior Eye* 1999; 22: 155. British Contact Lens Association Conference. Birmingham UK.(1999). Presented as a poster.
- 21) The subjective satisfaction of presbyopes wearing disposable/frequent replacement lenses: A comparison of monovision vs reading over-spectacles. **D Jones**, L Jones & T Simpson. *Optom Vis Sci* 1999; 76 (12s): 174. American Academy of Optometry. Seattle. (1999). Presented as a poster.
- 22) The influence of replacement frequency and care regimens on subjective satisfaction with disposable/frequent replacement lenses. L Jones, **D Jones** & T Simpson. *Contact Lens & Anterior Eye* 1999; 22: 147. British Contact Lens Association Conference. Bournemouth UK. (1999). Presented as a poster.
- 23) The impact of replacement frequency and care regimen on subjective satisfaction with disposable/frequent replacement lenses. L Jones, **D Jones** & T Simpson *Optom Vis Sci* 1999; 76 (12s): 172. American Academy of Optometry. Seattle. (1999). Presented as a poster.
- 24) Multi-purpose solution effects on the clinical performance and spoilage of daily-wear monthly planned replacement contact lenses. **D Jones**, L Jones, V Franklin, S Tonge & B Tighe. *Optom Vis Sci* 1998; 75 (12s): 276. American Academy of Optometry. San Francisco.(1998). Presented as a poster.
- 25) The influence of solution regimes on the *in vivo* wettability of Group II and Group IV frequent replacement lenses. L Jones, **D Jones**, C Langley & M Houlford. *Contact Lens & Anterior Eye* 1997; 20: 171. British Contact Lens Association. Bournemouth UK. (1997). Presented as a paper.
- 26) A clinical comparison of three polyhexanide-preserved multi-purpose contact lens solutions. L Jones, **D Jones** & M Houlford. *Optom Vis Sci* 1996; 73 (12s): 95. American Academy of Optometry. Orlando (1996). Presented as a poster
- 27) Problems, problems, problems. **D Jones** & L Jones. *Journal of the British Contact Lens Association* 1995; 18(4): 139.. British Contact Lens Association. London UK. (1995). Presented as a poster
- 28) Reactive or proactive contact lens fitting – does it make a difference? L Jones, **D Jones**, C Langley, M Houlford.. American Academy of Optometry. New Orleans. (1995). Presented as a poster.
- 29) Every picture tells a story. **D Jones** & L Jones. *Journal of the British Contact Lens Association* 1994; 17 (4): 154.. British Contact Lens Association. Torquay, UK. (1994). Presented as a poster.
- 30) A comparative evaluation of two high Dk aspheric RGP contact lenses. L Jones, **D Jones** & C Langley. *Journal of the British Contact Lens Association* 1994; 17 (4): 154. British Contact Lens Association. Torquay. UK. (1994). Presented as a poster
- 31) Effect of hydrogen peroxide neutralisation times on the fitting characteristics of group IV disposable contact lenses. L Jones, I Davies & **D Jones**. *Ophthal Physiol Opt* 1993; 14 (1): 108.

7.5.5 Other conference presentations

1. Multi-purpose solution effects on the clinical performance and spoilage of daily-wear monthly planned replacement contact lenses. **D Jones**, L Jones, V Franklin, S Tonge & B Tighe. B&L ERS Symposium, Prague (1998), Tenth Symposium on the Material Science and Chemistry of Contact Lenses, New Orleans (1998);
2. A clinical comparison of three polyhexanide-preserved multi-purpose contact lens solutions. L Jones, **D Jones** & M Houlford. Third prize winner; B&L ERS Symposium, Seville (1996)
3. Reactive or proactive contact lens fitting - does it make a difference? L Jones, **D Jones**, C Langley & M Houlford B&L Symposium, Seville (1996).
4. Problems, problems, problems. **D Jones** & L Jones. B&L Symposium, Seville (1996).
5. The time dependent effect of hydrogen peroxide neutralisation on the fitting characteristics of group IV disposable lenses. L Jones, I Davies & **D Jones**. B&L ERS, Lisbon (1994). Second prize winner.
6. Every picture tells a story. **D Jones** & L Jones. B&L ERS, Lisbon (1994). First Prize Winner.

7.5.6 Invited Continuing Education Lectures

1. Pediatrics – when and what to prescribe, University of Waterloo, School of Optometry CE cruise. January 2015
2. Myopia control – dream or reality. University of Waterloo, School of Optometry CE cruise. January 2015
3. Children’s Vision Pre-School and Beyond. Ontario Association of Optometrists Annual meeting, Niagara Falls. April 2014
4. Pediatric Optometry Workshop. Ontario Association of Optometrists Annual meeting, Toronto May 2012
5. Prescribing for the pre-Schooler. . Nova Scotia annual CE meeting. Halifax NS November 2012
6. Examining the pre-Schooler. Nova Scotia annual CE meeting. Halifax NS November 2011
7. Pediatric Eye Examinations - Where to Start. University of Waterloo, School of Optometry Annual CE conference June 2011
8. Contact lenses in Children. Saskatchewan annual CE conference. June 2009
9. Examination of the pediatric patient. Saskatchewan annual CE conference. June 2009
10. Pediatric Cases. Saskatchewan annual CE conference. June 2009
11. Pediatric Care. Waterloo/Wellington district optometric society. November 2008
12. Digital Imaging. Vision 2006 – the South African Optometric Association conference. Johannesburg September 2006.
13. Ocular emergencies. Vision 2006 – the South African Optometric Association conference. Johannesburg September 2006.
14. Digital Imaging. OAO annual conference March 2006. London, Ontario. Optometric Assistants Division
15. Age related macular degeneration OAO annual conference March 2006. London, Ontario. Optometric Assistants Division
16. Why is my vision bad doc? UW CE. Optical Assistants. June 2005
17. Examination of the pre-school child. CAO annual meeting. Ottawa July 2005
18. Refractive Management of the pre-school child. CAO Annual meeting. Ottawa. July 2005
19. Pediatric examination and management. Seminar to students and faculty at Hong Kong PolyU Optometry School. April 2005
20. What would you prescribe? – Pediatric case management. OSI Annual clinical conference. Puerto Vallarta. Mexico. Feb 2005
21. Pediatric Case Analysis. Nova Scotia Annual CE Meeting. Halifax NS. November 2004
22. Ten top Tips to Increasing Turnover. Nova Scotia Annual CE meeting. Halifax NS. November 2004

23. Urgencies and Emergencies. Optometric Assistants. Nova Scotia Annual CE Meeting. Halifax NS. November 2004
24. Pediatric Vision. Optometric assistants. Nova Scotia Annual CE meeting. Halifax NS November 2004
25. Urgencies and Emergencies. East West Conference. Allied Professionals Division. Cleveland. Ohio Oct 2004
26. Pediatric Vision. East West Conference. Allied Professionals Division. Cleveland. Ohio October 2004
27. Pediatrics – Why, What & When. Maritimes annual CE meeting. Prince Edward Island. May 2004
28. Urgencies and Emergencies Canadian Association of Optometrists Annual Meeting. Optometric assistant's division. Hamilton, Ontario. April 2004
29. Pediatric Vision. Canadian Association of Optometrists. Optometric Assistants. Hamilton, ON April 2003.
30. Ocular Urgencies and Emergencies - Manitoba Association of Optometrists – Optometric Assistants. Winnipeg, April 2003
31. Pediatric vision. Manitoba Association of Optometrists – Optometric Assistants. Winnipeg April 2003
32. Pediatric Vision. British Columbia Association of Optometrists, Optometric Assistants. Vancouver February 2003
33. Pediatric Prescribing – Why. What. When. British Columbia Association of Optometrists. Vancouver Feb 2003
34. Ocular Emergencies. Saskatchewan Paraoptometric Society. Regina October 2002
35. Pediatric vision. Saskatchewan Paraoptometric Society. Regina October 2002.
36. Corneal topography. Workshop. BCLA conference, Birmingham UK. May 2000
37. Digital imaging. Workshop at the World Congress 2000 Conference, University of Waterloo, Canada, May 2000.
38. Eyelid complications and contact lens practice. BCLA conference, Birmingham. June 1999
39. Paediatric Pearls of wisdom. University of Waterloo CE course, Ontario, Canada June 1999
40. Digital imaging in optometric practice. University of Waterloo CE course, Ontario, Canada. June 1999
41. Digital Imaging in contact lens practice. New Zealand Contact Lens Conference. Auckland, New Zealand. August 1997.
42. Slit Lamp Photography & Digital Imaging - BCLA Workshop, Bournemouth, June 1997.
43. Volk lens and BIO Workshop - Kent LOC Workshop, September 1996.
44. Slit Lamp Techniques and Imaging in the Contact Lens Practice - BCLA Workshop, Birmingham, May 1996.
45. Slit Lamp and Binocular Indirect Ophthalmoscopy - Welsh Residential Optical Congress, Llandrindod Wells, March 1996.

7.6 Reviewer duties

7.6.1 Manuscript reviewer

Typically review 3-4 submissions per year across the journals listed below

- Eye and Contact Lens
- British Journal of Ophthalmology
- Ophthalmology and Eye Diseases
- Annals, Academy of Medicine Singapore
- Optometry and Vision Science
- Pediatrics and Therapeutics:
- Clinical Ophthalmology

7.6.2 Other reviewing activities

- American Optometric Foundation: Review of applications for Terrance N. Ingraham Pediatric Optometry Residency Awards 2010, 2011 & 2012
- AOF Vistakon Innovation in Education Grants 2013, 2014

8 Special Projects

Development of a satellite optometry clinic within the Centre for Family Medicine (CFFM) in Kitchener.

The initial clinic was located at the initial CFFM Joseph Street site.

My role included:

- Initial discussion with the founders of the CFFM to determine the role of the optometry clinic
- Design of examination rooms and dispensary
- Liaison with equipment suppliers to equip the clinic
- Oversight of the opening of the clinic

In 2010 the CFFM moved to the newly build health sciences campus – Victoria Street. A new optometry clinic was designed in the new space. This was a joint initiative with the Centre for Family Medicine and the McMaster CeGroote School of Medicine.

My role included:

- Working with architect to design the optometry clinic space
- Working with UW project manager to oversee the building of the clinic
- Working with designer to create dispensary
- Oversight of move from old location to new location
- Oversight of the management of deficiencies after project completion

The Health Sciences Optometry Clinic has grown to be a highly interprofessional collaborative clinic, with referrals between medicine and optometry and joint teaching initiatives for optometry learner, medical students and family medicine residents.

9 Teaching and Supervisory Roles

9.1 Optometry Course Teaching

I have taught or currently teach in the following courses

9.1.1 Didactic

- OPT 347 - Contact Lens Course
- OPT 377 - Pediatric Course

9.1.2 Laboratory

- OPT 347L- Contact lens laboratory
- OPT 377L - Pediatric Laboratory
- OPT 152L and 252L Clinical Techniques

9.1.3 Clinical Supervision

- Pediatric and Special Needs clinic supervision
- Primary Care Supervision
- Contact Lens Clinic Supervision

9.2 Supervision of Overseas Thesis students

Students from the School of Optometry in Aalen, Germany are required to spend their final six months working on a defined project. The project is written up and submitted as part of their final degree program and can be conducted at home or overseas. The following are students I was directly involved with

Name	Year	Project Title	Present Position
Marc Schulze	2000	The production of an enhanced grading scale for determination of ocular hyperemia	Clinical scientist - CCLR
Karin Averbeck	2000	Visual acuity assessment: a comparison of two tests for measuring children's vision	Optometrist, Germany
Monika Enssle	2001	Recognition and resolution acuity in amblyopes. A comparison of acuity tests.	Optometrist, Germany

Marc Schulze was awarded the Da Vinci award by the British Contact Lens Association for his work; the award was presented at the annual conference, June 2001.

