University of Waterloo
SENATE
Notice of Meeting

Date:  Monday 19 June 2017
Time:  3:30 p.m.
Place:  Needles Hall, room 3407

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:30</td>
<td>OPEN SESSION</td>
</tr>
<tr>
<td>3:30</td>
<td>Consent Agenda</td>
</tr>
<tr>
<td>3:30</td>
<td>Motion: To approve or receive for information by consent items 1-6 below.</td>
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<tr>
<td>3:30</td>
<td>1. Minutes of the 15 May 2017 Meeting</td>
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<tr>
<td>3:30</td>
<td>Decision</td>
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<tr>
<td>3:30</td>
<td>2. Reports from Committees and Councils</td>
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<tr>
<td>3:30</td>
<td>a. Graduate &amp; Research Council</td>
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<td>3:30</td>
<td>Information</td>
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<td>3:30</td>
<td>b. Undergraduate Council</td>
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<td>3:30</td>
<td>Information</td>
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<td>3:30</td>
<td>3. Report of the President</td>
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<tr>
<td>3:30</td>
<td>a. Recognition and Commendation</td>
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<tr>
<td>3:30</td>
<td>Information</td>
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<td>3:30</td>
<td>4. Reports from the Faculties</td>
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<td>3:30</td>
<td>Information</td>
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<td>3:30</td>
<td>5. Committee Appointments</td>
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<tr>
<td>3:30</td>
<td>Decision</td>
</tr>
<tr>
<td>3:35</td>
<td>Regular Agenda</td>
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<tr>
<td>3:35</td>
<td>7. Business Arising from the Minutes</td>
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<tr>
<td>3:40</td>
<td>8. Research Presentation – Lora Giangregorio, Associate Professor, Kinesiology, Faculty of Applied Health Sciences</td>
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<tr>
<td>3:55</td>
<td>9. Reports from Committees and Councils</td>
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<tr>
<td>3:55</td>
<td>a. Graduate and Research Council</td>
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<td>3:55</td>
<td>Decision</td>
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<td>4:00</td>
<td>10. Report of the President</td>
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<td>4:15</td>
<td>11. Q&amp;A Period with the President</td>
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<td>4:25</td>
<td>a. Name Change: Centre for Contact Lens Research</td>
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<td>4:30</td>
<td>13. Report of the Vice-President, University Research</td>
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<td>4:40</td>
<td>14. Other Business</td>
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<td>4:45</td>
<td>CONFIDENTIAL SESSION</td>
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<tr>
<td>4:45</td>
<td>15. Minutes of the 15 May 2017 Meeting</td>
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<tr>
<td>4:50</td>
<td>16. Business Arising from the Minutes</td>
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<td>4:55</td>
<td>17. Report from the Honorary Degrees Committee</td>
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<td>5:05</td>
<td>18. Other Business</td>
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8 June 2017
Karen Jack
University Secretary

Guests: Bruce Campbell, Ana Frietas, Peggy Jarvie, Cathy Newell Kelly, Derek Madge, Chris Read, Daniela Seskar-Hencic, Gregory Smith, Allan Starr, Marilyn Thompson

Secretariat: Mike Grivicic, Karen Jack, Emily Schroeder


*regrets

OPEN SESSION

The president welcomed new and returning members to the first meeting of Senate’s 2017-18 cycle.

Consent Agenda
Senate heard a motion to approve or receive for information the items on the consent agenda.

Bruce and Dea.

Senator Easton noted that he was incorrectly noted as in attendance at the last meeting, and Peers advised that on page 30 of the agenda, Winny Shen’s correct department is Psychology, not the School of Accounting and Finance.

1. MINUTES OF THE 17 APRIL 2017 MEETING
Senate approved the minutes of the meeting.

2. REPORTS FROM COMMITTEES AND COUNCILS
Graduate & Research Council
Senate received the report for information.

Undergraduate Council
Senate received the report for information.

3. REPORT OF THE PRESIDENT
Recognition and Commendation. Senate received the report for information.

4. REPORTS FROM THE FACULTIES
Senate received the reports for information.
5. **COMMITTEE APPOINTMENTS**
Senate approved appointments to the Senate Executive Committee (Robert Bruce), Senate Undergraduate Council (Russ Tuppling), the University Committee on Student Appeals (John Mielke) and the Board of Governors (Robert Bruce).

The question was called, and subject to the changes noted above, the motion carried unanimously.

**Regular Agenda**

6. **BUSINESS ARISING FROM THE MINUTES**
Senate heard that Casello will bring information regarding domestic enrollments in professional and research based masters programs to the June meeting.

7. **PRESENTATION**
**SALLY GUNZ, PRESIDENT, FACULTY ASSOCIATION OF THE UNIVERSITY OF WATERLOO**
Gunz informed Senators about the Faculty Association and its work representing faculty at the university. She reviewed 2016-17 achievements, described the work of FAUW’s committees and spoke to coming initiatives. Following her presentation, the chair thanked Gunz for her service over the last two years.

Slides used in the presentation may be seen at here:

8. **REPORTS FROM COMMITTEES AND COUNCILS**

**Graduate & Research Council**
Senate heard motions to the following effects:

**Waterloo Centre for Microbial Research.** To approve the establishment of the Waterloo Centre for Microbial Research.

Dixon and Moffatt. Carried unanimously.

**Faculty of Applied Health Sciences, School of Public Health and Health Systems.** To approve a new plan, the Collaborative Master of Science Program in Public Health and Health Systems effective 1 September 2017.

Dixon and Rush. Carried unanimously.

To approve a new plan, the Collaborative PhD Program in Public Health and Health Systems – Water effective 1 September 2017.

Dixon and Rush. Carried unanimously.

**Faculty of Environment, School of Environment, Enterprise and Development.** To approve the inactivation of the Social Innovation Graduate Diploma effective 1 May 2017.

Dixon and Dea. Carried unanimously.

**University Committee on Student Appeals**
Coniglio spoke to the report briefly. In response to questions, members heard: some changes in practices, including increased vigilance have affected the numbers reported; technology can be the
cause of more infractions, but is also useful in identifying them; taxonomy used across the Faculties may not be consistent and is something he is looking at; a suggestion that including the total numbers of the student body for each year may be useful. Coniglio advised that the report will follow annually in the fall.

9. **REPORT OF THE PRESIDENT**

Hamdullahpur presented a report on recent activities, including: a visit by the Business Council of Canada and several successful pitches by Velocity students; work on innovation superclusters and the Strategic Mandate Agreement; the recent hire of the university secretary and that the committee tasked with the search for a new provost will begin soon. He also highlighted the recent research funding success by faculty and thanked Dixon for his office’s efforts to facilitate this and advised that the University has been recognized by Research Infosource for publication efficiency. He closed with an update on the President’s Advisory Committee on Student Mental Health which has an approved terms of reference and membership; the group will meet for the first time on 24 May with milestones and updates to be brought to Senate in the future.


The chair invited Senator Parry to provide members with an update on the HeForShe initiative. Senate heard: about the 30 global partners, that the initiative runs until 2020, about the University’s commitments (boost female student participation in STEM outreach activities, enhance female faculty representation, attract and advance female leaders into senior academic and administrative roles) and progress made so far, about other related initiatives, the identities of faculty and campus advocates, the UN’s parity report, and how to become involved.

10. **Q&A PERIOD WITH THE PRESIDENT**

There were no questions.

11. **REPORT OF THE VICE-PRESIDENT, ACADEMIC & PROVOST**

Roster of Graduands. Senate heard a motion to delegate approval of the roster of graduands for the June convocation to its Executive Committee since the roster of graduands must be approved before convocation which occurs before the June meeting of Senate.

Orchard and Gerrits. Carried unanimously.

**Canada Research Chairs Program’s Equity Initiative.** Orchard advised that the program’s steering committee has been urging institutions to make concerted efforts to address the underrepresentation of four designated groups (women, Aboriginal Peoples, persons with disabilities and visible minorities) in nominations for Canada Research Chair positions. The University has found it is making good progress and needs to continue the good work being done. In response to questions, Dixon advised that he would provide more data at the next meeting, and Orchard advised that the targets are set by the steering committee and while there are no current consequences for not cooperating, it is fair to assume that the government is paying attention and is looking for real progress. The chair advised that in a recent meeting with the Prime Minister and Minister Duncan this subject arose, and there was agreement that excellence needs to be the driver, removing unconscious bias will help, as will attracting these groups to study at the graduate level so the pool continues to grow.

12. **REPORT OF THE VICE-PRESIDENT, UNIVERSITY RESEARCH**

Dixon briefly reviewed his report and advised that some announcements regarding CIHR funding will occur tomorrow.
13. **OTHER BUSINESS**

A student Senator drew members’ attention to the differences between the amount of funding for STEM and non-STEM scholarships included in the agenda package. In Shoveller’s absence, it was understood that this subject will be discussed at the June meeting.

Pankratz advised that Marcus Santz will become the new president of Conrad Grebel University College on 1 October.

Senate convened in confidential session.

20 May 2017

Karen Jack
University Secretary
CONFIDENTIAL SESSION

Confidential minutes have been removed.

The meeting was adjourned at 4:45 p.m.

20 May 2017
Karen Jack
University Secretary
Senate Graduate & Research Council met on 8 May 2017, and on behalf of Senate approved the renewal of one centre, membership to research ethics committees and curricular submissions. Council agreed to forward these items to Senate for information. Council recommends that these items be included in the consent agenda.

Further details are available at: https://uwaterloo.ca/secretariat/committees-and-councils/senate-graduate-research-council

FOR INFORMATION

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RENEWAL OF SENATE-APPROVED CENTRE

MEMBERSHIP TO RESEARCH ETHICS COMMITTEES
On behalf of Senate, council approved new and continuing membership to research ethics committees.

CURRICULAR SUBMISSIONS
On behalf of Senate, new courses, course revisions, course inactivations, and ten minor program revisions were approved for the Faculties of arts (sociology), engineering (chemical engineering), and theology.

/ar  Jeff Casello       George Dixon
    Associate Provost, Graduate Studies       Vice President, University Research
Senate Undergraduate Council met on 9 May 2017, and on behalf of Senate approved course submissions, minor plan changes, Faculty regulation changes and changes to admissions requirements. Council agreed to forward the following items to Senate for information. Council recommends that these items be included in the consent agenda.

Further details are available at: [https://uwaterloo.ca/secretariat/committees-and-councils/senate-undergraduate-council](https://uwaterloo.ca/secretariat/committees-and-councils/senate-undergraduate-council)

FOR INFORMATION

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CURRICULAR MODIFICATIONS
Course submissions, minor plan changes and Faculty regulation changes were approved for the Faculties of arts (American sign language; classical studies; cross-registration with Wilfrid Laurier University; East Asian studies; economics; English language and literature; fine arts; French studies; peace and conflict studies; philosophy; political science; religious studies; social development studies; sociology and legal studies; studies in Islam), environment (knowledge integration), and science (bioinformatics; biology; biomedical sciences; biotechnology; communication in the science; life physics; science and business).

ADMISSIONS REQUIREMENTS
Council approved minor amendments to admission conditions for admitted students from the Chinese National curriculum pertaining to requirements for student writing the National Chinese Entrance Exam (NCEE, also known as Gao Kao), and also for those students who forgo writing the said exam.

Mario Coniglio
Associate Vice-President, Academic

/mg
FOR INFORMATION

Recognition and Commendation

The Centre for Extended Learning (CEL) in conjunction with Associate Vice President, Academic Mario Coniglio were pleased to announce the recipients of the University of Waterloo’s inaugural Online Teaching and Design Awards: Professor Edwin Ng and Professor Doug Cowan. Edwin Ng (Assistant Professor, School of Social Work, Renison University College) was nominated for the Online Teaching Award based on his teaching of SWK 605R: Knowledge Mobilization and Evidence-Based Practice, SWK 601R: Health Policy, and SWK 609R: Social Work Practice in Mental Health, part of the online Master of Social Work program at Waterloo, which is unique in Canada. The Online Course Design award goes to Doug Cowan, Professor of Religious Studies and Social Development Studies for his authorship of RS 270R: Religion and Popular Film, developed with CEL support. The course is cross-listed as Fine Arts 252. The Online Teaching and Design Awards are given out annually. In addition to a Certificate of Recognition, each recipient will receive a monetary prize of $1000, sponsored by the Office of the Associate Vice-President, Academic. Students, teaching assistants, faculty, instructors, chairs, and deans are all eligible to nominate any fully online course for the Online Course Design Award. For the Online Teaching Award, students are encouraged to nominate their online instructor at the end of each term in a course announcement. (Adapted from the Daily Bulletin, 20 April 2017.)

The Waterloo Aboriginal Education Centre (WAEC) won the Equity and Inclusivity Award from the University’s Status of Women and Equity Committee (SWEC). While the Centre is first and foremost a supportive and safe space for Indigenous students, it also manages to engage non-Indigenous students, staff, and faculty in the sharing of Indigenous knowledge, and has been especially successful in forming collaborative partnerships with other community organizations. WAEC activities include everything from outreach educational programs with Indigenous communities, lectures and events, an annual Pow Wow, and – to those on campus – Soup and Bannock lunches every week during the Fall and Winter. (Adapted from the Daily Bulletin, 21 April 2017.)

On April 18th, The Fields Institute held its inaugural thesis competition in collaboration with TEDxUofT. Doctoral students studying any form of mathematics from across Ontario competed to see who could best present their thesis topic within three minutes. Three of the eleven student presenters were from Waterloo. Congratulations to Thomas Bury (Applied Mathematics) who placed second, Tyrone Ghaswala (Pure Mathematics) who placed third, and Anton Mosunov (Pure Mathematics) who received an honorable mention. (Adapted from the Faculty of Mathematics News website, 21 April 2017.)

Excellence in teaching is both a tradition and a core mission of the University of Waterloo’s Faculty of Science. Each year the Faculty of Science celebrates this dedication and superior teaching calibre by selecting up to two instructors to receive its highest teaching honour: the Excellence in Science Teaching Award (ESTA). This year’s ESTAs were awarded to Michael Beazely an associate professor in the School of Pharmacy and Richard Epp, a continuing lecturer in the Department of Physics and Astronomy. The winners of the ESTA receive a certificate and a monetary award, which is used to support teaching activities. (Adapted from the Daily Bulletin, 25 April 2017.)