9.2.1 Graduate Teaching and Supervision

Committee member

Name	Degree	Year	Project Title	Present Position
Muntz A	PhD	Commenced 2012	Tear assessment using a novel device	PhD student UW Optometry
Walther, H	PhD	Commenced Summer 2011	Conformational state of lipids on contact lens materials	PhD Student UW Optometry
Schulze, M	PhD	2005 - 2009	Grading Scales for the Anterior Segment of the Eye	Clinical Scientist CCLR

10 Media Experience

Media experience includes:

- Live TV interviews
- Interviews with national and local press
- Pre-recorded TV interviews

11 Community Activity

1. Klemmer Farmhouse Cooperative Daycare – President of Board of Directors 1999 – 2001
2. Upper Beechwood #1 Home Association – President of Board of Directors 2000 – current
3. Bushwood Court Neighbourhood project – Co-Chair. Successful application to the city of Waterloo for a grant for replanting of an island on Bushwood Court and for hosting a community event. Grant awarded \$1800. Duties included oversight of sub-committees and organization of matching funds through donations and organization of the community event.

A. Shekhar Pandey, MD, FRCPC, ABIM, CBNC

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Cambridge, Ontario
Canada, N1R-6V6
T: 519-624-3511, F: 519-624-3411
pandey@rogers.com

QUALIFICATIONS:

- | | |
|------|---|
| 1998 | Diplomate of the Certification Board of Nuclear Cardiology (Board Certified in Nuclear Cardiology) |
| 1997 | Diplomate in Cardiovascular Disease of the American Board of Internal Medicine (Board Certified in Cardiology) |
| 1996 | Fellow of the Royal College of Physicians and Surgeons of Canada (FRCP(C), Cardiology) |
| 1995 | Fellow of the Royal College of Physicians and Surgeons of Canada (FRCP(C), Internal Medicine) |
| 1994 | Diplomate of the American Board of Internal Medicine (Board Certified in Internal Medicine) |
| 1992 | FLEX Examination Parts 1 & 2 |
| 1992 | General License, College of Physicians and Surgeons of Ontario |
| 1991 | Licentiate of the Medical Council of Canada (LMCC) |

EDUCATION:

- | | |
|-----------|---|
| 1987-1991 | Doctor of Medicine
University of Toronto |
| 1984-1987 | Bachelor of Science
Dalhousie University,
Halifax, Nova Scotia |

POSTGRADUATE APPOINTMENTS:

- 2010- present. Assistant Clinical Professor. Department of Medicine,
McMaster University
- 2001- present STAFF CARDIOLOGIST, P.R.E.V.N.T. Clinic, Cambridge Cardiac Care Inc,
Cambridge Ont. A multi-disciplinary, nurse led high risk
prevention clinic
- 2001- present STAFF CARDIOLOGIST, Cardiac Catheterization Lab, St. Mary's General
Hospital, Kitchener, Ontario
- 2000- present STAFF CARDIOLOGIST & LABORATORY SUPERVISING PHYSICIAN,
Cambridge Cardiac Care Centre, Cambridge Ont.
- 1998- present STAFF CARDIOLOGIST, Cambridge Memorial Hospital, Cambridge, Ontario
- 1998 LOCUM CARDIOLOGIST / INTERNIST, Wellesley Hospital, and Women's
College Hospital, Toronto.
- 1996-1998 HEART AND STROKE FOUNDATION OF CANADA CARDIOLOGY
RESEARCH FELLOW IN CONGESTIVE HEART FAILURE,
AND CARDIAC CATHETERIZATION
University of Toronto
- 1994-1996 CARDIOLOGY RESIDENCY
University of Toronto
- 1991-1995 INTERNAL MEDICINE INTERNSHIP & RESIDENT, University of
Toronto

CLINICAL RESEARCH EXPERIENCE:

Since 1996, Principal Investigator in over 25 clinical trials phase 2- phase 4 in various aspects of cardiovascular & endocrine / metabolism research including hypertension, hyperlipidemia, diabetes, metabolic syndrome, thrombosis & anti-thrombotics, anti-caagulants, NSTEMI, STEMI, ACS, atrial fibrillation, CHF, CVA / TIA, PAD, device development, echocardiography, stress testing. Affiliations with various industry, university & government granting agencies. Large staff of qualified, dedicated, GCP & human research ethics trained research personnel.

AWARDS:

- 1998 Rhodes Fellowship for Young Investigators, International Society of Heart
Research
- 1997 Heart and Stroke Foundation of Canada Research Fellowship Award

1996 Heart and Stroke Scientific Research Corporation of Canada Research Fellowship Award

Heart and Stroke Foundation of Canada 3 year Research Fellowship Award
(declined)

Royal College of Physicians and Surgeons of Canada-Medical Research Council of Canada-Sandoz 2 year Clinical Research Fellowship Award (declined)

1995 First Place, IODE Ursula Bangs University of Toronto Cardiology Trainee Research Competition, May 18, 1995.

1994 Student Research Presentation Award, 47th Annual Meeting, Canadian Cardiovascular Society, Edmonton, Alberta, October 26th, 1994.

1993 The Toronto Hospital Post-Graduate Medical Trainee Teaching Citation

1989 Toronto Women's Breast Cancer Foundation Summer Research Scholarship

1987 Natural Sciences & Engineering Research Council Summer (NSERC) Student Research Award

1987 Natural Sciences And Engineering Research Council Summer Student Research Award

1986 Ross Stewart Smith Scholarship, Dalhousie University

Natural Sciences and Engineering Research Council Summer Student Research Award

1985 Hector McInnes Scholarship, Dalhousie University

1984 Dalhousie University Entrance Scholarship

Fourth Place/ Honorable Mention; Canada Wide Science Fair

PUBLICATIONS:

1. **Pandey, A.S.**, Breckenridge, J.E., and T.H. MacRae. Disruption of Artemia development by metals. *Canadian Society of Zoologists Bulletin*. 1988: 19; 48.
2. Go, E.C., **Pandey, A.S.** and T.H. MacRae. The effect of inorganic mercury on the emergence and hatching of the brine shrimp Artemia Franciscana. *Marine Biology*. 1990: 107; 93-102.

3. **Pandey, A.S.** and T.H. MacRae. Toxicity of organic mercury compounds to the developing brine shrimp *Artemia*. *Ecotoxicology and Environmental Safety*. 1991; 21; 68-79.
4. MacRae, T.H. and **A.S. Pandey**. Effects of metals on early life stages of brine shrimp *Artemia*: a developmental toxicity assay. *Archives of Environmental Contamination & Toxicology*. 1991;20; 247-252.
5. **Pandey, A.S.**, Rakowski H., Mickleborough L.L., Butany J.W., Omran A., Parker T. G. Right Heart Pulmonary Embolism in Transit: A Review of Therapeutic Considerations. *Can J Cardiol*. 1997; 13:397-402.
6. **Pandey, A.S.**, Stewart DJ, Cernacek P, Dawood F, Wen WH, Liu P. Chronic ET-1 Blockade Preserves Myocardial Contractility in Dilated Cardiomyopathy. *J Cardiovasc Pharmacol*. 1998; 31 Suppl 1: S306-S308.
7. Parker JD, Thiessen JJ, Reilly R, Tong JH, Stewart DJ, **Pandey A.S.** Human endothelin-1 clearance kinetics revealed by a radiotracer technique. *J Pharmacol Exp Ther* 1999; 289:261-265
8. Chan KL, Teo K, Tam J, Dumesnil JG; Astronomer Investigators (**Pandey AS**). Rationale, design, and baseline characteristics of a randomized trial to assess the effect of cholesterol lowering on the progression of aortic stenosis: the Aortic Stenosis Progression Observation: Measuring Effects of Rosuvastatin (ASTRONOMER) trial. *Am Heart J*. 2007 Jun;153(6):925-31.
9. Jassal DS, Tam JW, Dumesnil JG, Giannoccaro PJ, Jue J, **Pandey AS**, Joyner CD, Teo KK, Chan KL. Clinical Usefulness of Tissue Doppler Imaging in Patients with Mild to Moderate Aortic Stenosis: A Substudy of the Aortic Stenosis Progression Observation Measuring Effects of Rosuvastatin Study. *J Am Soc Echocardiogr*. 2008 Apr 10
10. Jassal DS, Tam JW, Bhagirath KM, Gaboury I, Sochowski RA, Dumesnil JG, Giannoccaro PJ, Jue J, **Pandey AS**, Joyner CD, Teo KK, Chan KL. Association of mitral annular calcification and aortic valve morphology: a substudy of the aortic stenosis progression observation measuring effects of rosuvastatin (ASTRONOMER) study. *Eur Heart J*. 2008 Jun; 29(12):1542-7.
11. Chan KL, Teo K., Dumesil JG, Ni A, Tam J; Astronomer Investigators (**Pandey, AS**). Effect of Lipid lowering with rosuvastatin on progression of aortic stenosis: results of the aortic stenosis progression observation: measuring effects of rosuvastatin (ASTRONOMER) trial. *Circulation* 2010 Jan 19; 121 (2):306-14.
12. McPherson, R., Colloquium: Strategies to help achieve the new Canadian targets for lipid management (The Panel: Francis, G., Gregoire, J.C., Awde, M., **Pandey, AS**). *The Medical Post* 2010 Mar; 46 (5): 1-4.

ABSTRACTS:

1. **Pandey, A.S.**, and T.H. MacRae. The brine shrimp *Artemia* as a biological assay for organic and inorganic mercury”, *University of Toronto Medical Journal*. 1987: Vol. LXV Supplement; S18.
2. **Pandey, A.S.**, Breckenridge, J.E., and T.H. MacRae. Disruption of *Artemia* development by metals. *Abstracts, NATO Advanced Research Workshops on Cell and Molecular Biology of Artemia Development*. 1988:20.
3. **Pandey, A.S.**, Buckman R. Pritchard, K.I., and D.J. Sutherland. Response of metastatic breast cancer to single agent adriamycin given on a weekly schedule: results and analysis of criteria for response. *Abstracts, The Breast Cancer Site Group Conference on Controversies in the Etiology, Detection, Treatment of Early Breast Cancer*. 1990; 22.
4. **Pandey, A.S.**, Sole, M.J., Floras, J.S., Dawood, F., Wen, W.H., and P. Liu . The Role of Sympathetic Activity in Murine Myocarditis leading to Dilated Cardiomyopathy. *Can J Cardiol* 1994;10;75C.
5. **Pandey, A.S.**, Sole, M.J., Floras, J.S., Dawood, F., Wen, W.H., Wee, L. and P. Liu. The Role of Sympathetic Activity in Murine Myocarditis leading to the Development of Dilated Cardiomyopathy. *J Am Coll Cardiol* 1995: Feb;132A-133A.
6. **Pandey, A.S.**, Stewart, D.J., Dawood, F., Wen, W.H., and P. Liu. The Endothelin Blocker SB-217242 Preserves Myocardial Function in a Chronic Myocarditis Model of Heart Failure. *Can J Cardiol*. 1995: 11: 135E.
7. **Pandey, A.S.**, Stewart, D.J., Dawood, F., Wen, W.H., and P. Liu. The Endothelin Blocker SB-217242 Preserves Myocardial Function in a Chronic Myocarditis Model of Heart Failure. *Circulation*. 1995: 95; I-61.
8. **Pandey, A.S.**, Stewart D.J., Cernacek P., Dawood F., Wen W.H., and P Liu. Endothelin Blockade Augments Cardiac Endothelin Content and Ventricular Contractility in a Myocarditis Model of Congestive Heart Failure. *Can J Cardio.l* 1996; 12: 106E.
9. **Pandey, A.S.**, Stewart D.J., Cernacek P., Dawood F., Wen W.H., and P Liu. Endothelin Blockade Augments Cardiac Endothelin Content and Ventricular Contractility in a Myocarditis Model of Congestive Heart Failure. *Circulation*. 1996;94: I-74.