The Fields Institute has announced that Professor Brian Forrest of the University of Waterloo’s Department of Pure Mathematics was chosen as the 2017 recipient of the Margaret Sinclair Memorial Award. This honour recognizes innovation and excellence in mathematics education. “The adjudication committee was impressed by the significant impact his accomplishments have had at all levels of mathematics education: high school, undergraduate, graduate, postdoctoral, and teacher education,” says a statement from the Fields Institute. Professor Forrest is the first University of Waterloo recipient of this award. “It is a tribute to him as a talented mathematician, an outstanding teacher and a driving force for curricular development,” says an article on the Mathematics website. (Adapted from the Daily Bulletin, 10 May 2017.)
Five University of Waterloo researchers have been awarded more than $6 million through the Canada Research Chairs (CRC) and Canada Foundation for Innovation’s John R. Evans Leaders Fund (JELF). The researchers named in the announcements are: Chris Eliasmith (Philosophy & Systems Design Engineering) – CRC advancement from Tier 2 to Tier 1 in Theoretical Neuroscience ($1.4 million over seven years). Professor Eliasmith was also awarded $69,965 through CFI’s JELF for Computational and Robotic Infrastructure for Large-Scale Neural Simulation. Laura Hug (Biology) – New Tier 2 CRC in Environmental Microbiology ($500,000 over five years). Assistant professor Hug was also awarded $50,000 through CFI’s JELF for Microbial Diversity and Function in Contaminated Sites. Raafat Mansour (Electrical and Computer Engineering) – Renewed Tier 1 CRC in Micro and Nano Integrated Radio Frequency (RF) Systems ($1.4 million over seven years). Janusz Pawliszyn (Chemistry) – Renewed Tier 1 CRC in New Analytical Methods and Technologies ($1.4 million over seven years). Catherine Rosenberg (Electrical and Computer Engineering) – Renewed Tier 1 CRC in the Future Internet ($1.4 million over seven years). (Adapted from the Daily Bulletin, 17 May 2017.)
FOR INFORMATION

A. APPOINTMENTS

Adjunct Appointments

Undergraduate Instruction

AYER, Nadina, Lecturer, Recreation and Leisure Studies, May 1, 2017 – August 31, 2017.

FLANAGAN, Ashley, Lecturer, Recreation and Leisure Studies, May 1, 2017 – August 31, 2017.

MILLER, Maggie, Lecturer, Recreation and Leisure Studies, May 1, 2017 – August 31, 2017.

ROGALSKY, Kristen, Lecturer, Recreation and Leisure Studies, May 1, 2017 – August 31, 2017.

Graduate Supervision

HO, Joanne Man-Wai, Assistant Professor, School of Public Health and Health Systems, May 1, 2017 – December 31, 2018.

Special Appointments

BEYER, Kit, Lecturer, Department of Kinesiology, May 1, 2017 – August 31, 2017.

KANGMENNAANG, Joseph, Lecturer, School of Public Health and Health Systems, May 1, 2017 – August 31, 2017.

MOONEY (nee Dixon), Jenna, Lecturer, School of Public Health and Health Systems, May 1, 2017 – August 31, 2017.

Postdoctoral Fellow to Research Appointments

OREMUS, Carolina, School of Public Health and Health Systems, April 1, 2017 – May 31, 2017.

Research Appointments


GIANGREGORIO, Lora, Schlegel Research Chair in Mobility and Aging, September 1, 2017 – August 31, 2022.

Cross-appointments

LEE, Joonwu, Assistant Professor, School of Public Health and Health Systems to Statistics and Actuarial Science, June 1, 2017 – May 30, 2019.

James W.E. Rush, Dean
Faculty of Applied Health Sciences
A. APPOINTMENTS

Probationary Term Appointments

BABLE, Jordan (BA 2006 Master of Professional Accountancy 2011 West Virginia University, PhD expected 2017 University of Pittsburgh), Assistant Professor, School of Accounting and Finance, July 1, 2017 to June 30, 2020. Jordan Bable joins the accounting area of the School. His research interests are financial and managerial accounting topics including determinants of investor and employee behavior; primarily experimental methods. His teaching interests include undergraduate and graduate teaching in managerial and financial accounting. In 2016 he received the Deloitte Foundation Doctoral Fellowship. Jordan will contribute to the School of Accounting and Finance by strengthening research and teaching in our management accounting area.

BAUER, Tim (BA 2002 MA 2003 PhD 2011 University of Waterloo), Assistant Professor, School of Accounting and Finance, July 1, 2018 to June 30, 2021. Tim Bauer joins the accounting area of the School. His research interests include judgement/decision-making in accounting, assurance and taxation. His teaching interests include undergraduate and graduate teaching in assurance. Tim was a co-investigator with A. Bauer and D. Curran and was awarded a $74,000 Social Sciences and Human Research Council-Insight Development grant for the years 2015-2017. He will contribute to the School of Accounting and Finance by strengthening research and teaching in our assurance area.

LU, Ross (MBA 2002 Wake Forest University, Master of Finance 2010 PhD expected 2017 University of Toronto), Assistant Professor, School of Accounting and Finance, July 1, 2017 to June 30, 2020. Ross Lu joins the accounting area of the School. His research interests include economic consequences of corporate governance disclosure, managerial ability and bank loan pricing. His teaching interests include financial and managerial accounting. Ross will contribute to the School of Accounting and Finance by strengthening research and teaching in our financial accounting area.

NOLETTE, Nicole (BA 2006 MA 2008 University of Alberta, PhD 2014 McGill University) Assistant Professor, Department of French Studies, July 1, 2017 to June 30, 2020. Dr. Nolette’s areas of research are minority studies (Acadie, Ontario, Western Canada, and Québec), French Canadian theatre, and literary translation (theatre) into French in a minority context. After a postdoctoral fellowship at Harvard University (2014-2016), Nicole taught French literature and language at Acadia University (2016-2017) before joining the Department of French Studies. Nicole has many publications and an award-winning book - *Jouer la traduction* - for which she received the Canadian Association for Theatre Research 2016 “Ann-Saddlemeyer prize”.

OZ, Seda (BSc 2007 Bilkent University, MPhil 2010 PhD 2013 New York University), Assistant Professor, School of Accounting and Finance, July 1, 2017 to June 30, 2020. Seda Oz joins the accounting area of the School. Her research interests include financial institutions, information intermediaries, regulation and corporate disclosure. Her teaching interests include financial accounting, financial statement analysis and empirical research methods. In 2016 she was awarded the McGill All Star Professors award. Seda will contribute to the School of Accounting and Finance by strengthening research and teaching in our financial accounting area.

PRESSLEE, Adam (BComm 2004 University of Alberta, PhD 2014 University of Waterloo), Assistant Professor, School of Accounting and Finance, January 1, 2018 to June 30, 2021. Adam Presslee joins the accounting area of the School. His research and teaching interests include topics related to managerial accounting. In 2016 he was awarded the Katz Graduate School of Business Teacher of the Year award.
He will contribute to the School of Accounting and Finance by strengthening research and teaching in our management accounting area.

**VITALIS, Adam** (BAcc 1994 University of San Diego, MA 2005 New York University, PhD 2012 University of Wisconsin), Assistant Professor, School of Accounting and Finance, July 1, 2017 to June 30, 2020. Adam Vitalis joins the accounting area of the School. His research interests include using experimental methods to explore the limitations of information processing in financial and audit settings. His teaching interests include assurance and management accounting. He will contribute to the School of Accounting and Finance by strengthening research and teaching in our assurance area.

**Definite Term Reappointments**

BALABAN, Steven, Lecturer, School of Accounting and Finance, July 1, 2017 to June 30, 2018.

BERBERICH, Greg, Lecturer, School of Accounting and Finance, July 1, 2017 to June 30, 2018.

BLAIR, Gavin, Lecturer, School of Accounting and Finance, July 1, 2017 to June 30, 2018.

DADEY, Bruce, Lecturer, Department of English Language and Literature, May 1, 2017 to April 30, 2018.

EULETTE, Lynette, Lecturer, Department of Psychology, July 1, 2017 to June 30, 2020.

GEORGE, Ryan, Lecturer, Department of Economics, September 1, 2017 to August 31, 2020.

HA, David, Lecturer, School of Accounting and Finance, July 1, 2017 to June 30, 2018.

HARRIGAN, Kevin, Research Associate Professor, Department of Drama & Speech Communication, May 1, 2017 to April 30, 2018.

**Visiting Reappointment**

SRSA BENKO, Aleksandra, Visiting Lecturer, Department of Germanic and Slavic Studies, September 1, 2017 to April 30, 2018.

**Adjunct Appointments – Instruction**

MACFARLANE, Kayla, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

MAHN, Anne, Lecturer, Department of Germanic and Slavic Studies, September 1, 2017 to April 30, 2018.

**Adjunct Appointments – Graduate Supervision**

TIERNEY-HYNES, Rebecca, Associate Professor, Department of English Language and Literature, July 1, 2017 to December 31, 2021.

**Adjunct Reappointments – Instruction**

ARNASON, Mark, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

ARNOLD, Brian, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

BARICHELLO, Steve, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

BIRKE, Lisa, Lecturer, Department of Fine Arts, June 13, 2017 to August 31, 2017.

BRIGGS, Catherine, Lecturer, Department of History, May 1, 2017 to August 31, 2017.
BULLOCH, Dean, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

CARVER, Matthew, Lecturer, Department of Fine Arts, May 1, 2017 to August 31, 2017.

CUMMINGS, Ruth, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

DEMAN, J. Andrew, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

DIGNAN, Paul, Lecturer, Department of Fine Arts, May 1, 2017 to August 31, 2017.

DUCARME, Robert, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

FERNANDEZ, Stephen, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

FOERSTER, Allan, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

HANCOCK, Michael, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

HARVIE, Jo, Lecturer, Department of Drama and Speech Communication, May 1, 2017 to August 31, 2017.

HAYES, Nicole, Lecturer, Department of Anthropology, May 1, 2017 to August 31, 2017.

HILL, Heather, Lecturer, Department of Drama and Speech Communication, May 1, 2017 to August 31, 2017.

HUTCHISON, Jesse, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

IV, Kieng, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

MANNING, Thomas, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

MCDERMOTT, Neil, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

MORGAN, Derek, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

MURRAY, Neil, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

NURSE-GUPTA, Jodey, Lecturer, Department of History, May 1, 2017 to August 31, 2017.

PECKHAM, William, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

RAJSIC, Predrag, Lecturer, Department of Economics, May 1, 2017 to August 31, 2017.

SABZIAN, Saeed, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

SNYDER, Carrie, Lecturer, Department of English Language and Literature, May 1, 2017 to August 31, 2017.
SPELTZ, Andrea, Assistant Professor, Department of Germanic and Slavic Studies, May 1, 2017 to August 31, 2017.

STETTNER, Shannon, Lecturer, Department of Philosophy, May 1, 2017 to August 31, 2017.

STEVENSON, Michael, Lecturer Department of Political Science, May 1, 2017 to August 31, 2017.

THARMALINGAM, Pirapa, Lecturer, Department of Economics, May 1, 2017 to August 31, 2017.

THOMPSON, James Craig, Lecturer, Department of History, May 1, 2017 to August 31, 2017.

TIMBIRG, Robert, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

WENSELY, Karen, Lecturer, School of Accounting and Finance, May 1, 2017 to August 31, 2017.

Adjunct Reappointments – Graduate Supervision

BIRD, Frederick, Professor, Department of Political Science, July 1, 2017 to June 30, 2020.

MARIN-DOMINE, Marta, Associate Professor, Department of Sociology and Legal Studies, January 1, 2017 to August 31, 2017.

Graduate Students Appointed as Part-Time Lecturers

ARULDASON, Shereena, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

BERIAULT, Philipe, Department of Philosophy, May 1, 2017 to August 31, 2017.

CHENIER, Allison, Department of Sociology and Legal Studies, May 1, 2017 to August 31, 2017.

CONNOY, Laura, Department of Sociology and Legal Studies, May 1, 2017 to August 31, 2017.

DOYLE, Jennifer, Department of Drama and Speech Communication, May 1, 2017 to August 31, 2017.

DUSOWOTH, Sushma, Department of French Studies, May 1, 2017 to August 31, 2017.

HAIDER, Amna, Department of English Language and Literature, May 1, 2017 to August 31, 2017.

HAYDON, Nathan, Department of Philosophy, May 1, 2017 to August 31, 2017.

HOCKLEY, Brett, Department of Philosophy, May 1, 2017 to August 31, 2017.

MACDONALD, Ian, Department of Philosophy, May 1, 2017 to August 31, 2017.

MATSINHE, Daniel, Department of French Studies, May 1, 2017 to August 31, 2017.

MCCHESNEY, Dylon, Department of Philosophy, May 1, 2017 to August 31, 2017.

PLAIN, Amanda, Department of Philosophy, May 1, 2017 to August 31, 2017.

SHOEMAKER, Corrie, Department English Language and Literature, May 1, 2017 to August 31, 2017.

SILK, Matthew, Department of Philosophy, May 1, 2017 to August 31, 2017.
Staff Appointments to Faculty

CAMPBELL, Greg, Lecturer, Department of Drama and Speech Communication, May 1, 2017 to August 31, 2017.

CARSON, Linda, Lecturer, Department of Psychology, May 1, 2017 to August 31, 2017.

DI GRAVIO, Katrina, Department of Psychology, May 1, 2017 to August 31, 2017.

GLOVER, Adam, Lecturer, Department of Fine Arts, May 1, 2017 to August 31, 2017.

SCHMIDLIN, Karin, Lecturer, Faculty of Arts, Stratford Programmes, May 1, 2017 to August 31, 2017.

B. ADMINISTRATIVE APPOINTMENTS

BETZ, Emma, Associate Chair, Undergraduate Studies, Department of Germanic and Slavic Studies, July 1, 2017 to June 30, 2019.

DEA, Shannon, Associate Chair, Graduate Studies, Department of Philosophy, July 1, 2017 to June 30, 2018.

HELLEINER, Eric, Associate Chair, Undergraduate Studies, Department of Political Science, July 1, 2017 to August 31, 2018.

ROZOTTO, David, Associate Chair, Undergraduate Studies, Department of Spanish and Latin American Studies, May 1, 2017 to April 30, 2018.

SBARDELLATI, John, Associate Chair, Undergraduate Studies, Department of History, July 1, 2017 to December 31, 2017.

Administrative Appointments – Change in Dates

WOODY, Erik, Associate Chair, Graduate Studies, Department of Psychology, from May 1, 2016 to May 31, 2017, to May 1, 2016 to April 30, 2017.

Administrative Reappointment

DOUCET, Mathieu, Associate Chair, Undergraduate Studies, Department of Philosophy, July 1, 2017 to June 30, 2018.

C. RESIGNATION

GARCIA, Joanna, Assistant Professor, School of Accounting & Finance, effective June 30, 2017.

MITCHELL, Tim, Assistant Professor, School of Accounting & Finance, effective August 31, 2017.

SCHULZE, Mathias, Professor, Department of Germanic & Slavic Studies, effective August 15, 2017.

Douglas M. Peers
Dean, Faculty of Arts
REPORT OF THE DEAN OF ENGINEERING TO SENATE
June 19, 2017

For information:

A.  APPOINTMENTS

  Probationary Term Appointments
  WARD, Valerie, Assistant Professor, Department of Chemical Engineering, January 1, 2018 – June 30, 2021. PhD University of Western Ontario August 2016; MASc University of Waterloo 2012; BSc University of Waterloo 2009. Valerie Ward will bring to the Department of Chemical Engineering new and complementary strengths in biochemical engineering, especially in the growing field of biorefining for chemical and fuel production. This research area fit very well with Department’s strengths in biotechnology and sustainable energy.

  New Definite Term Appointment – full-time
  REDDY, Roopa, Lecturer, Conrad Business, Entrepreneurship & Technology Centre, June 1, 2017 – June 30, 2018. Bed Ensena Por Colombia, Bogota, Colombia 2011; MSc London School of Economics 2009; BBA Honours Wilfrid Laurier University 2006; BMath Honours University of Waterloo 2006. Roopa Reddy’s background is in Business and Math. She taught social entrepreneurship and has a particular interest in exploring innovative education models.