10. **Pandey, A.S.**, Stewart DJ, Liu P. Chronic ET-1 Blockade Preserves Myocardial Contractility in Dilated Cardiomyopathy. *Fifth International Conference on Endothelin Abstracts*. 1996; O-38.
11. **Pandey, A.S.**, Newton G., and J.D. Parker. Muscarinic Control of Cardiac Sympathetic Activity in Human Congestive Heart Failure. *Circulation*. 1997
12. **Pandey, A.S.**, Newton G., and J.D. Parker. Muscarinic Control of Cardiac Sympathetic Activity in Human Congestive Heart Failure. *Can J Cardiol*. 1997;13: 96C
13. **Pandey, A.S.**, Bissonnete S., Boukas S., Ssampalis, J.S. Lipid Profile Improvement with Ezetimibe 10mg/day Co-Administered with Statins Vs. Doubling of Statin Dose in High Risk CAD Risk Patients who are not at Target LDL-C after Statin Monotherapy: The EZE (STAT)² Trial. *Canadian Journal of Cardiology* 2006; 22 Supl D 133D
14. **Pandey, A.S.**, Bissonnete S., Boukas S., Ssampalis, J.S. Effectiveness & Tolerability of Ezetimibe 10mg/day Co-Administered with Statins Vs. Statin Dose Doubling in Patients with Diabetes who are not at Target LDL-C after Statin Monotherapy: The EZE (STAT)² Trial. *Canadian Journal of Cardiology* 2006; 22 Supl D 136D
15. **Pandey, A.S.**, Bissonnete S., Boukas S., Ssampalis, J.S. "Featured Research of the CCS 2006" Effectiveness & Tolerability of Ezetimibe 10mg/day Co-Administered with Statins Vs. Statin Dose Doubling in Patients at High Risk for Coronary Artery Disease who are not at Target LDL-C after Statin Monotherapy: The EZE (STAT)² Trial. *Canadian Journal of Cardiology* 2006; 22 Supl D 136D Chan KL, Tam J, Sochowski R, Dumesnil JG, Giannoccaro P, Jue J, Pandey S, Joyner C, Teo K. Influence of gender on left ventricular and left atrial adaptation to aortic stenosis: the ASTRONOMER study. *Can J Cardiol*. Oct 2006;22(Suppl D):218D.
16. Chan K, Tam J, Sochowski R, Dumesnil JG, Giannoccaro P, Jue J, **Pandey S**, Joyner C, Teo K. Determinants of aortic valve calcification in aortic stenosis: insights from the Astronomer study. *Can J Cardiol*. Oct 2007;23(Suppl C):284-85C.
17. Jassal DS, Tam JW, Sochowski RA, Dumesnil JG, Giannoccaro PJ, Jue J, **Pandey AS**, Joyner CD, Teo KK, Chan KL. Clinical usefulness of tissue doppler imaging in patients with mild to moderate aortic stenosis: a substudy of the aortic stenosis progression observation measuring effects of rosuvastatin (Astronomer) study. *Can J Cardiol*. Oct 2007;23(Suppl C):250-51C.
18. Tam JW, Jassal DS, Sochowski RA, Dumesnil JG, Giannoccaro PJ, Jue J, **Pandey AS**, Joyner CD, Teo KK, Chan KL. Effect of aortic valve morphology on aortic valvular calcification and mitral annular calcification in patients with mild to moderate aortic stenosis. *Can J Cardiol*. Oct 2007;23(Suppl C):251-52C.
19. Chan KL, Tam J, Sochowski R, Dumesnil JG, Giannoccaro P, Jue J, **Pandey S**, Joyner C, Teo K. Abstract 2655: Correlates Of Aortic Valve Calcification In Aortic Stenosis: Insights From The Astronomer Study. *Circulation*, Oct 2007; 116: II_588.

20. Tam J, Jassal DS, Chan KL, Predicting Subclinical Heart Failure in patients with Mild to Moderate Aortic Stenosis: A Substudy of the ASTRONOMER study, European Journal of Heart Failure 2008; 7 (1): 46.

ORAL PRESENTATIONS:

- Oct 25, 2006 “Featured Research of the CCC 2006: Effectiveness & Tolerability of Ezetimibe 10mg/day Co-Administered with Statins Vs. Statin Dose Doubling in Patients at High Risk for Coronary Artery Disease who are not at Target LDL-C after Statin Monotherapy: The EZE (STAT)² Trial.”
- Canadian Cardiovascular Congress 2006, Vancouver, B.C.
- Nov. 11, 1997 “Muscarinic Control Of Cardiac Sympathetic Activity In Human Congestive Heart Failure”
- American Heart Association 70th Scientific Session, New Orleans, Louisiana
- Oct. 6, 1997 “Muscarinic Control Of Cardiac Sympathetic Activity In Human Congestive Heart Failure”
- Canadian Cardiovascular Society, 49th Annual Meeting, Winnipeg, Manitoba
- Sept. 14, 1997 “Chronic ET-1 Blockade Preserves Myocardial Contractility in Dilated Cardiomyopathy”
- Fifth International Conference on Endothelin. Kyoto, Japan
- May 15, 1997 “Muscarinic Control Of Cardiac Sympathetic Activity In Human Congestive Heart Failure”
- IODE Ursula Bangs University of Toronto Cardiology Research Competition, Toronto, Ontario.
- Nov. 15, 1996: “Endothelin Blockade Augments Cardiac Endothelin Content and Ventricular Contractility in a Myocarditis Model of Congestive Heart Failure.”
- American Heart Association 69th Scientific Session, New Orleans, Louisiana
- May 16, 1996: “Endothelin Blockade Restores Cardiac Endothelin Content and Augments

Cardiac Systolic and Diastolic Performance in Dilated Cardiomyopathy”

IODE Ursula Bangs University of Toronto Cardiology Research
Competition, Toronto, Ontario.

Oct. 27, 1995 “The Endothelin Blocker SB-217242 Preserves Myocardial Function in a
Chronic Myocarditis Model of Heart Failure”

Canadian Cardiovascular Society, 48th Annual Meeting,
Toronto, Ontario

May 18, 1995: “Endothelin Blockade Preserves Myocardial Function in Dilated
Cardiomyopathy”

IODE Ursula Bangs University of Toronto Cardiology Research
Competition, Toronto, Ontario.

March 20, 1995: “The Role of Sympathetic Activity in Murine Myocarditis Leading
to the Development of Dilated Cardiomyopathy”

American College of Cardiology, 44th Annual Scientific Session,
New Orleans

Oct. 26, 1994: “The Role of Sympathetic Activity in Murine Myocarditis Leading
to Dilated Cardiomyopathy”

Canadian Cardiovascular Society, 47th Annual Meeting,
Edmonton, Alberta

POSTER PRESENTATIONS:

Oct. 23, 2006 Lipid Profile Improvement with Ezetimibe 10mg/day Co-Administered
with Statins Vs. Doubling of Statin Dose in High Risk CAD Risk Patients
who are not at Target LDL-C after Statin Monotherapy: The EZE (STAT)²
Trial.

Canadian Cardiovascular Congress 2006, Vancouver, B.C.

Oct. 23, 2006 Effectiveness & Tolerability of Ezetimibe 10mg/day Co-Administered
with Statins Vs. Statin Dose Doubling in Patients with Diabetes who are
not at Target LDL-C after Statin Monotherapy: The EZE (STAT)² Trial.

Canadian Cardiovascular Congress 2006, Vancouver, B.C.

- Oct. 30, 1996: “Endothelin Blockade Augments Cardiac Endothelin Content and Ventricular Contractility in a Myocarditis Model of Congestive Heart Failure.”
Canadian Cardiovascular Society, 49th Annual Meeting, Montreal, Quebec
- Nov. 13, 1995 “The Endothelin Blocker SB-217242 Preserves Myocardial Function in a Chronic Myocarditis Model of Heart Failure”
American Heart Association, 68th Scientific Sessions, Anaheim, California
- April 5, 1990 “Response of metastatic breast cancer to single agent adriamycin given on a weekly schedule: results and analysis of criteria for response”
International Conference on the Controversies in the Aetiology, Detection, and Treatment of Early Breast Cancer, The Breast Cancer Site Group, Department of Medicine, University of Toronto, Toronto, Ontario.
- Dec. 5, 1989 “Response of metastatic breast cancer to weekly low dose adriamycin”
The University of Toronto Undergraduate Medical Student Research Day, Fourth Annual Meeting, Toronto, Ontario.
- May 8-10, 1988 “Disruption of brine shrimp *Artemia* development by metals”
Canadian Society of Zoology Meeting, Halifax, Nova Scotia
- Dec. 1, 1987 “The brine shrimp *Artemia* as a biological assay for organic and inorganic mercury”
The University of Toronto Undergraduate Medical Student Research Day, Second Annual Meeting, Toronto, Ontario.

ORGANIZATIONAL APPOINTMENTS:

- 2009 – Present Member: University of Waterloo Clinical Research Ethics Committee: Category: **Clinical Physician, Clinical Trials Research**
- 2000- Present MOHLTC: Ontario Drug Benefit Formulary **Advisory Physician**
- 1999- Present Waterloo-Wellington Regional Cardiac Care Committee, **Cambridge Representative.**
- 1990-1991 **Student Representative**, Curriculum Management Working Group Task Force For Curriculum Renewal of the Faculty of Medicine, University of

Toronto, Toronto, Ontario.

1989-1990 **Editor and Staff writer**, The Auricle: The Newspaper of the Faculty of Medicine, University of Toronto, Toronto, Ontario.

1988-1989 **Student Hospital Representative**, Year II, Sunnybrook Heath Science Centre, University of Toronto, Toronto, Ontario.

1986-1987 **President**, Dalhousie Association of Biology Students, Dalhousie University, Halifax, Nova Scotia.

Marsha Mann, *B.Sc. M.Sc.F.*



Education

1988 Master of Science in Forestry, University of New Brunswick

1984 Bachelor of Science in Forestry, University of New Brunswick

Experience

Owner

No Gaps Ltd.

September 2011 to present

- Litigation support to lawyers and law firms with respect to plaintiffs' medical negligence cases
- Review of clinical notes and records from all sources, identifying medical issues, treatments, and inconsistencies
- Research medical issues, identifying potential experts
- Review hospital policies, protocols and guidelines
- Preparation of comprehensive memoranda and briefs
- Attend at Examinations for Discovery and Pre-Trials as required.

Owner

Accent the Details Inc.

July 2008 to October 2012

- Conducted market research to develop a vision of a unique retail experience
- Sourced and retained a creative team to brand the vision
- Designed the interior of the store and oversaw the renovation of the retail space
- Secured commitments of exclusivity with key product lines for the store
- Used social media to compliment print and radio marketing campaigns
- Established a loyal customer base from Toronto through Eastern Ontario and Upstate New York

Executive Director

Ontario Trial Lawyers Association

March 1995 to June 2008

- First full-time employee with the Association and tasked with building the Association
- Achieved membership growth from 150 to over 1200 members
- Responsible for managing the Association's office, staffing and a budget in excess of \$1 M
- Expanded print publication, introduced bi-monthly newsletter and public education materials
- Negotiated facilities contracts, organized spring and fall conferences, specialized section meetings, breakfast and luncheon sessions, Annual General Meeting

- Ensured compliance with Law Society of Upper Canada requirements for programs
- Represented OTLA on the Chief Justice of Ontario's Advisory Committee on Professionalism
- Built and maintained a strong base of financial sponsorship support
- Organized fundraising events, including annual black tie dinner
- Facilitated the development of the "Helmets on Kids" program

Lecturer

University of New Brunswick

September 1988 to April 1989

- Taught two required courses (lectures and laboratory sessions) and participated on faculty committees

Memberships and Volunteer Experience

Founding President of the Cambridge Women's Liberal Association, Director of the Cambridge Provincial Liberal Association and Director of the Cambridge Federal Liberal Association.

I am a member of *Women for Nature*, an initiative of Nature Canada.

I am a member of Ancient Mariners Canoe Club (Cambridge, Ontario).

I served as President of Alzheimer Society of New Brunswick.

ARTS GRADUATE STUDIES

April 13, 2017 2017

TO: Members, Senate Graduate and Research Council

FROM: Rita Cherkewski, Administrative Coordinator, Arts Graduate Studies & Research

RE: Graduate Affairs Group Reports February 16th, 2017

The attached Arts Graduate Affairs Group reports were approved by the Arts Faculty Council meeting on April 10th, 2017 and are now being submitted for approval by the Senate Graduate and Research Council on May 8th, 2017.

Rita Cherkewski

Rita Cherkewski

Attach.

ARTS FACULTY COUNCIL REPORT TO
SENATE GRADUATE AND RESEARCH COUNCIL

CURRICULAR ITEMS for approval [bottom right pagination]

- A) Sociology:** Program Revision – *Changes to MA & MA Coop programs: changes to wording regarding passing grades [1-3]*
- B) Sociology:** Program Revision – *Changes to PhD and PhD Coop programs: addition of passing grades requirement [4-5]*

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Arts

Program: 1) Master of Arts (MA) in Sociology
2) Master of Arts (MA) in Sociology – Co-operative Program

Program contact name(s): Martin Cooke

Form completed by: Martin Cooke

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

Changing the statement about the minimum grade required in courses from:

“Students must obtain at least a 75% average in courses presented in fulfillment of the degree requirements.”

To

“In order to complete a course satisfactorily students must complete all course requirements, as specified by the instructor and receive a minimum passing grade of 75%.”

Is this a [major modification](#) to the program? No

Rationale for change(s):

The language regarding the 75% passing grade is unclear, as it is intended to refer to grades for individual courses, rather than an “average”. The language should also be harmonized with the PhD.

Proposed effective date: Term: Fall Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociologyandlegalstudies/masterartsma-sociology>

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociologyandlegalstudies/masterartsma-sociology-co-operative-program-direct-entry>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Thesis option:</p> <ul style="list-style-type: none"> • Courses 	<p>Thesis option:</p> <ul style="list-style-type: none"> • Courses

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> • Students must complete the following courses: <ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 708 Contemporary Debates in Sociology Theory ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 1 other graduate course with a minimum 0.50 unit weight. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • Students must obtain at least a 75% average in courses presented in fulfillment of the degree requirements. <p>Master's Research Paper option:</p> <p><input type="checkbox"/> Courses</p> <ul style="list-style-type: none"> • Students must complete the following courses: <ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 704 Key Theoretical Debates ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 3 other graduate courses with a minimum 0.50 unit weight each. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • Students must obtain at least a 75% average in courses presented in fulfillment of the degree requirements. <p>Coursework option:</p> <p><input type="checkbox"/> Courses</p> <ul style="list-style-type: none"> • Students must complete the following courses: 	<ul style="list-style-type: none"> • Students must complete the following courses: <ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 708 Contemporary Debates in Sociology Theory ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 1 other graduate course with a minimum 0.50 unit weight. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • <u>In order to complete a course satisfactorily, students must complete all course requirements as specified by the instructor and receive a minimum passing grade of 75%.</u> <p>Master's Research Paper option:</p> <p><input type="checkbox"/> Courses</p> <ul style="list-style-type: none"> • Students must complete the following courses: <ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 704 Key Theoretical Debates ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 3 other graduate courses with a minimum 0.50 unit weight each. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • <u>In order to complete a course satisfactorily, students must complete all course requirements as specified by the instructor and receive a minimum passing grade of 75%.</u> <p>Coursework option:</p> <p><input type="checkbox"/> Courses</p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 704 Key Theoretical Debates ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 5 other graduate courses with a minimum 0.50 unit weight each. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • Students must obtain at least a 75% average in courses presented in fulfillment of the degree requirements. • The Coursework option only requires that all 8 courses are completed by the end of the third term (typically at the end of August). 	<ul style="list-style-type: none"> • Students must complete the following courses: <ul style="list-style-type: none"> ○ Theory: 1 of SOC 700 Sociological Theory or 708 Contemporary Debates ○ Methods: SOC 712 Elements of Social Research ○ Statistics: SOC 710 Intermediate Social Statistics ○ At least 5 other graduate courses with a minimum 0.50 unit weight each. These courses must also require a substantial piece of research (project or essay). ○ Students may take a maximum of 1 reading course from University of Waterloo Sociology and Legal Studies Faculty or adjuncts. • <u>In order to complete a course satisfactorily, students must complete all course requirements as specified by the instructor and receive a minimum passing grade of 75%.</u> • The Coursework option only requires that all 8 courses are completed by the end of the third term (typically at the end of August).

How will students currently registered in the program be impacted by these changes?

There will be no impact for currently registered MA students.

Departmental approval date (01/26/17):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/14/2017

Faculty approval date (mm/dd/yy): April 10, 2017

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Arts

Program: 1) Doctor of Philosophy (PhD) in Sociology
2) Doctor of Philosophy (PhD) in Sociology – Co-operative Program (direct entry)

Program contact name(s): Martin Cooke

Form completed by: Martin Cooke

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

Adding the following statement to the “Courses” section of the program description:

“In order to complete a course satisfactorily students must complete all course requirements, as specified by the instructor and receive a minimum passing grade of 75%.”

Is this a [major modification](#) to the program? No

Rationale for change(s):

The calendar description did not provide a minimum grade that must be attained in a course, for credit toward the degree. Without this, the default minimum passing grade is 60, according to the University’s grading scheme. Most Arts graduate programs, including our own MA program) set this level at 70 or 75. This language was adapted from other Arts program calendar entries.

Proposed effective date: Term: Fall Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociology-and-legal-studies/master-arts-ma-sociology>

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociology-and-legal-studies/master-arts-ma-sociology-co-operative-program-direct-entry>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> • Courses <ul style="list-style-type: none"> • Students must complete 5 one-term graduate-level courses (with a unit weight of 0.50 each) beyond the MA degree. Normally, students will fulfill their coursework requirements by: <ul style="list-style-type: none"> ○ Taking at least 3 of the 5 courses as regularly scheduled sociology graduate courses. 	<ul style="list-style-type: none"> • Courses <ul style="list-style-type: none"> • Students must complete 5 one-term graduate-level courses (with a unit weight of 0.50 each) beyond the MA degree. Normally, students will fulfill their coursework requirements by: <ul style="list-style-type: none"> ○ Taking at least 3 of the 5 courses as regularly scheduled sociology graduate courses.

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> ○ Taking reading courses from University of Waterloo Sociology and Legal Studies faculty or adjuncts (maximum 1). ○ Taking regularly scheduled courses in other University of Waterloo cognate departments (maximum 1). ○ Taking regularly scheduled courses at other universities where no equivalent course is available at the University of Waterloo (maximum 1). • Any special coursework requests will need the approval of the student's advisor/supervisor and the Associate Chair, Graduate Studies. Normally, course work must be completed by the end of the fourth term in the PhD program. • Note: coursework beyond these minima may be required at the discretion of the Associate Chair, Graduate Affairs. If further coursework is required, the student will be notified in writing at the time of entry into the program. Additional coursework may be required if the student's MA preparation is not the equivalent of that required for the MA degree in Sociology at the University of Waterloo. Students whose area of specialization and/or thesis requires familiarity with a subject not normally given in the Department of Sociology are encouraged to undertake additional work in the appropriate department. 	<ul style="list-style-type: none"> ○ Taking reading courses from University of Waterloo Sociology and Legal Studies faculty or adjuncts (maximum 1). ○ Taking regularly scheduled courses in other University of Waterloo cognate departments (maximum 1). ○ Taking regularly scheduled courses at other universities where no equivalent course is available at the University of Waterloo (maximum 1). • Any special coursework requests will need the approval of the student's advisor/supervisor and the Associate Chair, Graduate Studies. Normally, course work must be completed by the end of the fourth term in the PhD program. • Note: coursework beyond these minima may be required at the discretion of the Associate Chair, Graduate Affairs. If further coursework is required, the student will be notified in writing at the time of entry into the program. Additional coursework may be required if the student's MA preparation is not the equivalent of that required for the MA degree in Sociology at the University of Waterloo. Students whose area of specialization and/or thesis requires familiarity with a subject not normally given in the Department of Sociology are encouraged to undertake additional work in the appropriate department. • <u>In order to complete a course satisfactorily, students must complete all course requirements as specified by the instructor and receive a minimum passing grade of 75%.</u>

How will students currently registered in the program be impacted by these changes?

Current students will not be affected. In graduate courses, grades below 75 are extremely rare.

Departmental approval date (01/26/17):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/14/2017

Faculty approval date (mm/dd/yy): April 10, 2017

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):



MEMO

TO: Alice Reynard
Associate University Secretary

FROM: B. Hellinga, Associate Dean, Graduate Studies
Faculty of Engineering

RE: Senate Graduate and Research Council Meeting

DATE: April 28, 2017

Please place the following motion on the agenda for the next Senate Graduate and Research Council meeting. This motion was approved by Engineering Faculty Council on April 12, 2017.

1. The **Department of Chemical Engineering** is requesting approval for the following motion:

Description of Proposed Change

Align the seminar requirements for part time students with that of full time students in the PhD, MAsC, and MEng programs. All Masters students will be required to attend 12 seminars, and all PhD students will be required to attend 24 seminars.

Rationale for Proposed Change

This change will provide necessary consistency of the degree requirements for both part time and full time students.

A handwritten signature in black ink, appearing to read "Bruce Hellinga".

Bruce Hellinga

BH: ag

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Master of Applied Science (MASc) in Chemical Engineering - Nanotechnology

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/master-applied-science-masc-chemical-engineering-nanotechnology>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> • Over the course of their degree program, full-time students must attend 12 seminars: <ul style="list-style-type: none"> ○ 8 seminars from the Waterloo Institute for Nanotechnology (WIN) ○ 4 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. 	<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> • Over the course of their degree program, <u>all</u> students must attend 12 seminars: <ul style="list-style-type: none"> ○ 8 seminars from the Waterloo Institute for Nanotechnology (WIN) ○ 4 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website.

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website. 	<ul style="list-style-type: none"> Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website.