  SANGARY, Nagula, Research Associate Professor, Department of Electrical & Computer Engineering, February 1, 2017 – January 31, 2018. MBA University of Oxford, United Kingdom 2014; PhD McMaster University 1995; MSc McMaster University 1992; BSc Texas A&M University, USA 1988. Dr. Sangary will conduct research with Prof. Safavi-Naeini on emerging microwave/millimetre wave satellite systems technologies, particularly as a part of world-wide IoT infrastructure and affordable intelligent radio/antenna technologies for mobile ubiquitous satellite internet access.

  Definite Term Reappointment – full-time

  Visiting Appointments

  BROOGHANI, Seyed Yousef Ahmadi, Associate Professor, Department of Mechanical & Mechantronics Engineering, July 1, 2017 – December 31, 2017.

  CHANG, Menglei, Scholar, Department of Chemical Engineering, June 20, 2017 – June 19, 2018.

  DARE, Emma Victoria, Scholar, Department of Chemical Engineering, July 1, 2017 – October 31, 2017.

  DENG, Li, Associate Professor, Department of Electrical & Computer Engineering, April 1, 2017 – March 31, 2018.

FAN, Yuxin, Scholar, Department of Mechanical & Mechatronics Engineering, July 1, 2017 – June 30, 2018.

GHARAEI GARAKANI, Hossein, Assistant Professor, Department of Electrical & Computer Engineering, May 1, 2017 – October 31, 2017.

JI, Yancheng, Scholar, Department of Electrical & Computer Engineering, April 1, 2017 – March 31, 2018.

JIN, Grace, Scholar, Department of Chemical Engineering, May 9, 2017 – August 31, 2017.

LEE, Sang Bin, Professor, Department of Electrical & Computer Engineering, July 1, 2017 – August 31, 2018.

LI, Yan, Researcher, Department of Electrical & Computer Engineering, May 1, 2017 – April 30, 2018.


LI, Zhao, Scholar, Department of Electrical & Computer Engineering, April 20, 2017 – April 19, 2018.

LIU, Xianguo, Scholar, Department of Electrical & Computer Engineering, October 10, 2017 – October 9, 2018.

PAL, Sujata, Researcher, Department of Electrical & Computer Engineering, May 1, 2017 – August 31, 2017.


SABBAGHI, Samad, Associate Professor, Department of Chemical Engineering, July 21, 2017 – July 20, 2018.


SHAKIR, Ammar Mahmood, Researcher, Department of Civil & Environmental Engineering, September 1, 2017 – August 31, 2018.


XU, Jing- lei, Scholar, Department of Mechanical & Mechatronics Engineering, August 15, 2017 – August 14, 2018.


XUAN, Haicheng, Associate Professor, Department of Electrical & Computer Engineering working at the Institute of Quantum Computing, June 29, 2017 – December 28, 2017.


ZHU, Xiaojun, Scholar, Department of Electrical & Computer Engineering, April 1, 2017 – March 31, 2018.

KARIMINIAAE HAMEDAANI, Hamid-Reza, Associate Professor, Department of Chemical Engineering, May 1, 2017 – September 30, 2017.

VAN DER WEIDE, Hans, Researcher, Department of Civil & Environmental Engineering, June 1, 2017 – August 31, 2019.

XAVIER, Nixson, Scholar, Department of Chemical Engineering, September 15, 2016 – September 14, 2018.

Special Appointments – Undergraduate Instruction
ABDUL GAFFOOR, Thouheed, Lecturer, Department of Civil & Environmental Engineering, May 1, 2017 – August 31, 2017.


BYSKAL, Daniel, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – December 31, 2017.

COOPER-STACHOWSKY, Michael, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 30, 2017.

HILAL, Allaa, Lecturer, Department of Electrical & Computer Engineering, May 1, 2017 – August 31, 2017.

NASSAR, Mohammed, Lecturer, Department of Electrical & Computer, May 1, 2017 – April 30, 2018.

OBRIEN, Nicole, Lecturer, Department of Civil & Environmental Engineering, May 1, 2017 – August 31, 2017.

OKYAY, Ahmet, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.
SAMADZADEH, TARIGHAT, Roohollah, Lecturer, Department of Electrical & Computer Engineering, May 1, 2017 – August 31, 2017.

SHAMS, Sholeh, Lecturer, Department of Civil & Environmental Engineering, May 1, 2017 – August 31, 2017.

TUNA, Burak, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 30, 2017.

Special Reappointments – Undergraduate Instruction
BALESHTA, James, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.

GRIFFITHS-FULTON, Karl, Lecturer, Department of Systems Design Engineering, May 1, 2017 – August 31, 2017.

HADWIN, Paul, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.

LIAO, Lihua (Melody), Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.

MATHER, David, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.

NGUYEN, Tam, Lecturer, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – August 31, 2017.

Adjunct Appointments – Graduate Supervision
SHAKER, George, Assistant Professor, Department of Mechanical & Mechatronics Engineering, May 1, 2017 – April 30, 2020.

Adjunct Appointments – Graduate Supervision and Research
GIDDA, Tej, Assistant Professor, Department of Civil & Environmental Engineering, July 1, 2017 – June 30, 2019.

LI, Kecheng, Professor, Department of Chemical Engineering, October 1, 2016 – September 30, 2019.

MADHURANTHAKAM, Chandra Mouli, Assistant Professor, Department of Chemical Engineering, May 1, 2017 – April 30, 2019.

Adjunct Reappointments – Research & Graduate Supervision
MOO YOUNG, Murray, Professor, Department of Chemical Engineering, July 1, 2019 – December 31, 2020.

UYSLAL, Murat, Associate Professor, Department of Electrical & Computer Engineering, May 1, 2017 – April 30, 2020.

YU, Ming, Professor, Department of Electrical & Computer Engineering, May 1, 2017 – April 30, 2020.
Cross Reappointments

YAVUZ, Mustafa, Associate Professor, Department of Mechanical & Mechatronics Engineering to Department of Electrical & Computer Engineering, May 1, 2017 – April 30, 2020.

Changes in Appointments

ELKAMEL, Ali, Sabbatical, Professor, Department of Chemical Engineering was May 1, 2017 – October 30, 2017 changed to September 1, 2017 – February 28, 2018, six months at 85% salary and May 1, 2018 – October 30, 2018 changed to September 1, 2018 – February 28, 2019, six months at 85% salary.

FOWLER, Michael, Sabbatical, Professor, Department of Chemical Engineering was July 1, 2017 – December 31, 2017 changed to July 1, 2018 – December 31, 2018, six months at 85% salary.

NAIRN, David, Administrative Appointment, Coordinator, On-line Initiative Project was September 1, 2013 – August 31, 2017 changed to September 1, 2013 – April 30, 2017.

B. RESIGNATIONS

GHADDAR, Bissan, Probationary Term Appointment, Assistant Professor, Department of Management Sciences, July 31, 2017.

C. SABBATICAL LEAVES

For Approval by the Board of Governors

FIDAN, Baris, Associate Professor, Department of Mechanical & Mechatronics Engineering, September 1, 2017 – August 31, 2018, twelve months at 85% salary.

J. Richard Culham
Acting Dean, Faculty of Engineering
FOR INFORMATION

A. APPOINTMENTS

Adjunct Appointments

Graduate Supervision

LETOURNEAU, Marcus, Assistant Professor, School of Planning, May 1, 2017 to April 30, 2018.

LEVKO, Charles, Assistant Professor, Department of Geography and Environmental Management, March 1, 2017 to April 30, 2021.

MacDONALD, Adriane, Assistant Professor, School of Environment, Enterprise and Development, January 1, 2017 to December 31, 2018.

MUNKITTRICK, Kelly, Professor, School of Environment, Resources and Sustainability, April 1, 2017 to March 31, 2020.

Special Appointments

Instruction

HERREMANS, Irene, Lecturer, School of Environment, Enterprise and Development, May 1, 2017 to August 31, 2017.

Cross Appointments

BROUWER, Roy, Professor, Department of Economics, Faculty of Arts, to the School of Environment, Resources and Sustainability, April 1, 2017 to March 31, 2020.

MERGO, Teferi, Assistant Professor, St. Paul’s University College to the Department of Geography and Environmental Management, April 1, 2017 to August 31, 2021.

Staff Appointment to Faculty

McKENZIE, Ian, Associate Professor, Department of Geography and Environmental Management, July 1, 2017 to June 30, 2020.

Graduate Students Appointed as Part-Time Lecturers

BARBEAU, Christine, School of Environment, Resources and Sustainability, May 1, 2017 to August 31, 2017.

ELMES, Matthew, Department of Geography and Environmental Management, May 1, 2017 to August 31, 2017.

MORISON, Matthew, Department of Geography and Environmental Management, May 1, 2017 to August 31, 2017

B. ADMINISTRATIVE REAPPOINTMENTS

McKENZIE, Ian, Director, Aviation Program (Geography and Science), Faculty of Environment and Faculty of Science, July 1, 2017 to June 30, 2018.

McKENZIE, Ian, Associate Chair, Undergraduate Studies, Aviation and Geomatics Programs, Department of Geography and Environmental Management, July 1, 2017 to June 30, 2018.

Jean Andrey
Dean
FOR INFORMATION

A. APPOINTMENTS (already approved by the Board of Governors)

Probationary-Term Appointments
SLOFSTRA, William (BMath, 2006, University of Waterloo; PhD, 2011, University of California, Berkeley), Assistant Professor, Dept. of Pure Mathematics, July 1, 2017 – June 30, 2020. Dr. Slofstra is currently a Research Assistant Professor at the Institute for Quantum Computing at Waterloo. He has obtained several major breakthrough results, that are of fundamental importance in quantum computing, by developing novel applications of techniques from combinatorial group theory. He will add research strength to both the Mathematics group in IQC and the Algebra group in the Dept. of Pure Mathematics.

Probationary-Term Reappointments
ADCOCK, James, Lecturer, Dept. of Statistics and Actuarial Science, August 30, 2017 – August 29, 2020.

RICHARDS, Gregor, Assistant Professor, David R. Cheriton School of Computer Science, July 1, 2017 – June 30, 2020.

Definite Term - Appointments
HUYNH, Mirabelle (BMath, 2011; MMath, 2011; PhD, (exp) 2017, all from the University of Waterloo), Lecturer, Dept. of Statistics and Actuarial Science, September 1, 2017 – August 31, 2020. Ms. Huynh will teach six courses per year and participate in departmental activities as required.

KOZLOWSKI, Emily (BMath, 2014, University of Waterloo; BEd, 2014, Queen’s University; MMath, 2017 (exp), University of Waterloo), Lecturer, Dept. of Statistics and Actuarial Science, September 1, 2017 – August 30, 2019. Ms. Kozlowski will teach six courses per year and participate in departmental activities as required.

NEKRITCH, Iakov (Bachelor in Computer Science, 1994; Master in Computer Science, 1996, both from the University of Latvia; PhD, 2001, University of Bonn), Research Assistant Professor, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2018.

POIRRIER, Laurent (MS, 2008; PhD, 2012, both from the University of Liege), Research Assistant Professor, Dept. of Combinatorics and Optimization, May 1, 2017 – April 30, 2020.

WALLMAN, Joel (BSc, 2008; PhD, 2013, both from the University of Sydney), Research Assistant Professor, Dept. of Applied Mathematics, July 1, 2017 – June 30, 2022.

Definite Term - Reappointments
AKASH, Mukto, Lecturer, Office of the Dean, April 29, 2017 – April 28, 2018.

GAMACHE, Alain, Lecturer, Office of the Dean, August 1, 2017 – August 31, 2017.

Visiting Appointments
LI, Bingyu (Northeast Normal University), Associate Professor, David R. Cheriton School of Computer Science, December 31, 2017 – December 30, 2018.
MUNSON, William, Research Associate, Dept. of Combinatorics and Optimization, May 1, 2017 – April 30, 2019.

XU, Juan (Nanjing University of Aeronautics and Astronautics), Professor, Dept. of Combinatorics and Optimization, August 10, 2017 – August 9, 2018.

Adjunct Appointments
Instructor
AHMADI, Omran, Lecturer, Dept. of Combinatorics and Optimization, May 1, 2017 – August 31, 2017.


Adjunct Reappointments
Instructor
AL-MASRI, Eyhab, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.

ALIAKABARA, Shahla, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.


ANDERSON, Jeffrey, Lecturer, Office of the Dean, May 1, 2017 – April 30, 2019.

ARROYO GUEVARA, Alan Marcelo, Lecturer, Dept. of Combinatorics and Optimization, May 1, 2017 – August 31, 2017.


GLEESON, Rob, Lecturer, Office of the Dean, September 1, 2017 – August 31, 2018.


HOSSAIN, EHSAAN, Lecturer, Dept. of Pure Mathematics, May 1, 2017 – August 31, 2017.

IBRAHIM, Ahmed, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.

ISTEAD, Lesley, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.

KARABINA, Burcu, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.

KERR, Reid, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.
KHARAL, Rosina, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.

KLEISATH, Elizabeth, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.

LENNOX, Michelle, Lecturer, Dept. of Statistics and Actuarial Science, May 1, 2017 – August 31, 2017.


McKINNON, Jennifer, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.

MURRAY, Dean, Lecturer, Office of the Dean, May 1, 2017 – April 30, 2019.

SOHAIL, Nasir, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.

TONDELLO, Gustavo, Lecturer, David R. Cheriton School of Computer Science, May 1, 2017 – August 31, 2017.

VICENTE-COLMENARES, Alejandra, Lecturer, Office of the Dean, May 1, 2017 – August 31, 2017.

Research

FORSYTH, Peter, Professor Emeritus, David R. Cheriton School of Computer Science, July 1, 2020 – June 30, 2022.

Graduate Students appointed as Part-time Lecturers

ABDI, Ahmad, Dept. of Combinatorics and Optimization, May 1, 2017 – August 31, 2017.


WU, Cong, Dept. of Applied Mathematics, May 1, 2017 – August 31, 2017.

Graduate Students reappointed as Part-time Lecturers


Postdoctoral Fellows appointed as Part-time Lecturers


Postdoctoral Fellow reappointed as part-time Lecturers

B. ADMINISTRATIVE APPOINTMENTS


WONG, Bernard, Associate Director, Graduate Studies, David R. Cheriton School of Computer Science, July 1, 2017 – June 30, 2019.


ADMINISTRATIVE REAPPOINTMENTS
ATLEE, Jo, Director, Women in Computer Science, David R. Cheriton School of Computer Science, July 1, 2017 – June 30, 2018.


WAN, Justin, Associate Director, David R. Cheriton School of Computer Science, July 1, 2017 – June 30, 2018.

C. SABBATICALS (already approved by the Board of Governors)
BAUCH, Christopher, Professor, Dept. of Applied Mathematics, January 1, 2018 – June 30, 2018, at 100% salary.

BELL, Jason, Professor, Dept. of Pure Mathematics, July 1, 2017 – June 30, 2018, with 85% salary.

CLEVE, Richard, Professor, David R. Cheriton School of Computer Science, August 1, 2017 – July 31, 2018, with 85% salary.

JAO, David, Associate Professor, Dept. of Combinatorics and Optimization, September 1, 2017 – August 31, 2018, with 85% salary.

PURBHOO, Kevin, Associate Professor, Dept. of Combinatorics and Optimization, September 1, 2017 – August 31, 2018, with 85% salary.