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have No part time MASc Nano students registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Master of Applied Science (MASc) in Chemical Engineering

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/master-applied-science-masc-chemical-engineering>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> Over the course of their degree program, full-time students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. Note: Part-time students are not required to fulfill this requirement. Note: At Chemical Engineering seminars, attendance is documented. At other approved 	<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> Over the course of their degree program, <u>all</u> students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminars, students must complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website .	seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have three part time MAsc students registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Master of Applied Science (MASc) in Chemical Engineering - Water

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/master-applied-science-masc-chemical-engineering-water>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> Over the course of their degree program, full-time students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the 	<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> Over the course of their degree program, <u>all</u> students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminar organizer. Full instructions are available on the Department website .	seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have one part time MASc Water student registered in our program

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Doctor of Philosophy (PhD) in Chemical Engineering - Nanotechnology

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/doctor-philosophy-phd-chemical-engineering-nanotechnology>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> ● Graduate Studies Seminar <ul style="list-style-type: none"> ● Over the course of their degree program, full-time students must attend 24 seminars: <ul style="list-style-type: none"> ○ 8 seminars from the Waterloo Institute for Nanotechnology (WIN) ○ 16 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. ● Note: At Chemical Engineering seminars, attendance is documented. At other approved 	<ul style="list-style-type: none"> ● Graduate Studies Seminar <ul style="list-style-type: none"> ● Over the course of their degree program, <u>all</u> students must attend 24 seminars: <ul style="list-style-type: none"> ○ 8 seminars from the Waterloo Institute for Nanotechnology (WIN) ○ 16 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. ● Note: At Chemical Engineering seminars, attendance is documented. At other approved

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminars, students complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website .	seminars, students complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have one part time PhD Nano student registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Master of Engineering (MEng) in Chemical Engineering

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/master-engineering-meng-chemical-engineering>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> • Over the course of their degree program, full-time students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. • Note: Part-time students are not required to fulfill this requirement. • Note: At Chemical Engineering seminars, attendance is documented. At other approved 	<p><input type="checkbox"/> Master's Seminar</p> <ul style="list-style-type: none"> • Over the course of their degree program, <u>all</u> students must attend 12 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department website. • Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminars, students must complete an attendance form and get it signed by the seminar organizer. Full instructions are available on the Department website .	seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have one part time Meng student registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Doctor of Philosophy (PhD) in Chemical Engineering

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We are amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/doctor-philosophy-phd-chemical-engineering>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> • Graduate Studies Seminar <ul style="list-style-type: none"> • Over the course of their degree program, full-time PhD students should attend 24 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department. • Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the 	<ul style="list-style-type: none"> • Graduate Studies Seminar <ul style="list-style-type: none"> • Over the course of their degree program, <u>all</u> PhD students should attend 24 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department. • Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminar organizer. Full instructions are available on the Department website .	seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have 8 part time PhD students registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Engineering

Program: Doctor of Philosophy (PhD) in Chemical Engineering - Water

Program contact name(s): Judy Caron

Form completed by: Judy Caron

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

We amending our degree requirements so that there is no difference between requirements for part time or full time students.

Is this a [major modification](#) to the program? No

Rationale for change(s):

This change will provide necessary consistency of the degree requirements for both part time and full time students.

Proposed effective date: Term: Spring Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-chemical-engineering/doctor-philosophy-phd-chemical-engineering-water>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> • Graduate Studies Seminar <ul style="list-style-type: none"> • Over the course of their degree program, full-time PhD students should attend 24 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department. • Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the 	<ul style="list-style-type: none"> • Graduate Studies Seminar <ul style="list-style-type: none"> • Over the course of their degree program, <u>all</u> PhD students should attend 24 seminars from departments and research institutions where Chemical Engineering faculty members have a membership. The Chemical Engineering seminars are documented in the Events section of the Chemical Engineering Department. • Note: At Chemical Engineering seminars, attendance is documented. At other approved seminars, students must complete an attendance form and get it signed by the

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
seminar organizer. Full instructions are available on the Department website .	seminar organizer. Full instructions are available on the Department website .

How will students currently registered in the program be impacted by these changes?

The Department will make accommodations for students already registered in our program. Currently we have no part time PhD Water students registered in our program.

Departmental approval date (mm/dd/yy):

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 02/03/2017

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

MEMORANDUM

TO: Alice Raynard, Senate Graduate and Research Council
FROM: Melodie Sherk, Conrad Grebel University College
DATE: 24 April 2017
SUBJECT: **SGRC agenda item from Theological Studies at Conrad Grebel**

Hello Alice,

Please see the attached documents. I have combined all of the course revision forms into one document for convenience. Please let me know if you have any questions.

Kind Regards.

- New milestone
- Program revision form
- Combined TS Course Revision forms

Faculty: Theology CGC

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item. Master's Seminar Presentation

For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)

Course Subject code: Choose an item. Course number:

Course Title (max. 100 characters incl. spaces):

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: Choose an item.

Course Credit Weight: Choose an item.

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only):

Meet Type(s): Choose an item. Choose an item. Choose an item. Choose an item.

Primary Meet Type: Choose an item.

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request:

The seminar presentation is a required component of the program for the Applied and Coursework streams. By making it a milestone, it more accurately reflects the program requirements and also ensures that the presentation is included on students' transcripts.

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

Faculty: Theology

Program: Master of Theological Studies (MTS)

Program contact name(s): Jeremy Bergen and Melodie Sherk

Form completed by: Melodie Sherk

Description of proposed changes:

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

- 1) Change to course title of 2 core courses for all study options (TS 610, TS 611).
- 2) Change to course title of 2 courses required for the Applied Studies option (TS 678, TS 679).
- 3) Edits to Academic calendar to reflect current practices.
- 4) Formalizing “Master’s Seminar Presentation” for the Coursework and Applied Studies options.

Is this a [major modification](#) to the program? No

Rationale for change(s):

- 1) The change of title for these two courses reflects the way the course has been taught over the past several years. The focus is on methods of interpreting the Old Testament and New Testament, rather than ways to teach and facilitate the study of these texts by others.
- 2) The change of title more clearly indicates that these are practical placements and may not necessarily be in a church setting.
- 3) Some of the information in the Academic Calendar is incorrect or does not reflect current practices. The edits are intended to clarify the existing practice and to eliminate unnecessary or out-of-date information.
- 4) The seminar presentation has always been a requirement for the Coursework and Applied streams, but is not currently listed as an official milestone in the calendar. Formalizing the milestone will clarify expectations for students and will also ensure that it is listed on students’ transcripts.

Proposed effective date: Term: Fall Year: 2017

Current [Graduate Studies Academic Calendar \(GSAC\)](#) page (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/theology/theological-studies/master-theological-studies-mts>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Degree requirements Once admitted to the program, students will consult with their faculty advisors to select an option and design a plan of study appropriate to their academic and professional backgrounds, interests, and goals.</p>	<p>Degree requirements Once admitted to the program, students will consult with their faculty advisors to select an option and design a plan of study appropriate to their academic and professional backgrounds, interests, and goals.</p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>All three program options require the completion of the equivalent of 8.00 unit weight graduate level credits (0.50 unit weight).</p> <p>Thesis option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete 8 graduate-level one-term courses (0.50 unit weight) including 4 core courses (4.00 unit weight credits total). ○ Students must maintain a 75% average. ○ Core courses (must be taken at Conrad Grebel University College (CGUC)): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 Reading and Teaching the Old Testament ▪ TS 611 Reading and Teaching the New Testament ▪ TS 640 The Mennonite Tradition in Historical Context ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Students may request permission to enrol in senior level undergraduate courses for graduate credit. Such arrangements must be approved by the student's faculty advisor and will require a separate graduate course syllabus which specifies research and writing requirements commensurate with graduate standards. Credit for such courses will normally be recorded as TS 601 Special Topics: xxx. ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. 	<p><u>The Coursework and Applied Studies options require the completion of 16 graduate level courses (0.5 unit weight). The Thesis option requires the completion of 8 graduate level courses (0.5 unit weight) and the successful completion of a thesis.</u></p> <p>Thesis option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete 8 graduate-level one-term courses (0.50 unit weight) including 4 core courses (4.00 unit weight credits total). ○ Students must maintain a 75% average. ○ Core courses (must be taken at Conrad Grebel University College (CGUC)): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 <u>Studying the Old Testament</u> ▪ TS 611 <u>Studying the New Testament</u> ▪ TS 640 The Mennonite Tradition in Historical Context ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. ○ The four core courses will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available.

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> ○ The four core courses will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available. ○ Full-time faculty do most of their teaching in the fall and winter terms. Two of the spring courses taught by full-time faculty are travel courses, one in Germany and the other in Greece and Turkey. Full-time faculty will also provide Reading Courses for students during the spring term. ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at CGUC with courses taken at Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools. • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses • Academic Integrity Workshop • Master's Thesis Proposal • Master's Thesis <ul style="list-style-type: none"> ○ Students must write and orally defend a thesis (4.00 unit weight credits total). ○ A thesis is approximately 120 pages in length and is considered to be the equivalent of 50% of the student's program. It consists of the following stages: <ol style="list-style-type: none"> 1. Preliminary Stage: consulting with the Program Director and faculty advisor to identify a research area and select a thesis supervisor. This stage should be completed by early in the second term of full time studies. 2. Thesis Proposal: writing a proposal under the guidance of the thesis supervisor, for approval by the Graduate Studies Committee. Two readers will be chosen once the proposal has been accepted. This stage should be completed by the end of the second term of full time studies. 3. Thesis Research: thesis research begins during the formulation of the thesis proposal. Some of the research can often be integrated into coursework. A significant period of focused research will also be required. Students whose research requires specific language skills (e.g. Hebrew, Greek) will be required to demonstrate competency in that language. 4. Thesis Writing: writing the thesis under the direction of the thesis supervisor normally occurs when coursework is complete. 5. Thesis Defence: when the thesis supervisor confirms that the thesis is ready for defence, it will be sent to the two readers for their assessment. If they agree that it is ready for defence a date for the defence will be confirmed. The defence will be chaired by the Program Director and involve the student, thesis supervisor and the two readers. It will be open to other faculty and students. 6. Thesis Completion: after the thesis has been successfully defended it will be revised or corrected, approved by the thesis supervisor, and then filed with the College and University in the form and according to procedures in 	<ul style="list-style-type: none"> ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at CGUC with courses taken at Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools. • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses • Academic Integrity Workshop • Master's Thesis Proposal • Master's Thesis <ul style="list-style-type: none"> ○ Students must write and orally defend a thesis A thesis is approximately 120 pages in length and is considered to be the equivalent of 50% of the student's program. It consists of the following stages: <ol style="list-style-type: none"> 1. Preliminary Stage: consulting with the Program Director and faculty advisor to identify a research area and select a thesis supervisor. This stage should be completed by early in the second term of full time studies. 2. Thesis Proposal: writing a proposal under the guidance of the thesis supervisor, for approval by the Graduate Studies Committee. Two readers will be chosen once the proposal has been accepted. This stage should be completed by the end of the second term of full time studies. 3. Thesis Research: thesis research begins during the formulation of the thesis proposal. Some of the research can often be integrated into coursework. A significant period of focused research will also be required. Students whose research requires specific language skills (e.g. Hebrew, Greek) will be required to demonstrate competency in that language. 4. Thesis Writing: writing the thesis under the direction of the thesis supervisor normally occurs when coursework is complete. 5. Thesis Defence: when the thesis supervisor confirms that the thesis is ready for defence, it will be sent to the two readers for their assessment. If they agree that it is ready for defence a date for the defence will be confirmed. The defence will be chaired by the Program Director and involve the student, thesis supervisor and the two readers. It will be open to other faculty and students. 6. Thesis Completion: after the thesis has been successfully defended it will be revised or corrected, approved by the thesis supervisor, and then filed with the College and University in the form and according to procedures in