Stephen M. Watt
Dean
A. APPOINTMENTS

**New Probationary Term**

**KLINKOVA, Anna**, Assistant Professor, Department of Chemistry, August 1, 2017 to June 30, 2020. [B.Sc., Saint Petersburg State University (2009); M.Sc., Bowling Green State University (2011); Ph.D., University of Toronto (2015).]  Dr. Klinkova is a Connaught Postdoctoral Fellow at the University of Toronto with Professor E. Kumacheva and Professor E. Sargent.  Her research proposes to develop novel approaches to the design and fabrication of metal nanoparticles and their use in a variety of catalytic systems, building on her strong background in chemistry, electrochemistry and nanotechnology.

**Probationary Term**

**McIver, Sarah**, Clinical Associate Professor, School of Optometry and Vision Science, July 1, 2018 to June 30, 2021.  [B.Sc., University of Waterloo (2010); OD, University of Waterloo (2010); Ocular Disease Residency, State University of New York (2011).]

**New Definite Term**

**IGBOELI, Okechukwu (Okey)**, Lecturer, Dean of Science Office, June 12, 2017 to June 11, 2020.  [DVM, University of Nigeria (2002); M.Sc., University of Nigeria (2006); Ph.D. Atlantic Veterinary College, University of Prince Edwards Island (2015).]  The Science and Business program is delighted to welcome Dr. Okey Igboeli for a 3-year definite term as Lecturer.  Over the last two years, Dr. Igboeli has been the president of True Spring Pharmaceuticals and brings to Waterloo an extensive slate of innovation, commercialisation and business skills as well as DNA extraction, purification and manipulation expertise to the university.  He has experience as a post-doctoral fellow at UPEI, technology liaison officer at UPEI, a lecturer in the University of Abuja, Nigeria and as a veterinarian in Nigeria.  His skill set is very broad and includes technology innovation, entrepreneurship and commercialization, molecular genetics, aquaponics and immunohistochemistry.  He is capable of teaching many of our Science and Business workshops at all undergraduate levels and has much experience that will provide an important bridge between Velocity and Science and Business.

**Definite Term Reappointment Full-Time**

**BOHLOULI-ZANJANI, Parisa**, Lecturer, Department of Physics and Astronomy, September 1, 2017 to August 30, 2019.

**Adjunct Appointments**

**Graduate Supervision**

**SOLTANI, Madjid**, Professor, Department of Earth and Environmental Sciences, April 1, 2017 to March 31, 2020.

**Graduate Supervision and Research**

**DUNKLEY, Ben T.**, Assistant Professor, School of Optometry and Vision Science, May 1, 2017 to April 30, 2020.
Adjunct Reappointments

Graduate Supervision

ENGLISH, Michael C., Professor, Department of Earth and Environmental Sciences, March 1, 2017 to February 28, 2020.

Cross Reappointments

DMITRIENKO, Gary, Associate Professor, Department of Chemistry, cross appointed to School of Pharmacy, June 1, 2017 to May 31, 2020.

HONEK, John, Professor, Department of Chemistry, cross appointed to School of Pharmacy, June 1, 2017 to May 31, 2020.

IOANNNIDIS, Marios, Professor, Department of Chemical Engineering, cross appointed to Department of Earth and Environmental Sciences, May 1, 2017 to April 30, 2019.

LEUNG, Debbie, Professor, Department of Combinatorics and Optimization, cross appointed to Department of Physics and Astronomy, April 1, 2017 to March 31, 2020.

MOSCA, Michele, Professor, Department of Combinatorics and Optimization, cross appointed to Department of Physics and Astronomy, April 1, 2017 to March 31, 2020.

Special Appointments

LIU, Peng, Lecturer, Department of Earth and Environmental Sciences, May 1, 2017 to August 31, 2017.

SALMAN, Maxime, Lecturer, Department of Earth and Environmental Sciences, May 1, 2017 to August 31, 2017.

Special Reappointment

DURR, Hans, Lecturer, Department of Earth and Environmental Sciences, May 1, 2017 to August 31, 2017.

PFISTERER, Steve, Lecturer, Department of Physics and Astronomy, September 1, 2017 to December 31, 2017.

B. RETIREMENTS

ROBERTSON, William, Research Associate Professor, Department of Earth and Environmental Sciences, effective May 1, 2017.
FOR APPROVAL BY THE BOARD OF GOVERNORS

E. SABBATICAL LEAVES

HILL, Robert W., Associate Professor, Department of Physics and Astronomy, September 1, 2017 to August 31, 2018, 100% salary arrangement.

HUDSON, Michael, Professor, Department of Physics and Astronomy, September 1, 2017 to August 31, 2018, 100% salary arrangement.

LAFLAMME, Raymond, Professor, Department of Physics and Astronomy, September 1, 2017 to August 31, 2018, 100% salary arrangement.

MARIANTONI, Matteo, Assistant Professor, Department of Physics and Astronomy, special early leave, September 1, 2017 to February 28, 2018, 100% salary arrangement.

ROSS, Martin, Associate Professor, Department of Earth and Environmental Sciences, January 1, 2018 to December 31, 2018, 100% salary arrangement.

RP. Lemieux
Dean

RPL:lw
Senate Committee Appointments

Motion: To approve the following appointments:

- **Senate Long Range Planning Committee:** Peter Johnson (geography & environmental management) as the member from the Board of Directors of the Faculty Association of the University of Waterloo, term 19 June 2017 to 30 April 2018.

- **Senate Graduate & Research Council:**
  - Daniel Martel (kinesiology) as applied health sciences graduate student representative, term 19 June 2017 to 30 April 2019.
  - Emily Cyr (psychology) as arts graduate student representative, term 19 June 2017 to 30 April 2019.
  - Takin Tadayon (electrical & computer engineering) as engineering graduate student representative, term 19 June 2017 to 30 April 2019.
  - Tom Bury (applied mathematics), replacing Adam Dor On, as mathematics graduate student representative, term 19 June 2017 to 30 April 2018.
  - Max Salman (earth & environmental sciences) as science graduate student representative, term 19 June 2017 to 30 April 2018.
FOR INFORMATION

University Research Chairs
The 2017 University Research Chairs: Marcel O’Gorman (English language and literature); Alice Kuzniar (Germanic and Slavic studies).

Waterloo has granted 67 University Research Chair awards since 2004. Current chair holders are: Jeff Chen (physics & astronomy), Duane Cronin (mechanical & mechatronics engineering), Xianshe Feng (chemical engineering) in 2016; Pu Chen (chemical engineering), Claude Duguay (geography & environmental management), Lila Kari (computer science), Debbie Leung (combinatorics & optimization), John Long (electrical and computer engineering), Brian McNamara (physics & astronomy), Heidi Swanson (biology), Ehsan Toyserkani (mechanical & mechatronics engineering) in 2015; James Geelen (combinatorics & optimization), Achim Kempf (applied mathematics), Xianguo Li (chemical & mechatronics engineering), Qing-Bin Lu (physics & astronomy), Mark Matsen (chemical engineering), Daniel Scott (geography & environmental management) in 2014; Chris Bauch (applied mathematics), Jason Bell (pure mathematics), Ravi Mazumdar (electrical & computer engineering), Norman Zhou (mechanical & mechatronics engineering) in 2013; Ian Goldberg (computer science), Elizabeth Irving (optometry & vision science), Shesha Jayaram (electrical & computer engineering), Lyndon Jones (optometry & vision science), Michele Mosca (combinatorics & optimization) in 2012; Fakhreddine Karray (electrical & computer engineering), Bill McIlroy (kinesiology), Sivabal Sivaloganathan (applied mathematics), Michael Tam (chemical engineering), Grace Yi (statistics & actuarial science) in 2011; Thomas Coleman (combinatorics & optimization), Richard Culham (mechanical & mechatronics engineering), James Forrest (physics & astronomy), Richard Oakley (chemistry), Ken Seng Tan (statistics & actuarial science) in 2010.

UNIVERSITY RESEARCH CHAIRS
University of Waterloo owes much of its reputation and stature to the quality of its professors and their scholarly accomplishments. University of Waterloo recognizes exceptional achievement and pre-eminence in a particular field of knowledge through the designation 'University Research Chair’ - a title which may be held for up to seven years, with the possibility of a re-nomination. A faculty member with this title will receive either a teaching reduction of one course per year or an annual stipend of $10,000, which will be allocated to the Department/School if teaching reduction is chosen. The University Research Chair title and benefits will be relinquished if a Canada Research Chair or other major research chair is awarded.

It is anticipated that there will be a limited number of University Research Chairs; at steady state, the intention is to make at most five appointments each year. The number of appointments will be reviewed annually by the Vice-President Academic & Provost in consultation with Deans’ Council and the program will be reviewed after an initial period of five to ten years.

Ian Orchard
Vice-President Academic & Provost
Two reports are recommended to be included in the regular agenda:

Report a: Report pursuant to the 8 May 2017 meeting

Report b: Report subject to approval at the 12 June 2017 meeting

/ar       Jeff Casello                          George Dixon
Associate Provost, Graduate Studies        Vice President, University Research
Senate Graduate & Research Council met on 8 May 2017. Council agreed to forward the following item to Senate for approval. Council recommends these items be included in the regular agenda.

Further details are available at: https://uwaterloo.ca/secretariat/committees-and-councils/senate-graduate-research-council

FOR APPROVAL

NEW RESEARCH CENTRE

Centre for Bioengineering and Biotechnology

1. **Motion:** To approve the establishment of the Centre for Bioengineering and Biotechnology, as described in attachment 1.

   **Rationale:** The Centre for Bioengineering and Biotechnology (CBB) will provide a structure for collaborative activities that involve biotechnology, bioengineering and biomedical engineering, and will also entail increasing research funding, deepening relationships with healthcare organizations, strengthening international relationships, supporting student talent, enhancing industry relations and academic partnerships. In particular:

   - CBB has members from all Faculties at the University of Waterloo 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.
   - 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.
   - CBB has established strong and accountable governance structures, in keeping with the requirements of Policy 44 – Research Centres and Institutes. CBB has the maturity in its processes to operate as a ‘University Centre’.
   - CBB has a solid financial plan for using the increased funding of a University Centre effectively; as emphasized below highlighting the top five priorities.


/ar Jeff Casello
Associate Provost, Graduate Studies

George Dixon
Vice President, University Research
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

\text{cbb.uwaterloo.ca}

5 Year Renewal Report
November 2011 – 2016

Prepared: September 2016
Contents

Executive Summary ................................................................................................................................... 3
Background, Mission and Objectives ........................................................................................................ 5
  Mission Statement ................................................................................................................................ 6
  Management Plan and Objectives ............................................................................................................ 6
Achievements and Results ........................................................................................................................ 7
  Show Tangible Value ............................................................................................................................. 7
  Attract New Research Funding ............................................................................................................. 8
  Improve Academic Environment ............................................................................................................ 10
  Achieve Research Recognition ............................................................................................................. 12
  Increase Partnerships .......................................................................................................................... 12
  Assessment of results to date ............................................................................................................. 13
Five Year Plan .......................................................................................................................................... 14
  A Collaborative Planning Process ........................................................................................................ 14
  Accomplishing the Five Year Plan ....................................................................................................... 15
Governance and Administration ............................................................................................................. 17
  Management Team and Staff ............................................................................................................. 17
  Reporting Structure ............................................................................................................................ 18
  Boards and Committees ...................................................................................................................... 18
  Governing Documentation ................................................................................................................. 20
Financials ................................................................................................................................................. 21
Appendix ................................................................................................................................................. 23
  A - Summary of member listing and Research Groups ....................................................................... 24
  B - Board members ............................................................................................................................. 41
  C - Operations committee ................................................................................................................... 43
  D - Constitution ................................................................................................................................... 44
  E - Listing of seminars and events ....................................................................................................... 56
  F - Member awards and achievements ............................................................................................... 59
  G - Summary of Year 5 member survey .............................................................................................. 65
  H - Letters of support ........................................................................................................................ 70
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)
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)](image)

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 (115/150\(^1\)). 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.

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\(^1\) 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 Waterloo 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).

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.](image)

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 Huisssoon, Mechanical and Mechatronics Engineering
7. Eric Croiset, Chemical Engineering
8. Carolyn Ren, Mechanical & Mechatronics Engineering
9. Chris Backhouse, Electrical and Computer Engineering
10. Elizabeth Meiering, 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

<table>
<thead>
<tr>
<th>Income</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
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<td></td>
<td>Nov-Apr</td>
<td>May-Apr</td>
<td>May-Apr</td>
<td>May-Apr</td>
<td>May-Apr</td>
<td>May-Apr</td>
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<td>-</td>
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<td>50,000</td>
<td>50,000</td>
<td>50,000</td>
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<tr>
<td>Seed Funding - Science</td>
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<td>25,000</td>
<td>25,000</td>
<td>25,000</td>
<td>25,000</td>
<td>-</td>
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<td>Membership revenue</td>
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<td>5,000</td>
<td>-</td>
<td>-</td>
<td>5,000</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>28,109</td>
<td>10,000</td>
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<tr>
<td>Contract Research funding</td>
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<td>40,000</td>
<td>10,696</td>
<td>18,687</td>
<td>119,916</td>
<td>58,368</td>
<td>40,833</td>
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<td>Sub total</td>
<td>-</td>
<td>120,000</td>
<td>85,696</td>
<td>93,687</td>
<td>199,916</td>
<td>161,477</td>
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<th>Expenses</th>
<th>Estimate</th>
<th>Year 6 commitments</th>
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<td>Business Development Manager</td>
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<td>Project Manager</td>
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<tr>
<td>Temporary / Contract Worker</td>
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<td>2,974</td>
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<td>Salaries Sub total</td>
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<td>Office expenses</td>
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<td>21,010</td>
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<td>Events</td>
<td>894</td>
<td>35,349</td>
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<td>Travel</td>
<td>786</td>
<td>31,266</td>
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<td>Sub total</td>
<td>6,622</td>
<td>87,625</td>
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<td>Total expenses</td>
<td>28,707</td>
<td>250,668</td>
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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

<table>
<thead>
<tr>
<th>Expenses</th>
<th>Year 6 May-Apr 2017/18</th>
<th>Year 7 May-Apr 2018/19</th>
<th>Year 8 May-Apr 2019/20</th>
<th>Year 9 May-Apr 2020/21</th>
<th>Year 10 May-Apr 2021/22</th>
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<tbody>
<tr>
<td>Administrative Assistant</td>
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<td>55,000</td>
<td>60,000</td>
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<td>Temporary / Contract Worker</td>
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Salaries Sub total 155,000 205,000 285,000 295,000 300,000

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<th>Expenses</th>
<th>Year 6 May-Apr 2017/18</th>
<th>Year 7 May-Apr 2018/19</th>
<th>Year 8 May-Apr 2019/20</th>
<th>Year 9 May-Apr 2020/21</th>
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<td>10,000</td>
<td>10,000</td>
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<tr>
<td>Special Initiatives</td>
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<td>Travel - Manager Int/Gov</td>
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<td>10,000</td>
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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)

<table>
<thead>
<tr>
<th>Biomedical</th>
<th>Environmental</th>
<th>Bioprocessing and Food Technology</th>
<th>Healthcare Systems</th>
<th>Imaging</th>
<th>Wearable and Healthcare Devices</th>
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</thead>
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<td>Engineering</td>
<td>39</td>
<td>22</td>
<td>12</td>
<td>14</td>
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<td>Science</td>
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<tr>
<td></td>
<td>75</td>
<td>40</td>
<td>16</td>
<td>30</td>
<td>38</td>
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## Members by Priority Area:

<table>
<thead>
<tr>
<th>Contact</th>
<th>Faculty</th>
<th>Department</th>
<th>Biomaterials and Biomanufacturing Innovations</th>
<th>Biomedical Systems and Device Technologies</th>
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</thead>
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<tr>
<td>Eihab Abdel-Rahman</td>
<td>Engineering</td>
<td>Systems Design Engineering</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stacey Acker</td>
<td>Applied Health Sciences</td>
<td>Kinesiology</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Adil Al-Mayah</td>
<td>Engineering</td>
<td>Civil &amp; Environmental Engineering</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bill (William) Anderson</td>
<td>Engineering</td>
<td>Chemical Engineering</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Jose (Frank) Arocha</td>
<td>Applied Health Sciences</td>
<td>School of Public Health &amp; Health Systems</td>
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</tr>
<tr>
<td>Marc Aucoin</td>
<td>Engineering</td>
<td>Chemical Engineering</td>
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<tr>
<td>Chris Backhouse</td>
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<td>Electrical &amp; Computer Engineering</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Gladimir Baranoski</td>
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<td>School of Computer Science</td>
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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

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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

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Bioprocessing and Food Technology (16 members)
(https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/70)

This research group 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

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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

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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

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Wearable and Healthcare Devices (41 researchers)
([https://uwaterloo.ca/bioengineering-biotechnology/about/people/group/80](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

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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.
**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)

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
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)


CBB Workshops (5)

1. “CIHR Info Session on open program changes and grant writing tips” Leslie Copp, University of Waterloo, January 8, 2014
3. “Mitacs Programs and Funding Opportunities” Shaylene Nancekivell, Business Development Specialist, Waterloo Mitacs, April 7, 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)

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
3. “Fermentation: Innocente Brewery. From Academic to Fermentologist” Steve Innocente, PhD, Head Brewer and Owner, Innocente Brewing Company, November 6, 2015
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-NAEIINI, 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 Doctoral 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
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. Deeping 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%

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%

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%

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%

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%

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%

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%

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%  No 5.6%

Yes 34  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%  No 11.1%

Yes 32  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.

<table>
<thead>
<tr>
<th>Priority</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>NA</th>
<th>Total</th>
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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.
- 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
- Veroniqué 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,

[Signature]

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
Dr. George Dixon  
Vice President, University Research  
University of Waterloo  
200 University Avenue West  
Waterloo, Ontario, N2L 3G1

September 5, 2016

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

cc. Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology
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 liasons, 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,

[Signature]

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-mechine 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 join 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. Mekillop) that are currently supporting two graduate students and two co-op students. Two additional grand proposal have been submitted, one NSERC-RTI and one Pilot Project Grant from Canadian Parkinson Society. I also participated two International Partnership Grants with the Univesity 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,

[Signature]

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://uwwaterloo.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,

[Signature]

Brian Ingalls
Associate Professor
Department of Applied Mathematics
University of Waterloo

cc. 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
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.

Anotex 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, [Signature]

Jason Dowel, 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 UoW 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.
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 impact 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.

Fiona Fitzgerald
National Zone Leader
GE Healthcare Life Science, Canada
Fitzi.a.Fitzgerald@ge.com
Tel: 51483196700
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. Catharine 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 affecting 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 aboard.

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 Steele 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 devise 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,

[Signature]

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 it's 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,

[Signature]

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,

[Signature]

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 if 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,

VERONIQUE AIGER, 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 4496
e.schiweck@utwente.nl

DEPARTMENT
Psychology, Health & Technology

COPY TO
Dr. Catherine Burns, Director, Centre for Bioengineering and Biotechnology,
University of Waterloo

DATE
31 August 2016

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 2018 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, big data science technology including computer science, 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 Sklodowska-Curie Actions Program. It is anticipated that there may be significant joint funding opportunities available 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 personal exchange of researchers CBB and UT.
- A draft Cooperation Agreement that captures aspects of a sustainable communication, confidentially, 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 Canadian-Dutch collaboration in the medical and healthcare domain.

Sincerely,

Professor Dr. T.A.J. Tooman
Dean of Faculty Behavioural Management and Social Sciences
University of Twente

P.O. Box 217, 7500 AE Enschede
The Netherlands
www.utwente.nl
VELOCITY

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 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 difficulty 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,

[Signature]

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.

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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.

![CBB Administrative Structure](image)

**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

<table>
<thead>
<tr>
<th>Ex-officio</th>
<th>Burns Catherine</th>
<th>Dr.</th>
<th>Director, Centre for Bioengineering and Biotechnology</th>
<th>University of Waterloo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member</td>
<td>Cotter Frank</td>
<td>Dr.</td>
<td>VP, Mobile Computing</td>
<td>BlackBerry</td>
</tr>
<tr>
<td>Member</td>
<td>D’Amore Tony</td>
<td>Dr.</td>
<td>VP, Product R&amp;D - Global</td>
<td>Sanofi Pasteur</td>
</tr>
<tr>
<td>Member</td>
<td>Dowd Jason</td>
<td>Dr.</td>
<td>Director, Product Development, Biopharmaceuticals</td>
<td>Apotex</td>
</tr>
<tr>
<td>Member</td>
<td>Fitzgerald Fiona</td>
<td>Ms.</td>
<td>Zone Leader, Life Sciences Canada</td>
<td>GE Healthcare</td>
</tr>
<tr>
<td>Member</td>
<td>Foody Brian</td>
<td>Mr.</td>
<td>President and CEO</td>
<td>IOGEN</td>
</tr>
<tr>
<td>Member</td>
<td>Garcia Luis</td>
<td>Mr.</td>
<td>Chair, Institute of Food Processing Technology</td>
<td>Conestoga College</td>
</tr>
<tr>
<td>Member</td>
<td>Gerson Donald</td>
<td>Dr.</td>
<td>President and CEO</td>
<td>PnuVax SL Biopharmaceuticals, Inc.</td>
</tr>
<tr>
<td>Member</td>
<td>Higgs Gary</td>
<td>Mr.</td>
<td>Integrated Chief Information Officer</td>
<td>St. Mary's and Grand River Hospitals</td>
</tr>
<tr>
<td>Member</td>
<td>Karlsson Tim</td>
<td>Mr.</td>
<td>Director, Emerging Technologies Directorate</td>
<td>Industry Canada</td>
</tr>
<tr>
<td>Member</td>
<td>Moo-Young Murray</td>
<td>Dr.</td>
<td>Distinguished Professor Emeritus, Chemical Engineering</td>
<td>University of Waterloo</td>
</tr>
<tr>
<td>Member</td>
<td>Pinho George</td>
<td>Dr.</td>
<td>President</td>
<td>Christie Medical Division</td>
</tr>
<tr>
<td>Member &amp; Board Chair</td>
<td>Thompson John</td>
<td>Dr.</td>
<td>Associate Vice-President Research, University Research</td>
<td>University of Waterloo</td>
</tr>
</tbody>
</table>
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 Meiering, 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,

[Signature]

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,

[Signature]

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,

[Signature]

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 devise 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,

[Signature]

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 it's 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,

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
Pending approval by Senate Graduate & Research Council on 12 June 2017 meeting, the following items are submitted to Senate for approval.

Further details are available at: https://uwaterloo.ca/secretariat/committees-and-councils/senate-graduate-research-council

FOR APPROVAL

NEW INSTITUTES

Cybersecurity and Privacy Institute

1. **Motion:** To approve the establishment of the Cybersecurity and Privacy Institute, as described in attachment 1.

   **Rationale:** In cryptography, security and privacy, the University of Waterloo has national prominence and a worldwide reputation. By establishing a University-level Institute, the collaboration among the core group of scientists in Combinatorics and Optimization, the Cheriton School of Computer Science, and Electrical and Computer Engineering, will be solidified and extended to include others in related technologies, areas of application, and policy, society and the economy. This interdisciplinary Institute, led by an Executive Director of international stature, will solidify Waterloo’s position as Canada’s leader in cybersecurity and privacy.

Waterloo Artificial Intelligence Institute

2. **Motion:** To approve the establishment of the Waterloo Artificial Intelligence Institute, as described in attachment 2.

   **Rationale:** The extent to which Artificial Intelligence (AI) is now ingrained in science/technology development and increasingly central to everyday life is captured in the report and mission of the One Hundred Year Study on Artificial Intelligence (September 2016). The study’s international cross-sectoral panel aims to review periodically and advise on the impact of developments in AI. AI has been inspired by, but not strictly analogous to, the ways in which humans think and act. AI advances strive to achieve, to ever-greater degrees of efficacy, reliability and safety, the ways in which machines and systems perceive, see, speak, decide, respond, act and plan in an environment. AI questions engage investigators across a range of disciplines—from the computer, statistical and actuarial sciences; to electrical/computer, mechatronics and civil engineering, and systems design; to combinatorics and optimization; cognitive science; psychology; biology; applied health science; economics; political science; and law; among others.

   The development of AI through its direct subcomponent fields and broad applications is advancing rapidly. These encompass technologies in machine learning, statistical learning, data mining and deep-learning training of artificial neural networks; computer vision; natural-language processing; robotics; human-computer interaction; affective computing and sentiment analysis; probabilistic models, knowledge discovery and knowledge representation; optimization and decision making; data analytics; algorithmic game theory and intelligent agents, and the Internet of Things (IoT).

   These advances include establishing rigorous mathematical and algorithmic foundations for the science of machine learning. A core strength of AI at Waterloo and of this University of Waterloo (Waterloo) proposal for The WAII is its focus on operational or application-driven AI research.
This has a crucial benefit, beyond advancing the applications themselves. It allows us to identify – and subsequently overcome – shortcomings in existing AI approaches and so contribute to the foundations of the field.

AI must continue to expand and accelerate its impact, for human well-being, enriched learning and convenience, and economic growth. Consequent applications include but are not limited to: services and software applications across the internet and mobile platforms; monitoring, diagnostics and AI-driven devices in healthcare and home services; autonomous devices and systems on the plant floor and in vehicles; new-media content and processes in digital/film entertainment; Virtual Reality/Augmented Reality (VR/AR) in serious and entertainment gaming and simulations; and whole new smart systems for public safety and security; immigration; and supply-chain efficiencies at international borders.

The Government of Canada, in Budget 2017, has also recognized that AI is a frontier that is inexorably pushing forward, to be explored and mapped through its Pan Canadian AI Strategy. The federal government has cited Waterloo Region as one of four Canadian strategic nodes of expertise for further development, together with the Toronto area, Montreal and Edmonton. Establishing The WAII, therefore, provides a centralized point of reference to give Canada access to research and results from the University of Waterloo node of Canadian AI, and to formalize and profile Waterloo’s advances in the field. Through the proposed WAII, the robust and productive nature of AI as a multidisciplinary science over the shorter and long term will be coupled with Waterloo’s distinct Canadian expertise, in order to fill notable gaps in the translation of “theory into things,” into physical devices and systems. The WAII is, accordingly, proposed as a university-level initiative, co-directed by Waterloo’s Faculties of Engineering and Mathematics.

This proposal to establish an AI institute sits squarely within Waterloo’s current Strategic Plan and its theme of Transformational Research.

NEW PROGRAM

Faculties of Engineering and of Mathematics

3. **Motion**: To approve the Type II Graduate Diploma in Quantum-Safe Cryptography titled “CryptoWorks21 program”, effective 1 September 2017, as described in attachment 3.

**Rationale**: Information security is at the core of information and communication technologies (ICT). Organizations around the world go to great lengths to ensure important information is secure and reliable. As new technologies emerge – such as quantum information processing, which poses novel threats to information security – so too does the need to develop innovative strategies to guarantee data security. Quantum computers will break some of the foundational pieces of our current cybersecurity infrastructure. It is imperative that new cryptography tools designed to be safe in an era with quantum computers be designed, implemented, standardized, tested, and deployed before Quantum computers are available to adversaries. It is therefore critical to develop these cutting-edge tools and train the next generation of Highly Qualified Personnel (HQP) in the field.

The 5-year-old CryptoWorks21 program (NSERC CREATE Training Program in Building a Workforce for the Cryptographic Infrastructure of the 21st Century) have been preparing this new generation of HQP to pioneer a new global infrastructure for quantum-safe cryptography. It is hosted by the University of Waterloo’s Centre for Applied Cryptographic Research (CACR) and the Institute for Quantum Computing (IQC). Since the program inception in 2012, the Program Director, Professor Mosca alongside industry and academic partners and
collaborators have developed and delivered two important training programs: a Specialized Technical Skills and a Specialized Professional Skills program. These complementary programs have been preparing students in the CryptoWorks21 (CW21) program ready to tackle forthcoming Cryptographic challenges. The training programs have brought together researchers, organizations and industry members from a wide range of areas and expertise to ensure Canada’s HQP lead the current market for emerging technology research and development.

/ar
Jeff Casello
Associate Provost, Graduate Studies

George Dixon
Vice President, University Research
June 2, 2017

Professors George Dixon and Jeff Casello
Senate Graduate and Research Council
University of Waterloo

Re: Establishment of the Cybersecurity and Privacy Institute

Dear Professors Dixon and Casello,

As the Chair of the Steering Committee for the formation of the Cybersecurity and Privacy Institute (CPI), I am enthusiastically requesting the Senate Graduate & Research Council recommend Senate approval to establish CPI as a University-level institute.

The steering committee has representation among the cybersecurity and privacy researchers in the Department of Combinatorics and Optimization, Cheriton School of Computer Science, Department of Electrical and Computer Engineering, and IQC. Representatives from each faculty involved in work related to the research and application of security and privacy, behavioural issues, policy-making, and so on, have contributed strongly on the Steering Committee. Other members include representation from the Office of Research, Advancement, Engineering Research, and the Institute for Computer Research.

As described in the attached proposal, Waterloo has an exciting opportunity to form a multidisciplinary and collaborative CPI University-level Institute that will exceed any similar efforts elsewhere in Canada. Our achievements and reputation in cryptography, cybersecurity and privacy are world-class. Most of the researchers in our two relevant research groups, the Centre for Applied Cryptographic Research (CACR) and the Cryptography, Security and Privacy research group (CrySP) are excited about the potential for multi-disciplinary work with researchers who apply security and privacy in domains, create new technologies to be secured, or investigate relevant human and societal issues.

Over the past eighteen months, while the CPI Steering Committee has been defining the Institute, companies have been approaching Waterloo about collaborative research in security and privacy. Aware of Waterloo’s reputation in security and privacy, underlying mathematics, data science, usability, systems and ICT in general, they expect we would have a multi-themed holistic approach to this significant challenge. Waterloo can also play a leadership role in advancing Canada’s ability to
address the adoption of quantum-safe cryptosystems, resulting in standardization and export.

I strongly encourage the Council to recommend the establishment of the Cybersecurity and Privacy Institute as one of Waterloo’s University-level institutes.

Respectfully submitted,

Stephen Watt

Chair, Cybersecurity and Privacy Steering Committee
Dean, Faculty of Mathematics
Cybersecurity and Privacy Institute (CPI) – A Proposal to Establish a University-level Research Institute

Summary:
In cryptography, security and privacy, the University of Waterloo has national prominence and a worldwide reputation. By establishing a University-level Institute, the collaboration among the core group of scientists in Combinatorics and Optimization, the Cheriton School of Computer Science, and Electrical and Computer Engineering, will be solidified and extended to include others in related technologies, areas of application, and policy, society and the economy. This interdisciplinary Institute, led by an Executive Director of international stature, will solidify Waterloo’s position as Canada’s leader in cybersecurity and privacy.