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Hebrew, Greek) will be required to demonstrate competency in that language.</p> <p>4. Thesis Writing: writing the thesis under the direction of the thesis supervisor normally occurs when coursework is complete.</p> <p>5. Thesis Defence: when the thesis supervisor confirms that the thesis is ready for defence, it will be sent to the two readers for their assessment. If they agree that it is ready for defence a date for the defence will be confirmed. The defence will be chaired by the Program Director and involve the student, thesis supervisor and the two readers. It will be open to other faculty and students.</p> <p>6. Thesis Completion: after the thesis has been successfully defended it will be revised or corrected, approved by the thesis supervisor, and then filed with the College and University in the form and according to procedures in force at that time. Students will be responsible for the costs of this stage.</p> <p>Coursework option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete 16 graduate-level one-term courses (0.50 unit weight) including 4 core courses (6.50 unit weight credits total). ○ Students must maintain a 75% average. ○ Core courses (must be taken at CGUC): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 Reading and Teaching the Old Testament ▪ TS 611 Reading and Teaching the New Testament ▪ TS 640 The Mennonite Tradition in Historical Context ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Students may request permission to enrol in senior level undergraduate courses for graduate credit. Such arrangements must be approved by the student's faculty advisor and will require a separate graduate course 	<p>force at that time. Students will be responsible for the costs of this stage.</p> <p>Coursework option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete 16 graduate-level one-term courses (0.50 unit weight) including 4 core courses (6.50 unit weight credits total). ○ Students must maintain a 75% average. ○ Core courses (must be taken at CGUC): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 <u>Studying the Old Testament</u> ▪ TS 611 <u>Studying the New Testament</u> ▪ TS 640 The Mennonite Tradition in Historical Context ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. ○ The four core courses will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available. ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at the CGUC with courses taken at

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>syllabus which specifies research and writing requirements commensurate with graduate standards. Credit for such courses will normally be recorded as TS 601 Special Topics: xxx.</p> <ul style="list-style-type: none"> ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. ○ The four core courses will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available. ○ Full-time faculty do most of their teaching in the fall and winter terms. Two of the spring courses taught by full-time faculty are travel courses, one in Germany and the other in Greece and Turkey. Full-time faculty will also provide Reading Courses for students during the spring term. ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at the CGUC with courses taken at Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools. <ul style="list-style-type: none"> • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses • Academic Integrity Workshop • Other requirements <ul style="list-style-type: none"> ○ Research Paper and Research Seminar requirement: <u>S</u>tudents in the Coursework option will choose one of the papers written for a course taken during the second year of full-time studies, or within the last four terms of part-time studies. In consultation with the professor for whom the original paper was written, the student will make any revisions required to qualify 	<p>Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools.</p> <ul style="list-style-type: none"> • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses • Academic Integrity Workshop • <u>Master's Seminar Presentation</u> <ul style="list-style-type: none"> ○ Students in the Coursework option will choose one of the papers written for a course taken during the second year of full-time studies, or within the last four terms of part-time studies. In consultation with the professor for whom the original paper was written, the student will make any revisions required to qualify the paper as a research paper. Length will normally be 25-30 pages (7,500 words). The paper will be presented and defended in the research seminar. After the presentation in the research seminar the student will make revisions to the paper under the supervision of the professor. The research paper will then be filed with the Department. ○ The research seminar is a colloquium chaired by the Program Director in which research papers are presented to Theological Studies faculty and graduate students. In addition to presenting their own research paper they will be expected to read and present an oral evaluation of one of the other research papers presented in the seminar. <p>Applied Studies option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete <u>16</u> graduate-level one-term courses (0.50 unit weight) including 4 core courses (6.50 unit weight credits total) <u>and the four Applied Studies required courses.</u> ○ Students must maintain a 75% average. ○ Core courses (must be taken at CGUC): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 <u>Studying the Old Testament</u> ▪ TS 611 <u>Studying the New Testament</u>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>the paper as a research paper. Length will normally be 25-30 pages (7,500 words). The paper will be presented and defended in the research seminar. After the presentation in the research seminar the student will make revisions to the paper under the supervision of the professor. The research paper will then be filed with the Department.</p> <ul style="list-style-type: none"> ○ The research seminar is a colloquium chaired by the Program Director in which research papers are presented to Theological Studies faculty and graduate students. Students are required to participate in this seminar in the academic year in which they present their research paper. In addition to presenting their own research paper they will be expected to read and present an oral evaluation of one of the other research papers presented in the seminar. <p>Applied Studies option:</p> <ul style="list-style-type: none"> • Graduate Academic Integrity Module (Graduate AIM) • Courses <ul style="list-style-type: none"> ○ Students must complete 13 graduate-level one-term courses (0.50 unit weight) including 4 core courses (6.50 unit weight credits total). ○ Students must maintain a 75% average. ○ Core courses (must be taken at CGUC): <ul style="list-style-type: none"> ▪ TS 600 Thinking Theologically ▪ TS 610 Reading and Teaching the Old Testament ▪ TS 611 Reading and Teaching the New Testament ▪ TS 640 The Mennonite Tradition in Historical Context ○ Students must complete TS 677 Church and Ministry before they can begin their supervised field work. ○ Students must also complete 2 supervised field work internships for a total of 1.00 unit weight credits. ○ The internships that are part of the Applied Studies option are integrated into two courses (TS 678 The Minister in the Church: Supervised Experience in Ministry I and TS 679 The Minister in the Church: Supervised Experience in Ministry II) that include supervised field 	<ul style="list-style-type: none"> ▪ TS 640 The Mennonite Tradition in Historical Context ○ <u>Applied Studies required courses (must be taken at CGUC):</u> <ul style="list-style-type: none"> ▪ <u>TS 677 Church and Ministry</u> ▪ <u>TS 678 Supervised Experience in Ministry I</u> ▪ <u>TS 679 Supervised Experience in Ministry II</u> ▪ <u>TS 783 Integration Seminar</u> ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. ○ The four core courses and the internships will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available. ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at the CGUC with courses taken at Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools. • Academic Integrity Workshop • <u>Master's Seminar Presentation</u> <ul style="list-style-type: none"> ○ <u>Students in the Applied option will choose one of the papers written for a course taken during the second year of full-time studies, or within the last four terms of part-time studies. In</u>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>experience and a seminar for theological reflection and professional formation. While most of the internships are likely to be in congregations and chaplaincy settings, other options will be available, as they have been in the previous program.</p> <ul style="list-style-type: none"> ○ Courses taken in other departments: at least 50% of the courses required for the degree must be taken in the Theological Studies program. Transfer credits will be specified at the time of admission. After admission, courses may be taken in other departments or institutions, with the approval of the student's faculty advisor. ○ Students may request permission to enrol in senior level undergraduate courses for graduate credit. Such arrangements must be approved by the student's faculty advisor and will require a separate graduate course syllabus which specifies research and writing requirements commensurate with graduate standards. Credit for such courses will normally be recorded as TS 601 Special Topics: xxx. ○ Course schedule: courses are normally offered in weekly three-hour daytime or evening time slots, with occasional classes offered on a three or four weekend-per-term schedule. In the spring term there will be intensive courses offered over one or two weeks, with substantial preparatory work required before the first class and major research assignments due after the conclusion of the class schedule. ○ The four core courses and the internships will be scheduled annually during the fall and winter terms. Another four to six graduate courses will be offered each fall and winter term, with an additional two to three offered in the spring. Thus in an annual cycle there will normally be 16 or more courses available. ○ Full-time faculty do most of their teaching in the fall and winter terms. Two of the spring courses taught by full-time faculty are travel courses, one in Germany and the other in Greece and Turkey. Full-time faculty will also provide Reading Courses for students during the spring term. 	<p><u>consultation with the professor for whom the original paper was written, the student will make any revisions required to qualify the paper as a research paper. Length will normally be 25-30 pages (7,500 words). The paper will be presented and defended in the research seminar. After the presentation in the research seminar the student will make revisions to the paper under the supervision of the professor. The research paper will then be filed with the Department.</u></p> <ul style="list-style-type: none"> ○ <u>The research seminar is a colloquium chaired by the Program Director in which research papers are presented to Theological Studies faculty and graduate students. In addition to presenting their own research paper they will be expected to read and present an oral evaluation of one of the other research papers presented in the seminar.</u> <ul style="list-style-type: none"> • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> ○ Full-time status is three courses in each fall or winter term and two courses in the spring term. ○ Students can complement their studies at the CGUC with courses taken at Waterloo Lutheran Seminary, McMaster Divinity School, the Toronto School of Theology and other graduate schools. • Link(s) to courses <ul style="list-style-type: none"> ○ Theological Studies (TS) courses • Academic Integrity Workshop • Other requirements <ul style="list-style-type: none"> ○ Students must complete the Integration Seminar which includes the capstone project for this option (0.50 unit weight credits). 	

How will students currently registered in the program be impacted by these changes?

- 1) Students who have already completed these courses will not be impacted by these changes. Students who are already in the program but have not yet taken these courses will register for the courses under their new course titles and these titles will appear on their transcripts.
- 2) Students who have already completed these courses will not be impacted by these changes. Students who are already in the program but have not yet taken these courses will register for the courses under their new course titles and these titles will appear on their transcripts.
- 3) As these edits reflect the current practice, current students will not be affected.
- 4) Student who complete the Master's Seminar Presentation after Fall 2017 will have the milestone officially recognized on their transcript. Students who have previously completed the milestone will not.

Departmental approval date (mm/dd/yy): 02/10/17

Reviewed by GSO (for GSO use only) date (mm/dd/yy): 04/13/2017

Faculty approval date (mm/dd/yy): 02/17/17

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):

Senate approval date (mm/dd/yy) (if applicable):

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 612

Course Title (max. 100 characters incl. spaces): Teaching the Bible

Course Short Title (max. 30 characters incl. spaces): Teaching the Bible

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description: This course will explore the role and function of teaching the Bible in a variety of ministry settings, seeking to effectively link biblical scholarship with communal practice and reflection. It will draw on selected biblical genres, themes, and passages. Topics may include gaining expertise with the use of tools to engage original biblical languages, experience with various approaches to hermeneutics, as well as practice with diverse pedagogical and facilitation methods.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: TS 610 Reading and Teaching the Old Testament and TS 611 Reading and Teaching the New Testament, two of the four core courses in the program, were designed to explore

issues of interpreting these texts, as well as teaching in church, academic, and community settings. Given the need to introduce students to a range of interpretive methods, the core courses are being refocused and renamed Studying the Old Testament and Studying the New Testament. However, there is still a need for a course that provides students with theoretical and practical tools to lead and facilitate others in the study and interpretation of these texts.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 641

Course Title (max. 100 characters incl. spaces): History of Christianity (300-1500)

Course Short Title (max. 30 characters incl. spaces): History of Christianity

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description: A history of Christian life and thought from Constantine through the Middle Ages. Topics may include doctrine, worship, mystics, ecclesiastical institutions, saints, pilgrimages, and gender.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: While various courses in the program address the history of the Christianity from 1500 to the present, none focus explicitly on the period from 300 to 1500. This course addresses a gap.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 686

Course Title (max. 100 characters incl. spaces): Spiritual Formation Across the Life-Cycle

Course Short Title (max. 30 characters incl. spaces): Spiritual Formation: Life-Cycle

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description: This multidisciplinary course explores perspectives on human development within a 21st century cultural context, and Christian faith formation. Students will reflect on a theology of spiritual formation, the process of meaning making, age appropriate spiritual practices, life-cycle transitions, and crises of faith.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: This course addresses a gap in the curriculum.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 755

Course Title (max. 100 characters incl. spaces): Preaching

Course Short Title (max. 30 characters incl. spaces): Preaching

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description: This course introduces major issues in homiletics such as biblical interpretation for preaching, delivery/embodiment of the sermon, the contextual nature of preaching, and sermon form. Matters such as the place of preaching in worship, the image/role of the preacher, as well as purposes and theologies of preaching will be addressed throughout the class. Students will preach in class and analyze the sermons of other students.