What Is Being Proposed:
We seek a recommendation from the Senate Graduate & Research Council for Senate approval to establish the University-level institute called the Cybersecurity and Privacy Institute.

This Institute would have ~88 regular faculty members representing all UW Faculties. Currently, the break-down is approximately as follows:

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An list of initial and potential initial members is provided in Appendix A.

Characteristics of a University-Level Institute:
Under Waterloo’s Policy 44, University Research Institutes are cross-Faculty, University-supported research units that facilitate collaborative research across departments, schools and faculties, as well as international research collaborations.

There are currently four approved University institutes:
IQC (Institute for Quantum Computing)
WIN (Waterloo Institute for Nanotechnology)
WISE (Waterloo Institute for Sustainable Energy)
The Water Institute

The advantages to CPI of being a University-level institute include the expectation of an international search for an Executive Director and the provision of ~$300K from the University each year, based on a successful strategic budget prepared by CPI’s Executive Director, to support the institute’s operation.
Timing of the Establishment of the Institute—Why Now?
Waterloo has decades of achievement in cryptography, beginning with the late FRS Bill Tutte, who was named to the Order of Canada for his contributions to cryptography research labelled as “the greatest intellectual feat of the Second World War”, to the creation of the Centre for Applied Cryptographic Research (CACR), the spin-off of Certicom and the broadening into privacy and privacy enhancing technologies with the formation of the Cryptography, Security and Privacy (CrySP) research group. (CACR and CrySP will be federated with CPI) Several accomplishments of these cybersecurity and privacy researchers are summarized in Appendix B.

Cybersecurity and privacy are growing in importance as business moves to the Internet, with big data analytics enabling new kinds of services and opportunities. The Internet of Things, and its looming use in integrated transportation systems, autonomous driving, advanced manufacturing and elsewhere add pressure. Customers are seeing breaches in their credit card and identity information on a monthly basis in the news. New information processing paradigms, including the shift to the cloud, exacerbate the threat of attacks.

Many of the problems in securing information and preserving privacy are not purely technical, and members of CACR and CrySP are seeking connection with researchers in other disciplines to collaborate on issues in application of security, policy-making, behavior of users/hackers/insiders, etc.

The recent decision to apply for a Canada Excellence Research Chair in next-generation cryptographic technologies, and the preparation of proposals to the last round of CERC (in cybersecurity and privacy) and the first round of CFREF, have also created a desire for a larger multidisciplinary cybersecurity and privacy research institute, which would be a natural home for the CERC and related new faculty hires, and would amplify their research efforts.

Two of Canada’s banks, and several other large companies, have approached Waterloo seeking research collaborations in topics such as intrusion detection, privacy enhancing technologies, etc. The CPI would play an active role in coordinating and maximizing such opportunities in the future, including possibly hosting some research staff who could attend to the day-to-day interaction with companies and solidify the relationships.

Other Canadian universities are mobilizing to create centres in cybersecurity and privacy. University of New Brunswick, Carleton and Calgary all have research centres with sizable Web presence. Ryerson has hired Ann Cavoukian, the previous Privacy Commissioner for Ontario, and has a Privacy and Big Data Institute. Benoit Dupont, a criminologist from University of Montreal, formed SERENE, a federally-funded knowledge-mobilization National Centre of Excellence, to work with government and companies to provide a safer online experience and promote privacy. ($1.6m for 2014–2018 for about a dozen researchers.) Benoit is rumored
to be preparing a full NCE application. (~$25m for 5 years.)

The Institute for Quantum Research has uniquely positioned Waterloo to lead in quantum-safe cryptography, with several Waterloo researchers now tackling aspects of this problem. Spin-off companies are forming to address the opportunities created by the potential for quantum computers to accelerate cryptographic attacks and effectively break current cryptosystems in the foreseeable future. Prof. Michele Mosca has engaged the financial industry and government policymakers in discussions about the importance of addressing this threat and the opportunity to export solutions. This Institute could help press government to take action to mobilize the quantum-safe agenda.

As the federal government implements their economic cluster policy, there is talk of a Fintech and Cybersecurity cluster in the Toronto/southern Ontario area, and a vibrant CPI would be an advantage for our involvement in such a cluster.

**Progress to Date:**
Stephen Watt has been chairing a Steering Committee for the formation of CPI, with representation from CACR, CrySP, ECE, each Faculty, Advancement, and the Office of Research. This has resulted in a shared vision of the University-level institute and the draft CPI constitution in Appendix C. Representatives from each faculty have put initial efforts into engaging researchers to become members, and 32 of the 88 potential members in Appendix A have already agreed.

Each of the Deans have provided letters enthusiastically supporting the formation of this University-level Institute, provided in Appendix D. The Chair of the Department of Combinatorics and Optimization, the Chair of the Department of Electrical and Computer Engineering, and the Director of Computer Science, have also provided letters.

The VP University Research and the Associate VP Research are both very enthusiastic about the formation of the Institute, in part because of the importance of cybersecurity and privacy at this time and into the future.

**Plan for the Executive Director’s Office:**
Waterloo will recruit an Executive Director, who is a cybersecurity and privacy researcher of international stature, who may be an internal or external candidate. If an external candidate, the candidate will become a faculty member at Waterloo. The CPI Steering Committee is responsible to conduct the search, and may form a subcommittee to perform the search itself. There are perhaps synergies with the search for the CERC in Next Generation Cryptographic Technologies which can benefit the CPI search.

The Executive Director will hire a managing director for activities and collaboration, and a communications person who also does some administration and accounting.
Research:
There are several research benefits and opportunities made available by the establishment of CPI, including:

- The emphasis on multidisciplinary research, and activities to promote it, will create more collaboration across faculties. This will also provide a richer environment for the training of multi-faceted HQP.
- CPI’s existence is evidence of the strategic importance of cybersecurity and privacy at Waterloo, which will aid principal investigators in competing for tri-council and other funding.
- The Executive Director’s office, and the activities undertaken by CPI, will provide “one stop shopping” for companies and government agencies interested in approaching Waterloo about security and privacy. This will result in more opportunity for researchers in CPI.
- Waterloo has pursued several institution-level grant opportunities in the last five years in security and privacy. The creation of CPI will provide a natural locus for future applications.
- Discussions and ideas bounced among CPI researchers will benefit research enormously. CPI increases Waterloo’s potential to secure data and communication networks, used for government, industry, health and transportation, against unknowable future threats by: changing the way people think about privacy; creating algorithms to provide services without keeping personal data subject to exfiltration; discovering ways to process encrypted information; and inventing quantum-safe cryptosystems.

Success targets include:

- Increasing the external funding available for security and privacy research from the ~$4.5m per year for the 22 researchers linked with the CERC proposal to an annual amount of $10m per year for the total of all CPI researchers at the end of CPI’s first five years.
- Initiating significant collaborations between technology researchers in Math and Engineering with researchers in each of the other faculties.
- Building on the momentum initiated by the $2m (total for three years) relationship with RBC, to create significant external sponsored research relationships with three other companies in the first five years of CPI.
- Succeeding at one or more institution-level grants such as a SSHRC Partnership Grant, a CFREF award, an NSERC Research Network, or a large CFI facility.

Facilities:
CPI will have distributed facilities, including lab space available to members of groups federated with CPI, such as CrySP, which has it’s own lab and a world-scale privacy enhancing technologies testbed, called RIPPLE, CFI-funded (~$2m) and operated by SHARCNet. As part of the CPI collaboration with RBC, RBC will provide $280K in 2017 to update and upgrade the RIPPLE facility. CACR (another federated group) has members in the Department of Combinatorics and Optimization, the
Cheriton School of Computer Science and the Department of Electrical and Computer Engineering, where researchers have labs provided by their departments. For example, in ECE, Profs. Guang Gong and Mark Aagaard lead the Communications Security Lab. Catherine Gebotys heads a laboratory for side-channel attacks on embedded systems and smartphones.

As part of the CERC application, the Faculty of Mathematics has proposed 10,000 square feet of office, meeting rooms and lab facilities, initially in the Math and Computer Building. This will be one of CPI’s primary locations and the Faculty of Mathematics will provide extra office space for the CPI Executive Director and the two staff members in the Director’s Office if needed.

Budget:
Currently, the external funding available for security and privacy research, for the 22 researchers linked with the CERC proposal, averages about $4.5m per year, including tri-council, industry funds, and large institutional awards such as CFI.

We intend to increase this annual funding to $10m per year for the total of all CPI researchers (88 researchers) at the end of CPI’s first five years. We don’t have a baseline for the 88 researchers now. It might appear that 22 of 88 researchers are now averaging $4.5m/yr so 88 researchers would probably bring in more than $10m/yr now, but we have captured the highest flyers, who are solely focused on security and privacy, in the 22 researchers in the CERC.

The early formation of CPI has already helped create a $1.8m collaboration with RBC (including sponsorship for research, the CyberWorks21 CREATE program, the RIPPLE facility upgrade and a meeting area on-campus to collaborate with RBC’s security researchers and data scientists.) The table below provides an estimate of incremental income and expenses related to the activities of CPI.

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Appendix A: List of Potential Members
(32 have already confirmed their membership)

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Impacts of Security and Privacy on Policy, Society and the Economy

Kelly Anthony
School of Public Health/Health Systems
AHS

Efrim Boritz
School of Accounting & Finance
Arts

Phillip Boyle
Sociology and Legal Studies Dept.
Arts

Lorne Dawson
Sociology and Legal Studies Dept.
Arts

Kathryn (Kate) Henne
Sociology and Legal Studies Dept.
Arts

Vanessa Iofolla
Sociology and Legal Studies Dept.
Arts

Veronica Kitchen
Political Science
Arts

John McLevey
Knowledge Integration
Environment

Bessma Momani
Political Science
Arts

Plinio Morita
School of Public Health/Health Systems
AHS

Daniel O'Connor
Sociology and Legal Studies Dept.
Arts

Marcel O'Gorman
English Language and Literature
Arts

Jennifer Whitson
Sociology and Legal Studies Dept.
Arts

John Yard
School of Accounting & Finance
Arts

Integrity of Infrastructure

Mark Aagaard
ECE
Engineering

Otman Basir
ECE
Engineering

Dan Berry
SCS
Mathematics

Slim Boumaiza
ECE
Engineering

Timothy Brecht
SCS
Mathematics

Peter Buhr
SCS
Mathematics

Charles Clarke
SCS
Mathematics

Gordon Cormack
SCS
Mathematics

Krzysztof Czarnecki
ECE
Engineering

Nancy Day
SCS
Mathematics

Werner Dietl
ECE
Engineering

Ehab El-Saadany
ECE
Engineering

Sebastian Fischmeister
ECE
Engineering

Michael Godfrey
SCS
Mathematics

Wojciech Golab
ECE
Engineering

Pin-Han Ho
ECE
Engineering

Jesse Hoey
SCS
Mathematics

Martin Karsten
SCS
Mathematics

Amir Khandani
ECE
Engineering

Patrick Lam
ECE
Engineering

Kate Larson
SCS
Mathematics

Ondrej Lhotak
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Mathematics
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<td>Peter VanBeek</td>
<td>SCS</td>
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<td>Stephen Watt</td>
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<td>Bernard Wong</td>
<td>SCS</td>
<td>Mathematics</td>
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<tr>
<td>Weihua Zhuang</td>
<td>ECE</td>
<td>Engineering</td>
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</tbody>
</table>
Appendix B: Some Notable Accomplishments of Cybersecurity and Privacy Researchers at Waterloo

• Cryptanalysis work by Scott Vanstone and Ron Mullin found a vulnerability in a discrete logarithm cryptosystem chip that HP intended to bring to market in the 1980s. Soon afterwards, they were joined by Gordon Agnew and Ian Blake from ECE, and they focused on the use of elliptic curves for public key cryptosystems. This led to the foundation of the Centre for Applied Cryptographic Research (CACR).

• Interest in the robustness of classic cryptography in a world with available quantum computing was a partial attraction for the first quantum researchers at Waterloo, who seeded the formation of the Institute for Quantum Computing.

• A digital signature scheme for the protection of data, giving partial message recovery, based on elliptic curves, developed by Vanstone and Pitney-Bowes industry collaborator Pintsov, and adopted as an ANSI standard in 2009.

• A scheduling algorithm for the Tor anonymity-preserving network, based on the exponentially weighted moving average for the number of cells sent on each circuit, was adopted by Tor in 2010.

• Off-The-Record Messaging (OTR) has been widely adopted, implemented and extended, to provide security and privacy for instant messaging (IM) networks.

• Key results in quantum communication, including proof that zero-knowledge protocols are secure against quantum attack.
Appendix C: 
Cybersecurity and Privacy Institute 
Draft Constitution

The Cybersecurity and Privacy Institute (CPI) is a University Research Institute as defined in the University of Waterloo Policy 44 on Research Centres and Institutes, anticipated to be approved by Senate on the recommendation of the Senate Graduate & Research Council.

Mission: To facilitate collaborative research in cybersecurity, privacy and cryptography, across the entire University and with companies, research centres and other institutions in Canada and internationally.

Objectives:
- To extend Waterloo’s strength and impact in cybersecurity and privacy
- To strengthen existing research collaborations among departments, schools and faculties, and foster new collaborations, to broaden the research and impact of Waterloo researchers in all topics related to cybersecurity and privacy
- To foster external research collaborations with companies, research centres and others, where appropriate
- To facilitate application for institutional-level grants, such as CFI, ORF, CERC, CFREF, CRC and other grants, to build on Waterloo’s long-term strength and more recent growth in the research and application of cybersecurity and privacy
- To increase the visibility and strength of Waterloo’s cybersecurity and privacy research to attract the best new faculty and HQP

Structure:
The organizational structure of the Cybersecurity and Privacy Institute will comprise:

Members, who are faculty members from all Faculties, whose research is primarily focused on cybersecurity or privacy, or whose research impacts, applies, or studies the impact of, cybersecurity and privacy.

Federated Groups which are UW research labs, groups, centres or institutes primarily focused on cybersecurity or privacy. Normally all members of such groups would be eligible to be members of CPI, based on their research.

Executive Director, who is a cybersecurity and privacy researcher of international stature, who is also a faculty member.
Management and Administration Staff, which will include a managing director for institute activities and collaborations, and a communications coordinator/administrative assistant, all of whom report to the Executive Director. Research staff may be hired as needed, to support initiatives with industry and other receptors.

**Initial Membership:**
More than 75 individual faculty members, from all faculties.

Two Federated Groups initially, namely the Centre for Applied Cryptographic Research (CACR) and the Cryptography, Security and Privacy Research Group (CrySP).

**Reporting Structure and Board Composition:**
In accordance with Policy 44, the Executive Director will report to the CPI Board of Directors which will be chaired by the Vice President University Research, or her or his designate.

The CPI Board of Directors includes:
- Vice President University Research (Chair)
- Dean of Mathematics (ex-officio)
- Dean of Engineering (ex-officio)
- Dean of Arts (ex-officio)
- One other Dean, chosen from the Deans of Science, Environment and AHS (ex-officio)
- Executive Director of CPI
- A representative of CrySP Research Group
- Director of CACR
- 3 Members-at-Large

The director position for one of the Dean of Science, Dean of Environment and Dean of AHS will rotate every two years, with selection made by the Chair of the Board.