New course description (for revision only):

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Enrolment was high when this course was been offered as a topic in TS 690 Seminars in Theological Studies. Preaching is a skill that many students in the Applied Studies option

are expected to have. This course will likely be offered once every two years by an adjunct instructor who is tenured at a related institution.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 600

Course Title (max. 100 characters incl. spaces): Thinking Theologically

Course Short Title (max. 30 characters incl. spaces): Thinking Theologically

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): An advanced introduction to the classical themes in Christian theology, with attention to the nature of theological argumentation, and the significance of social location in the practice of theology.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Previous description reflects a different program model in which this course was an introduction to the program. It is now one of the four core courses in the program and serves as an advanced introduction to one of several sub-disciplines within theological studies.

Prepared by: Melodie Sherk

Date: 21-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 601

Course Title (max. 100 characters incl. spaces): Special Topics in Theological Studies

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: Students may request permission to participate in a senior undergraduate course and complete graduate level requirements as specified in a separate syllabus. Students in the coursework and applied options may be given permission to take up to three courses in this way. Formerly MTS 601 A-Z.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites:

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: This scenario can be handled through a reading course that requires participation in a senior UG course, with additional reading, writing, and meeting with an instructor.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description, title
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 610

Course Title (max. 100 characters incl. spaces): Studying the Old Testament

Course Short Title (max. 30 characters incl. spaces): Studying the Old Testament

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of the literary genres, history of composition, and canonization of the Old Testament documents. The course will examine various methodological approaches to the Old Testament, including their implications for Christian theological interpretation.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The change of title and description reflects the way the course has been taught over the past several years. The focus is on the methods of interpreting the Old Testament, rather than ways to teach and facilitate the study of these texts by others. A new course, TS 6xx Teaching the Bible, is being developed to address this. The description has also been edited to be parallel with TS 611 Studying the New Testament.

Prepared by: Melodie Sherk

Date: 21-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description, title
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 611

Course Title (max. 100 characters incl. spaces): Studying the New Testament

Course Short Title (max. 30 characters incl. spaces): Studying the New Testament

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of the literary genres, history of composition, and canonization of the New Testament documents. The course will examine various methodological approaches to the New Testament, including their implications for Christian theological interpretation.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The change of title and description reflects the way the course has been taught over the past several years. The focus is on the methods of interpreting the New Testament, rather than ways to teach and facilitate the study of these texts by others. A new course, TS 6xx Teaching the Bible, is being developed to address this. The description has also been edited to be parallel with TS 610 Studying the Old Testament.

Prepared by: Melodie Sherk

Date: 21-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 613

Course Title (max. 100 characters incl. spaces): Special Topics in Old Testament Themes

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: An analysis and discussion of selected ethical, ritual, sociological, or theological issues recurrent in Hebrew Scripture, with attention to their historical meanings and contemporary relevance. Formerly MTS 513 Old Testament Themes.

New course description (for revision only):

Meet Type(s): Lecture Seminar Reading Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Course has not been offered. Special topics in Old Testament themes can be offered through TS 690: Seminars in Theological Studies

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 617

Course Title (max. 100 characters incl. spaces): Unity and Diversity in the New Testament

Course Short Title (max. 30 characters incl. spaces): Unity & Diversity in N.T.

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of distinctive and shared ways in which New Testament authors view a variety of theological, ethical, and social issues.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Allows course to encompass a broader range of themes.

Prepared by: Melodie Sherk

Date: 21-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 619

Course Title (max. 100 characters incl. spaces): The Bible and Peace

Course Short Title (max. 30 characters incl. spaces): The Bible and Peace

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): An examination of diverse biblical views of peace in relation to war, justice, and salvation with attention to their relevance for the contemporary quest for peace.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status: PACS 671; approved.

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Prepared by: Melodie Sherck

Date: 21-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 621

Course Title (max. 100 characters incl. spaces): Special Topics: Pastor's Theology Seminar

Course Short Title (max. 30 characters incl. spaces): Pastor's Theology Seminar

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): This seminar is for pastors, graduate students and others interested in reading and discussing theological texts relevant to understanding Christian faith and the church in the contemporary world. The focus varies annually. The class is normally held once a month from September to April. Students may be given permission to take the course more than once depending on their program and the focus of the course.

Meet Type(s): Seminar Lecture Reading Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 631

Course Title (max. 100 characters incl. spaces): Contemporary Christian Theology

Course Short Title (max. 30 characters incl. spaces): Contemporary Christian Theology

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): An examination of how Christian beliefs and practices have been reinterpreted by representative Christian theologians to address the challenges of the 20th and 21st centuries.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Revised to reflect changes to the associated UG course: RS 351. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 632

Course Title (max. 100 characters incl. spaces): Modern Christian Thought

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: A biographical and thematic approach to the study of the major nineteenth century thinkers who shaped modern theology, including Schleiermacher and liberalism, Kierkegaard and existentialism, Troeltsch and historicism. Formerly MTS 522.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: UG companion course has been deleted. No plans to offer this as a stand-alone graduate course.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 633

Course Title (max. 100 characters incl. spaces): Contemporary Mennonite Theology

Course Short Title (max. 30 characters incl. spaces): Contemp Mennonite Theology

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): The course will focus on some of the central themes of the Anabaptist-Mennonite theological tradition: adult baptism, separation from the world, biblical authority, peace and non-resistance, and discipleship as a way of life.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 636

Course Title (max. 100 characters incl. spaces): Christian Approaches to Peacemaking

Course Short Title (max. 30 characters incl. spaces): Christian Approaches to Peace

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of the foundations, history, and practice of peacemaking within the Christian tradition, including an exploration of the roots of present practice and the ecumenical and practical diversity of contemporary peacemaking.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Requisites

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 637

Course Title (max. 100 characters incl. spaces): War and Peace in Christian Theology

Course Short Title (max. 30 characters incl. spaces): War and Peace in Christian Theology

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): Examination of Christian teachings on war and peace from the early church to the present, including crusade, just war, and pacifist traditions, as well as twentieth century discussions of realism, just revolution, nuclear pacifism, and non-violent resistance.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites: None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

PACS 670 War and Peace in Christian Theology; approved

Sections combined/held with:

Rationale for request: TS 670 is being eliminated. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 638

Course Title (max. 100 characters incl. spaces): Doing Development: Issues of Justice and Peace

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: This course focuses on current issues in international development, and examines how various interpretations of justice and peace help to understand these issues and to address the constraints to development in the global community. Formerly MTS 575.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Over the past 10 years, only 1 MTS student has taken this course and we do not expect to offer it in the future.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 642

Course Title (max. 100 characters incl. spaces): The Radical Reformation

Course Short Title (max. 30 characters incl. spaces): The Radical Reformation

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of Anabaptism and its place in the history of the Christian Church and of the Reformation period.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 645

Course Title (max. 100 characters incl. spaces): Reformation History

Course Short Title (max. 30 characters incl. spaces): Reformation History

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): A study of the major sixteenth-century reformers and their intellectual background in humanism and late medieval scholasticism. Special attention will be given to the Lutheran and Reformed traditions and their ideological, social, political expressions.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TSChoose an item. Course number: 651

Course Title (max. 100 characters incl. spaces): Christian Worship

Course Short Title (max. 30 characters incl. spaces): Christian Worship

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): This course examines the historical and theological dimensions of those symbols and rituals which relate to people's corporate experience of God. The relationship of Christian worship to ethics and inter-faith dialogue will also be examined.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Title, description
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 652

Course Title (max. 100 characters incl. spaces): The Christian Hymn

Course Short Title (max. 30 characters incl. spaces): The Christian Hymn

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): The origins of the Christian hymn and its development up to the present. The course considers the hymn as theological, poetic, musical, cultural, and spiritual expression, and the use of hymns in a variety of worship settings.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary. Title and description changed to reflect change to MUS 363/CMW 363/RS 357.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Title, description

(*e.g. consent, description, title, requisites*)

Course Subject code: TS Choose an item. Course number: 653

Course Title (max. 100 characters incl. spaces): Worship and its Music

Course Short Title (max. 30 characters incl. spaces): Worship and its Music

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): The nature of worship and the role of music within worship in historical, theological, and cultural perspective. Field trips to services of various traditions.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary. Title and description changed to reflect change to MUS 364/CMW 364/RS 358.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 662

Course Title (max. 100 characters incl. spaces): Dietrich Bonhoeffer: Life and Thought

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: This course examines the theological writings of Dietrich Bonhoeffer in the context of his life - his studies and teaching, and his involvement in the World Council of Churches, the Confessing Church movement, and the resistance to Hitler.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The professor who developed and taught this course has retired. No plans to offer this course.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 670

Course Title (max. 100 characters incl. spaces): War and Peace in Christian Thought

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: An examination of Christian teaching on war and peace from the early Church to the present, including the "just war" theories of Augustine, Aquinas, the Reformers and recent Catholic statements, as well as the pacifist views of Quakers, Mennonites and Brethren.

Antirequisite: Students may not receive credit for both TS 670 and TS 637.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Title and description overlap with TS 637 War and Peace in Christian Theology.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Title

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 674

Course Title (max. 100 characters incl. spaces): Church as Mission

Course Short Title (max. 30 characters incl. spaces): Church as Mission

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description: This course examines the development and meaning of the "missional church" paradigm as a way of articulating the relationship between communities of faith and their cultural settings, in both contemporary and historical contexts.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Change in course title from Church Mission to Church as Mission better reflects the paradigm outlined in the course description.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 677

Course Title (max. 100 characters incl. spaces): Church and Ministry

Course Short Title (max. 30 characters incl. spaces): Church and Ministry

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): This course combines a theological study of the Christian church and the development of a theology of ministry, including the church's mission and institutional life and the personal calling to a life of ministry. The Believers Church tradition provides the primary perspective, augmented by the experiences of other Christian traditions.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Description reflects the way the course is being taught.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Title, description, requisites, grading basis
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 678

Course Title (max. 100 characters incl. spaces): Supervised Experience in Ministry I

Course Short Title (max. 30 characters incl. spaces): Supervised Experience in Ministry I

Grading Basis: CREDIT/NO CREDIT

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): This course explores ministry in a practical setting. A ten hour per week placement will be chosen by the student with the approval of the Applied Studies Coordinator. With the guidance of a local supervisor, the student will set learning goals, develop a reading list, and write a summative paper that will be shared with other students taking this courses. Graded on a C/NC basis.

Meet Type(s): Practicum Choose an item. Choose an item. Choose an item.

Primary Meet Type: Practicum

[Requisites](#): Prerequisite: TS 677 and at least two core courses.

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The former description was too limiting in its specification of a congregational setting for ministry. Students may work in hospitals, long-term care facilities, and social service agencies, among many other options. The title of the church has also be changed from “Minister in the

Congregation: Supervised Experience in Ministry” to “Supervised Experience in Ministry” to more clearly indicate that this is a practical placement. Length of placement is specified. C/NC is common in other programs at the university for this kind of course.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Title, description, requisites, grading basis
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 679

Course Title (max. 100 characters incl. spaces): Supervised Experience in Ministry II

Course Short Title (max. 30 characters incl. spaces): Supervised Experience in Ministry II

Grading Basis: CREDIT/NO CREDIT

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): This course explores ministry in a practical setting. A ten hour per week placement will be chosen by the student with the approval of the applied studies coordinator. With the guidance of a local supervisor, the student will set learning goals, develop a reading list, and write a summative paper that will be shared with other students taking this courses. Graded on a C/NC basis.

Meet Type(s): Practicum Choose an item. Choose an item. Choose an item.

Primary Meet Type: Practicum

[Requisites](#): Prerequisite or co-requisite: TS 678

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The former description was too limiting in its specification of a congregational setting for ministry. Students may work in hospitals, long-term care facilities, and social service agencies, among many other options. The title of the church has also be changed from “Minister in the

Congregation: Supervised Experience in Ministry” to “Supervised Experience in Ministry” to more clearly indicate that this is a practical placement. Length of placement is specified. C/NC is common in other programs at the university for this kind of course.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 689

Course Title (max. 100 characters incl. spaces): Aging and the Spiritual Life

Course Short Title (max. 30 characters incl. spaces): Aging and the Spiritual Life

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Choose an item.

Course Description:

New course description (for revision only): Through experiential, reflective, and theoretical learning, this course will explore spirituality as a central aspect of growth and development in later life. The perspectives of various faith and humanistic traditions will be included. Topics may include: religious beliefs, spiritual concerns, and spiritual resources later in life; a theology of aging; ministry with persons in later life; spirituality and dementia; death and dying.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The list of topics are of possible topics, and not all iterations of the course will necessarily include all of them. Listing former course numbers is no longer necessary.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 690

Course Title (max. 100 characters incl. spaces): Seminars in Theological Studies

Course Short Title (max. 30 characters incl. spaces): Seminars in Theological Studies

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): Course topics and instructors will be announced each term.

Meet Type(s): Seminar Lecture Reading Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: More accurately reflects current practice.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 691

Course Title (max. 100 characters incl. spaces): Directed Readings in Theological Studies

Course Short Title (max. 30 characters incl. spaces): Directed Readings in TS

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): The scope, focus, and requirements of a reading course are determined by the professor in consultation with the student. Permission for a reading course must be obtained at the time of registration, prior to the term in which the course will be conducted.

Meet Type(s): Reading Lecture Seminar Choose an item.

Primary Meet Type: Reading

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Changing course title from “Selected Special Topics in Theological Studies” to “Directed Readings in Theological Studies” more accurately reflects the nature of the course. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Requisite, description, title

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 692

Course Title (max. 100 characters incl. spaces): Explorations in Theological Studies

Course Short Title (max. 30 characters incl. spaces): Explorations in TS

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): This course provides a framework for students to pursue specialized topics by completing courses which may be available off-campus or on-line.

Meet Type(s): Lecture Seminar Reading Choose an item.

Primary Meet Type: Lecture

[Requisites](#): None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Prerequisite is not required. "Ministry coordinator" language has been discontinued; department consent is adequate.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 715

Course Title (max. 100 characters incl. spaces): Special Topics in Old Testament Exegesis

Course Short Title (max. 30 characters incl. spaces): Spec. Topics in OT Exegesis

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Instructor

Course Description:

New course description (for revision only): This course uses a variety of methods of analysis and interpretation of biblical texts to conduct a close reading of an Old Testament book. Students may be given permission to take the course repeatedly, given that focus and content changes each time offered.

Meet Type(s): Seminar Lecture Reading Choose an item.

Primary Meet Type: Seminar

[Requisites](#): None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Description changed to parallel TS 718 Special Topics in New Testament Exegesis.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 718

Course Title (max. 100 characters incl. spaces): Special Topics in New Testament Exegesis

Course Short Title (max. 30 characters incl. spaces): Spec. Topics in NT Exegesis

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Instructor

Course Description:

New course description (for revision only): This course uses a variety of methods of analysis and interpretation of biblical texts to conduct a close reading of a New Testament book. Students may be given permission to take the course repeatedly, given that focus and content changes each time offered.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites](#): None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Description changed to parallel TS 715 Special Topics in Old Testament Exegesis. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 724

Course Title (max. 100 characters incl. spaces): Biblical Foundations of Peace

Course Short Title (max. 30 characters incl. spaces): Biblical Foundations of Peace

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This course explores the various dimensions of peace in the Bible, including biblical depictions of God as judge and warrior, texts which reflect wholeness and security (shalom), texts which describe God's attempts to make peace with humanity (salvation), and the role of Jesus as foundation of peace and model for peacemaking.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites](#): None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 731

Course Title (max. 100 characters incl. spaces): Christianity's Encounter with Other Faiths

Course Short Title (max. 30 characters incl. spaces): Christianity and Other Faiths

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This course will examine several contemporary theological responses to the encounter of Christianity with other faiths. The meaning and dynamics of inter-religious dialogue and the resources within the Christian faith for such an encounter will be explored.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

Requisites: None

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status: PACS 672. Approved.

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description, title
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 735

Course Title (max. 100 characters incl. spaces): Peace Church Theology

Course Short Title (max. 30 characters incl. spaces): Peace Church Theology

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): An examination of contemporary peace theologies as they have developed within the Historic Peace Churches (Mennonite, Brethren, Quaker), through ecumenical engagements, and in response to contemporary challenges.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Change reflects the interests of the instructor. Course to be developed to be offered for cross-listing with Graduate Centre for Theological Studies at the Toronto School of Theology, University of Toronto.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 738

Course Title (max. 100 characters incl. spaces): Systematic Theology

Course Short Title (max. 30 characters incl. spaces): Systematic Theology

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description:

New course description (for revision only): A study of a major work in theology by a single author, or works by several authors around a common theme.

Meet Type(s): Seminar Lecture Reading Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Revised description in light of actual practice. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 746

Course Title (max. 100 characters incl. spaces): Anabaptist Spirituality in Historical Context

Course Short Title (max. 30 characters incl. spaces): Anabaptist Spirituality: Hist

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This is an examination of sixteenth-century Anabaptist spirituality and its historical development, particularly as it evolved in the Mennonite tradition in Europe and North America, and in the churches of the southern hemisphere.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 751

Course Title (max. 100 characters incl. spaces): Worship Ritual and Ministry

Course Short Title (max. 30 characters incl. spaces): Worship Ritual and Ministry

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This course examines the role of ritual in congregational life, develops a theological and pastoral understanding of congregational rituals, and equips students to carry out this aspect of worship. Particular attention is given to baptism, communion, weddings, and funerals.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Description add specificity that reflects the way the course is actually being taught. Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 779

Course Title (max. 100 characters incl. spaces): Specialized Supervised Experience

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required: Instructor

Course Description: This is a supervised advanced training experience tailored for a specific student. Formerly MTS 695.

New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: This course has been taken by only 1 student since 2008.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 783

Course Title (max. 100 characters incl. spaces): Integration Seminar

Course Short Title (max. 30 characters incl. spaces): Integration Seminar

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This seminar provides a setting for understanding leadership through integrating theology, biblical reflection, and practical experiences in ministry. The tasks of ministry will be reviewed in the context of power relations, boundaries, and self-care. Assignments include a case study research project and a final summative paper on personal call and vocation.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites](#): Prerequisite or corequisite: TS 679

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Change reflects some redesign of the course by current instructor. The explicit identification of power relations, boundaries, and self-care ensures that all students in the applied option will cover these issues in their program. Listing former course numbers is no longer necessary.

Prepared by: Melodie Sherk

Date: 23-Dec-16

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 787

Course Title (max. 100 characters incl. spaces): Spiritual Guidance Seminar

Course Short Title (max. 30 characters incl. spaces): Spiritual Guidance Seminar

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description:

New course description (for revision only): This seminar analyzes the literature and research on spiritual guidance (direction) as a ministry in the Church and then examines the practice of spiritual guidance.

Meet Type(s): Seminar Choose an item. Choose an item. Choose an item.

Primary Meet Type: Seminar

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Listing former course numbers is no longer necessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 792

Course Title (max. 100 characters incl. spaces): Special Topics Seminars

Course Short Title (max. 30 characters incl. spaces): Special Topics Seminars

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:

Course Description: A reading seminar is a reading course for more than one student, which may be initiated either by student interest or by a professor's current research. Students and professor will normally meet on a semi-regular basis. Such a seminar will be announced along with other course offerings prior to each term. Formerly MTS 595-598, 696-698,

New course description (for revision only):

Meet Type(s): Reading Choose an item. Choose an item. Choose an item.

Primary Meet Type: Reading

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The scenario envisioned here can be addressed by several students enrolling in the same section of TS 691 Directed Readings in Theological Studies.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 796

Course Title (max. 100 characters incl. spaces): Thesis Preparation

Course Short Title (max. 30 characters incl. spaces): Thesis Preparation

Grading Basis: NUMERICAL

Course Credit Weight: 1.5 Choose an item.

Course Consent Required: Department

Course Description:

New course description (for revision only): Students are enrolled in thesis research and writing. Students continue to enroll in this course during thesis preparation until completion of their thesis.

Meet Type(s): Reading Lecture Seminar Choose an item.

Primary Meet Type: Reading

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Changes more accurately reflect current thesis process.

Prepared by: Melodie Sherck

Date: 7-Feb-17

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes: Description
(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 798

Course Title (max. 100 characters incl. spaces): Thesis Preparation

Course Short Title (max. 30 characters incl. spaces): Thesis Preparation

Grading Basis: NUMERICAL

Course Credit Weight: 1.00

Course Consent Required: Department

Course Description: Students are enrolled in part-time thesis research and writing. Students register for this stage of thesis preparation after their Thesis Proposal has been accepted by the Theological Studies department. Students continue to enroll in this course during full-time thesis preparation until completion of their thesis.

New course description (for revision only):

Meet Type(s): Reading Lecture Seminar Choose an item.

Primary Meet Type: Reading

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The new thesis preparation course TS 799 makes this course unnecessary.

Faculty: Theology Conrad Grebel University College

Effective term: Term/Year Fall 2017

Course New Revision Inactivation

Milestone New Revision Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites)

Course Subject code: TS Choose an item. Course number: 799

Course Title (max. 100 characters incl. spaces): Thesis Preparation

Course Short Title (max. 30 characters incl. spaces): Thesis Preparation

Grading Basis: CREDIT/NO CREDIT

Course Credit Weight: 0.50

Course Consent Required: Department

Course Description: Students are enrolled in thesis research and writing. Students continue to enroll in this course during thesis preparation until completion of their thesis.

New course description (for revision only):

Meet Type(s): Reading Lecture Seminar Choose an item.

Primary Meet Type: Reading

[Requisites:](#)

Special topics course: Yes No

Cross-listed: Yes No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: The Theological Studies program enrolls students and assesses tuition on a per course basis. In order to maintain part-time status while writing a thesis, students will enroll in this course. Alternatively, if students are taking 1-2 other courses and working on their thesis part-time, this course will ensure that their fees reflect this. Currently students may enroll in a 1.5 credit Thesis Preparation course or a 1.0 credit Thesis Preparation course. A Thesis Preparation course of 0.5 gives added flexibility for students. A student may be part-time and 0.5 reflects the actual amount of time

they are devoting to the project. Or, a student may be working a thesis while completing 2 other courses. This registration allows such a student to be full-time at the normal 3 course (= 1.5 credit) load.

Prepared by: Melodie Sherk

Date: 23-Dec-16