The three Members-at-Large will be nominated by a subcommittee of the Board, and elected by a majority of the Board members. One will be replaced each year, so the duration at steady state is three years. One principle to be followed in the nominations is to help ensure representation from a breadth of research interests across the Institute. Another principle is to meet the diversity and gender targets of the University in selecting the representatives.

**External Advisory Board**
The External Advisory Board, consisting of up to six notable experts from the public sector, industry and academia, will offer an independent prospective on progress towards institute goals, recommendations on achieving greater reputation and impact, and advice on research topics and expertise. The External Advisory Board
will advise on ways to enhance our reputation and recognition as an international cybersecurity and privacy innovation centre.

Criteria for Membership:
While membership is not a right, it is expected it will not be unduly withheld.

All faculty members whose research is related to cybersecurity and privacy, by advancing the science and technology, by applying cybersecurity and privacy, or by studying the impact of security and privacy on society, policy or the economy, are eligible for membership. For example, sociologists studying the behavior of hackers or insiders who provide access to intruders would be welcome as members. Policy experts who are curious about the formation of national policy relating to anonymity of customers, ownership of social media content or regulation about the adoption of quantum-safe cryptosystems would be welcome. Actuarial scientists studying risk in cyberinsurance would be eligible for membership. Software engineers building more robust software with an eye to reducing vulnerabilities and intrusion are also welcome.

Benefits and Responsibilities of Membership:
Members will benefit from the interdisciplinary relationships, awareness and collaboration made possible by the existence and activities of the Institute. The Executive Director, the Management and Administration staff, and others, will form a comprehensive single point of contact for external inquiries, collaborations and sponsorships about cryptography, security and privacy, which will create more opportunities for members. The cohesive research approach and multidisciplinary breadth made possible by the Institute will enable members to undertake research where each individual complements the others.

Members will be responsible to advance Waterloo's overall agenda in cybersecurity and privacy, by participating as enthusiastic members of the Institute. This includes participating in Institute activities to communicate research results, interact with research sponsors, and become aware of receptor organizations’ security and privacy needs. Members are expected to act as ambassadors by communicating the breadth and excellence of the work of Institute members in a positive way.

External Collaborative Research Sponsorships and Financial Responsibility:
The existence of CPI and the activities of members, the Executive Director and the Management and Administrative staff will increase the amount of external collaborative research funding, and hence the research capacity of the entire Institute.

For research sponsorships where CPI’s members, Executive Director and Management and Administrative Staff have had a significant role, the overhead on the sponsorship funds can be split, at the discretion of the relevant Dean(s) as noted on the UW Cover Sheet.
Appendix D:
Letters of Support
May 25th 2017

Senate Graduate and Research Council
University of Waterloo

Re: Establishing the Cybersecurity and Privacy Institute

Dear SGRC,

I am pleased to endorse the establishment of the Cybersecurity and Privacy Institute as a University-level institute. Security and privacy are strategically important topics, in which Waterloo researchers in both Engineering and Mathematics have distinguished themselves and created an international reputation for the University. The importance of security and privacy for the Internet of Things, autonomous driving, advanced manufacturing and other emerging technologies means the time has come for a University-level institute to draw together researchers from all faculties to amplify Waterloo’s significant strength in this area.

Engineering’s involvement in cryptography dates back to the 1980s when ECE Prof. Ian Blake (emeritus) collaborated with C&O Profs. Vanstone and Mullin on elliptic curves for public key cryptosystems, and ECE Prof. Gordon Agnew helped with the formation of spin-off companies leading to the formation of Certicom.

Engineering currently has over 30 faculty members involved in software and hardware aspects of cryptography, cybersecurity, privacy and infrastructure integrity. They have active research programs in a range of areas including design, implementation, and optimization of cryptographic circuits; cryptography and system security; software security; security for embedded systems; security and privacy for Internet of things, mobile devices, cloud, RFID, and machine-to-machine communications; cloud security, applied cryptography; cryptographic random number generators; secure vehicular communications and access control.

The creation of the Cybersecurity and Privacy Institute will strengthen multidisciplinary research among experts in all faculties. An active Executive Director, leading a small but effective centre staff, will provide a useful single point of contact for companies and organizations wishing to work with Waterloo, creating optimal multifaceted engagements with researchers across the University. Often when meeting with corporate leaders in Canada and overseas, opportunities have arisen to partner on security - an internal organization at Waterloo will build momentum and further expand research opportunities for the wider research community.
With the proliferation of networked communication and data collection and sharing, the availability of implementable cybersecurity and privacy solutions will be pivotal not just for the business community but also for all aspects of society. Given the critical mass of researchers across the University, we anticipate that the new institute will have a significant impact in a short time. Engineering fully supports the establishment of this Institute at the University level.

 Yours very truly,

[Signature]

Pearl Sullivan
Professor and Dean
Faculty of Engineering
May 22, 2017

Dr. George Dixon
Vice-President, University Research
University of Waterloo

Re: Establishing the Cybersecurity and Privacy Institute

Dear George:

I write to express my full support for the proposed Cybersecurity and Privacy Institute.

The Faculty of Science is an active member of the global race to quantum cybersecurity via satellites, space-related emerging technologies, and space-based research which has led to incredible technologies here on the ground. Fundamental to this pursuit is robust cybersecurity research.

To this end, the creation of a collaborative research institute for cybersecurity, privacy, and cryptography that would combine the talents of researchers across the University, industry, and research centres is timely and critical.

The Faculty looks forward to being a participating member of the Institute through the involvement of:

- Raymond Laflamme, Institute for Quantum Computing
- Norbert Lütkenhaus, Dept. of Physics and Astronomy
- Thomas Jennewein, Dept. of Physics and Astronomy

Sincerely,

Robert P. Lemieux
Dean of Science
Dr Stephen Watt,
Dean, Faculty of Mathematics
University of Waterloo

16 May 2017

Dear Dr Watt:

I am delighted to provide this letter of support for the initiative being championed by your Faculty to establish a university-wide research institute in the area of cybersecurity. Each day we see further evidence of just how topical a field this is, and given our historic strengths, it is a most welcome and timely proposal. The Cybersecurity and Privacy Institute builds upon our extensive expertise in these areas, and particularly the depth and breadth of our research programs, and will strengthen our position as an international leader in cybersecurity. More to the point, a university institute will provide a welcome catalyst to fostering greater multidisciplinary and transdisciplinary research. There are a number of researchers in Arts, many of whom have been recently hired, who are eager to participate in the Institute’s activities.

Sincerely

Douglas M Peers, PhD FRHS
Dean of Arts

cc. Dr Tim Kenyon, Associate Dean Research
May 31, 2017

Re: Support for proposed Cybersecurity and Privacy Institute

I am writing to offer my support for the establishment of a Cybersecurity and Privacy Institute. University of Waterloo has emerged as a national and global leader in this area of scholarship – an area that is critical to the everyday lives of people as well as business and nations.

Our Faculty looks forward to working with colleagues in mathematics and other experts on campus in building this institute and amplifying our collective research in this area.

Sincerely,

Jean Andrey
Dean, Faculty of Environment
TO: George Dixon, Vice-President, University Research
FROM: James W.E. Rush, Dean of Applied Health Sciences
DATE: May 17, 2017
SUBJECT: Cybersecurity and Privacy Institute (CPI)

On behalf of the Faculty of Applied Health Sciences, I am writing to show my enthusiastic support for the establishment of the Cybersecurity and Privacy Institute (CPI).

Once in place, this Institute will help to address critical issues in the realm of security and privacy, building on University of Waterloo expertise in this area and coming from multiple perspectives. The proposed interdisciplinary team and strong international leadership would contribute to capitalizing on and leveraging opportunities that are already coming to the university.

I believe that there is and will continue to be University-wide interest and engagement in CPI.
May 20, 2017

Senate Graduate and Research Council
University of Waterloo

Re: Establishing the Cybersecurity and Privacy Institute

Dear Council,

As the Director of the Cheriton School of Computer Science, I am writing to express my strong support for the formation of the Cybersecurity and Privacy Institute as a University-level institute. The School is home to the Cryptography Security and Privacy (CrySP) research group, which will be federated with CPI, and other researchers who have collaborated with the Centre for Applied Cryptographic Research (CACR). In the last few years security and privacy has been a priority area for new hires, and we are participating in the formulation of the current CERC for Next Generation Cryptographic Technologies, with the associated four new faculty positions. Security and privacy research is certainly high-profile and high impact, and involves computer science researchers with backgrounds in data science, machine learning and software engineering, among others.

CPI's activities will create new opportunities for researchers to work with industry, get industry support and lever that support with government at both the provincial and federal levels. This will help us attract new faculty members in security and privacy along with more high-quality graduate students.

Security and privacy are broad areas where researchers benefit greatly from multidisciplinary collaborations. Many of the presentations in the CrySP group, by external speakers, describe societal issues involving digital safety, privacy, anonymity, and access and control of information. There is an appetite at Waterloo to combine mathematicians and computer scientists with sociologists, behavioural specialists and policy experts to perform important work in privacy and security within the Cybersecurity and Privacy Institute.

Yours truly,

Mark Giesbrecht,
Professor and Director
Cheriton School of Computer Science
May 29, 2017

Senate Graduate and Research Council
University of Waterloo

Re: Cybersecurity and Privacy Research Institute

Dear Professor Watt,

I am supplying a letter in strong support of establishing the Cybersecurity and Privacy Institute.

Cryptography as a subject of investigation in the C&O department began in the 1980s with Profs. Ron Mullin and Scott Vanstones 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. New faculty joined C&O, partially because of the opportunity to work with these leaders in cryptosystems, including Profs. Alfred Menezes and David Jao. David Jao now directs CACR and is a world leader in the field of isogeny-based cryptography. Alfred Menezes is one of the inventors of an authenticated protocol for key agreement, known as MQV, which was adopted by the U.S. National Institute of Standards and Technology (NIST).

The C&O department was successful in recruiting Prof. Michele Mosca, after his Ph.D. in quantum algorithms at Oxford University, by partnering with St. Jeromes University. He began a quantum algorithms group at Waterloo, and met with Mike Lazaridis to make ambitious plans for quantum computing research, culminating in the formation of IQC. One vibrant aspect of IQCs research quantum cryptography and the need to secure conventional cryptosystems from future attacks using quantum computing. Prof. David Jao, an expert in mathematical cryptography, has teamed with Prof. Mosca to develop and commercialize quantum-safe public-key cryptosystems. In 2012, Prof. 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.

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 departments. Im sure that the momentum and growth related to the formalization of the Cybersecurity and Privacy Institute will create more opportunities in the decades to come.

Yours sincerely,

Jochen Koenemann
Professor and Chair, C&O
Memorandum

To: Members
Senate Graduate and Research Council

From: Dave Dietz
Director, Research and External Partnerships

Date: 26 May 2017

Subject: Waterloo Artificial Intelligence Institute Proposal

Please find attached the proposal to create the Waterloo Artificial Intelligence Institute for presentation at the UW Senate meeting on June 19. Documents supporting the proposal and also attached are:

- An email confirming funding support from Dean of Engineering Pearl Sullivan, Dean of Math Stephen Watt, and Provost Ian Orchard
- A letter of support from Dean of Engineering Pearl Sullivan
- Brief CVs of professors in the Math and Engineering faculties who will be key academic members of the institute
- A letter of support from Dean of Math Stephen Watt.
Thanks Pearl. Yes, happy to match with $100K per year for 5 years. Best Ian

Ian Orchard
Vice-President, Academic and Provost
University of Waterloo
200 University Ave, W
Waterloo, ON, Canada  N2L 3G1

From: Pearl Sullivan
Sent: Wednesday, April 12, 2017 4:43 PM
To: Vice Pres Academic Provost
Cc: Stephen Watt; Rick Culham
Subject: Waterloo AI Institute

Dear Ian,

Aside from the pan-Canadian AI developments shared in my email this morning, Math and Engineering have agreed to create a “Waterloo AI institute” to establish our own identify in AI research and to begin an intensive industry engagement program. We hope to have the proposal ready for Senate consideration in June.

Engineering and Math will each contribute $50k per year for 5 years. We are requesting your support to match our funds at the level of $100k per year for 5 years.
In addition to our two faculties, we already have researchers from Environment, Arts and Science expressing interest in involving AI in their research and participating in this institute.

Your support for this initiative would be most appreciated. Thank you for your consideration.
Regards,
Pearl
Proposal to Establish

The Waterloo Artificial Intelligence Institute (The WAII)

At the University of Waterloo

May 8, 2017
Contents

1. Name ....................................................................................................................................... 3
2. Overview ................................................................................................................................. 3
   2.1 Background and Rationale (Importance, Benefit Internationally, Nationally, Regionally) .. 3
   2.2 Mission ............................................................................................................................. 4
   2.3 Scope of Activities .......................................................................................................... 4
3. Constitution ............................................................................................................................ 5
   3.1 Objectives ....................................................................................................................... 5
   3.2 Organizational Structure ............................................................................................... 5
      3.2.1 Steering Committee ................................................................................................. 5
      3.2.2 Director ................................................................................................................... 6
      3.2.3 Advisory Board ....................................................................................................... 6
   3.2.4 Membership Categories and Criteria ....................................................................... 7
4. Management ............................................................................................................................... 7
   4.1 Financial Responsibility ................................................................................................. 7
   4.2 Reporting Mechanisms ................................................................................................. 7
5. Listing of Proposed Members ................................................................................................. 8
6. Research/Educational Component ......................................................................................... 8
   6.1 Waterloo’s Research Distinction and Opportunities for Collaboration ......................... 8
   6.2 Waterloo’s Approach to Addressing AI Challenges .................................................... 9
   6.3 Impact ............................................................................................................................ 10
   6.4 Talent ........................................................................................................................... 10
   6.5 Education ...................................................................................................................... 11
7. Facilities and Collaborators ................................................................................................... 11
   7.1 Institutional Collaborators and Facilities .................................................................... 11
   7.2 External Academic Collaborators .............................................................................. 12
8. Budget ................................................................................................................................... 13

Appendix 1 – WAII Membership ................................................................................................. 14
1. Potential Academic Members .............................................................................................. 14
2. Potential Initial Industry Affiliate Members ....................................................................... 16
Appendix 2 – Recent and Ongoing AI Project Highlights at Waterloo ..................................... 18
1. Name
The Waterloo Artificial Intelligence Institute (The WAII)

2. Overview

2.1 Background and Rationale (Importance, Benefit Internationally, Nationally, Regionally)

The extent to which Artificial Intelligence (AI) is now ingrained in science/technology development and increasingly central to everyday life is captured in the report and mission of the One Hundred Year Study on Artificial Intelligence (September 2016). The study’s international cross-sectoral panel aims to review periodically and advise on the impact of developments in AI. AI has been inspired by, but not strictly analogous to, the ways in which humans think and act. AI advances strive to achieve, to ever-greater degrees of efficacy, reliability and safety, the ways in which machines and systems perceive, see, speak, decide, respond, act and plan in an environment. AI questions engage investigators across a range of disciplines—from the computer, statistical and actuarial sciences; to electrical/computer, mechatronics and civil engineering, and systems design; to combinatorics and optimization; cognitive science; psychology; biology; applied health science; economics; political science; and law; among others.

The development of AI through its direct subcomponent fields and broad applications is advancing rapidly. These encompass technologies in machine learning, statistical learning, data mining and deep-learning training of artificial neural networks; computer vision; natural-language processing; robotics; human-computer interaction; affective computing and sentiment analysis; probabilistic models, knowledge discovery and knowledge representation; optimization and decision making; data analytics; algorithmic game theory and intelligent agents, and the Internet of Things (IoT). These advances include establishing rigorous mathematical and algorithmic foundations for the science of machine learning. A core strength of AI at Waterloo and of this University of Waterloo (Waterloo) proposal for The WAII is its focus on operational or application-driven AI research. This has a crucial benefit, beyond advancing the applications themselves. It allows us to identify—and subsequently overcome—shortcomings in existing AI approaches and so contribute to the foundations of the field.

AI must continue to expand and accelerate its impact, for human well-being, enriched learning and convenience, and economic growth. Consequent applications include but are not limited to: services and software applications across the internet and mobile platforms; monitoring, diagnostics and AI-driven devices in healthcare and home services; autonomous devices and systems on the plant floor and in vehicles; new-media content and processes in digital/film entertainment; Virtual Reality/Augmented Reality (VR/AR) in serious and entertainment gaming and simulations; and whole new smart systems for public safety and security; immigration; and supply-chain efficiencies at international borders.
The Government of Canada, in Budget 2017, has also recognized that AI is a frontier that is inexorably pushing forward, to be explored and mapped through its Pan Canadian AI Strategy. The federal government has cited Waterloo Region as one of four Canadian strategic nodes of expertise for further development, together with the Toronto area, Montreal and Edmonton. Establishing The WAII, therefore, provides a centralized point of reference to give Canada access to research and results from the University of Waterloo node of Canadian AI, and to formalize and profile Waterloo’s advances in the field. Through the proposed WAII, the robust and productive nature of AI as a multidisciplinary science over the shorter and long term will be coupled with Waterloo’s distinct Canadian expertise, in order to fill notable gaps in the translation of “theory into things,” into physical devices and systems. The WAII is, accordingly, proposed as a university-level initiative, co-directed by Waterloo’s Faculties of Engineering and Mathematics.

This proposal to establish an AI institute sits squarely within Waterloo’s current Strategic Plan and its theme of Transformational Research. The theme’s goals are: to identify and seize opportunities to lead in new/emerging areas; to enable conditions that support excellence and impact; to increase interdisciplinary/transdisciplinary research; and to build greater awareness, nationally and globally, of Waterloo’s research productivity and impact. The WAII will embed the active involvement of internal academic membership, coalescing a powerful network of researchers and their teams. Engaged members for the purposes of both foundational and operational AI will include computer science, statistics and actuarial sciences, combinatorics and optimization science; management sciences, electrical and computer, mechanical and mechatronics, systems design, civil and environmental, and chemical engineering; public health, health systems, biology, chemistry, earth and environmental sciences, and physics and astronomy (See Appendix 1 - Membership for details).

2.2 Mission

The WAII will cohere, advance, promote and exploit cross-disciplinary research at the frontiers of artificial intelligence and its applications at the University of Waterloo.

2.3 Scope of Activities

Under its mission, broadly, The WAII will focus on leveraging Waterloo’s pioneering advances and productive industry partnerships for social and economic benefit, supported by cross-disciplinary expertise and laboratory resources. The WAII will do this through formalizing and coordinating AI research among cross-disciplinary researchers on an identified-project basis.

The WAII’s goals in research will be:

- To catalyze fundamental research in the Faculty of Mathematics and the Faculty of Engineering, as well as applied-research applications across multiple Waterloo disciplines
- To meet end-user and receptor needs (through research/contract agreements and projects, demonstration/validation projects, knowledge-dissemination tactics)
- To enrich and support interdisciplinary research and R&D training of highly qualified personnel (HQP)
• To provide leadership on key external funding opportunities that would benefit The WAII’s research. The WAII will identify AI-specific avenues of support and remuneration that go beyond, while still including, existing research funding programs to identified faculty members and teams (e.g., NSERC CREATE, NSERC-SPG for Networks, ORF-RE, etc.)

The WAII, over the short and long term, will lead and foster outreach to achieve partnerships and collaboration:

• Within and among industry subsectors in AI for end-to-end technologies
• Among Waterloo HQP, researchers and industry partners
• With public-sector and other stakeholders nationally, provincially and regionally
• And with Canada’s other main centres of expertise in AI

The WAII will bring profile to the University of Waterloo (Waterloo):

• Through increasing the visibility of Waterloo AI in media, public and scholarly fora
• Through focusing on positioning Waterloo AI for global recognition in strategic areas of expertise

3. Constitution

3.1 Objectives

The WAII’s objectives will be to:

1. Advance the institute’s goals (Section 2.3, above) in pursuit of its mission
2. Periodically evaluate progress against goals and their relevance in the AI field and ensure course correction, as required
3. Ensure the institute’s day-to-day operations are carried out in accordance with its mandate
4. Maintain high-level accountabilities for the institute’s activities and budget
5. Protect and continually enhance the reputation of the institute and the University of Waterloo

3.2 Organizational Structure

3.2.1 Steering Committee

As per Policy 44 at Waterloo, the Steering Committee will be the proposed institute’s governing body. It will plan and implement the institute’s development; establish processes to manage/monitor its financial affairs; and establish and enforce rules governing the institute’s activities, consistent with university policies, procedures and guidelines. The committee, chaired by the V.P. University Research, will comprise the Deans of Engineering and Mathematics and six regular faculty members of The WAII (with an equal number of representatives from the Faculties of Engineering and Mathematics, and at least two members from each faculty). The
3.2.2 Director

The WAII’s Director, to be determined, will carry out, on a rotating basis every third year (non-renewable, rotating between the Faculties of Engineering and Mathematics) the institute’s mandate. He/she will be accountable to the Steering Committee and will be of academic stature, appointed for his/her intellectual and administrative abilities and commitment to research and education. The Director will be a tenured Associate or Full Professor, with the ability to: i) create an environment conducive to cross-disciplinary and cross-sectoral advances in the AI field; ii) associate productively with institute members; iii) maintain the confidence and co-operation of Waterloo colleagues; and iv) represent and effect the institute’s research mission and directions. The Director will manage staff, as relevant, and overall shall be governed by prevailing Faculty and university policies and practices. Any significant changes to institute practices and procedures will only proceed after wide consultation. The Director will also confer with the respective Deans on research-personnel, space, computing and other resource allocations, to be accessed by the institute, that may impact and come under the purview of the respective Faculties.

The procedure for nominating the institute’s Director will be adapted from Waterloo Policy 40, dealing with the nomination process of a Chair. The institute’s Director will appoint an Associate Director from the other Faculty to his/her own (three-year term, non-renewable) to fulfill specific roles, for example, in budget development; partner outreach; or activities such as workshops, seminars and public lectures. The Associate Director would also be deemed to represent the views of the Director in the Director’s absence. After each three-year finite term, the Director will be selected from the opposite Faculty to the original Director; likewise, the Associate Director.

3.2.3 Advisory Board

Under the university’s Policy 44, an Advisory Board is required to be established for Waterloo institutes or centres that have affiliate membership. The Board will be representative of the institute’s membership and stakeholders (membership initially proposed to be established through Internal Academic Members and Industry Affiliate Members; see Section 5 and Membership Appendix). The V.P. University Research will select the Chair of the Advisory Board, rotating annually, from the Board’s membership. The Board will serve in an advisory capacity on matters of general research management of The WAII. The Advisory Board will be composed of:

- The institute’s Director
- An external industry officer (one officer, rotating every two years)
- Public-sector officers, which may include representation from the federal Ministry of Research, Innovation and Science and the Ontario Ministry of Research, Innovation and Science
• A representative from not-for-profit-organization end receptors of innovation, e.g., the UW-Schlegel Research Institute for Aging, and other university-associated centres, with such representation rotating every third year
• Two representatives of the Internal Academic Membership, from Engineering and Mathematics, respectively, rotating annually

3.2.4 Membership Categories and Criteria

In the initial phase of The WAII, membership is proposed to comprise Internal Academic Members and Industry Affiliates (Other designated categories may be incorporated once The WAII is more firmly established (e.g., student members, external institutional members, organizational associates (e.g., government, honourary members). Each member category will be recognized according to the level and type of commitment (See Steering Committee).

**Internal Academic Members** are those active in research in areas of AI at Waterloo. They will have full voting rights. Additions to this membership will be effected via nomination from the relevant Faculty areas and the vote- selection decision of the Steering Committee. Academic members may cancel their membership via a letter request to the institute’s Steering Committee. The latter may withdraw a membership but shall not withdraw membership for reasons that would impact or pertain to the member’s academic freedom.

**Industry Affiliate Members** are companies, firms or agencies active in the development or application of the institute’s research, or active supporters of its facilities or research operations. Please See Appendix 1 - Membership for the initial proposed list of founding WAII members.

4. Management

4.1 Financial Responsibility
The institute’s Director will have primary responsibility for annual budget preparation, in consultation with the institute’s Steering Committee. The Director will authorize regular expenditures.

4.2 Reporting Mechanisms
The WAII’s Director will provide annual reports to the Steering Committee, detailing the institute’s activities, including progress towards goals and any interim goal reviews, current membership lists, research funding, technology transfer, and current financial position. Reports for institute renewal will be made to the Senate Graduate and Research Council, at least nine months prior to the end of the mandate of the institute, every five years. These reports will also include, in addition to the annual progress reports, a statement describing how/why/whether the institute has achieved or revised its original goals and objectives, along with a five-year plan that identifies future research directions and development strategies.
5. Listing of Proposed Members

Please see Appendix 1 – WAII Membership for the listing of proposed Academic and Industry Affiliate Members.

6. Research/Educational Component

6.1 Waterloo’s Research Distinction and Opportunities for Collaboration

Artificial intelligence will change our lives – transforming how we work, travel, treat disease, communicate, tackle global issues, and how we learn. The University of Waterloo is well-positioned to play a vital role in this transformation. Our researchers in the Faculties of Math/Computer Science and Engineering at the University of Waterloo are developing intelligent systems that can detect cancer and heart disease, understand natural language and human emotion and navigate roadways and factory floors better than ever before. Waterloo’s AI research groups are conducting award-winning research in topics including computer vision, natural language understanding, search engine optimization and autonomous driving, to name a few. Our researchers are building tomorrow’s next-generation intelligent systems today, translating commercial and industrial requirements into deployable, real-time embedded AI solutions.

The institution’s AI direction and distinction are the close research and teaching connections between Waterloo Engineering (including Electrical and Computer Engineering, Mechanical and Mechatronics, Systems Design, Civil and Environmental, Management Sciences, and Chemical Engineering) and Waterloo Mathematics (including, but not limited to, Computer Science, Statistical and Actuarial Sciences, and Combinatorics & Optimization). These two faculties have historically fit together in a number of areas, hand in glove. Perhaps this synchronicity and quality are reflected in U.S. News & World Report’s ranking of the University of Waterloo as number one in Engineering and Computer Science in Canada. For the proposed institute, this means that advances in AI will be end to end, both foundational, cross-faculty/cross-disciplinary, and embedded in software and physical systems. They will be studied, tested, simulated, validated, piloted and adopted with potential applications considered in the project plans from the outset, whether the applications are to benefit public-sector stakeholders and citizens or industry; for example, in mobile monitoring and medical care, assistive devices, environmental sensing stations or autonomous vehicles. These applications also necessitate productive research ties with the Applied Health Science and the Science Faculties at Waterloo. The WAII will formally establish this cross-disciplinary institute academic membership.

As a case in point for what Waterloo AI experts see as Operational AI, the university currently has the only license for autonomous vehicle operation on Canadian roads, for study, testing and training purposes. This research and education value necessarily extends to our robust industry partnerships and to Waterloo’s ability to rev up pre-commercialization and commercialization activity for economic prosperity, growth and the well-being of Ontarians, Canadians and globally. The proposed WAII will be an organizing focal point for proliferating cluster activity in Waterloo Region, one of the world’s top 25 start-up ecosystems, according to Startup Compass, 2015.
Open Text, currently employing 10,000, was an early successful start-up enterprise out of the University of Waterloo, from 1991. Maplesoft has provided mathematics-based software solutions to educators, engineers and researchers in science, technology, engineering and mathematics for more than 25 years. More than 8,000 educational institutions, research labs and companies in more than 90 countries use its products and services. Others range from Waterloo spin-offs Clearpath Robotics and its substantial client base in automotive, military, internet and software applications; and Kik Interactive; along with Miovision (2005), now a global transportation data-analytics company operating in 50 countries. Together, such companies as these and Aeryon Labs, Synaptive Medical and Thalmic Labs are providing home-grown high-tech employment and attracting millions in venture-capital investment. (A number of these companies are proposed as Industry Affiliate Members of The WAII.)

Meanwhile, corporations are being drawn to Waterloo Region for its value proposition of talent base and research/R&D/institutional expertise, among them Google, SAP and the Thomson Reuters Innovation Lab. As well, the university has demonstrated its capacity to adapt its IP policies and practices to industry needs; it maintains, for example, several long-term Master Agreements in Canada’s auto R&D and manufacturing heartland, Ontario, with Original Equipment Manufacturers (OEM), as well as collaborating closely with the automotive supply chain for the adoption of technologies.

In terms of the top alumni and Waterloo stakeholders who bring recognition to Waterloo and reflect the potential for The WAII to network for collaboration and support, outstanding alumni include Steven Woods (Waterloo Mathematics), Senior Engineering Director at Google Canada; Li Deng, formerly a Waterloo Engineering professor, now Chief Scientist of Artificial Intelligence in Microsoft’s Applications and Service Group; and Jennifer Chu-Carroll (Waterloo Mathematics) of IBM’s T.J. Watson Research Center, New York. Waterloo also has a powerful training and co-op education mindset and track record. Along with the institution’s inventor-owned policy that pertains to faculty, student and staff creative contributions to research and R&D (see start-ups, above), Waterloo R&D, technical and field training demonstrate the priority placed on putting highly qualified personnel (HQP), not just in Waterloo’s labs, but also in direct and meaningful contact with industry as projects come to fruition, whether through paid internships, research assistantships, student research capstone projects, or via co-op placements at employer sites. Further, Waterloo-trained computer scientists, software, computer and mechatronics engineers are in high demand worldwide, graduating with two years of real-world know-how through co-op placements with leading firms. Google alone employs dozens of Waterloo coop students every semester to populate their AI/deep learning teams.

6.2 Waterloo’s Approach to Addressing AI Challenges

A core research challenge in Canadian AI is the current, primary focus on big-data architecture, processing and analytics. This requires harnessing and deploying massive computing power, resources and connectivity, also with the attendant security challenges, for example, in the cloud. While undoubtedly very important over the long term, such a deep-learning approach on its own, in expanding the capacities of machine intelligence theoretically, may limit more immediate
applications of practical and sustainable value. These are the foci that the proponents of The WAI are proposing, the types of applications summarized in Section 2.

WAII will provide the setting for our professors and students to showcase their research excellence in AI, improve collaboration, and facilitate new opportunities with partners. Our researchers will conduct groundbreaking investigations in machine learning (to enable the extraction of meaningful information from raw data as well as data driven decision processes), multi-agent systems (to study strategic behavior, trust modeling, user modeling and communication issues in systems with multiple cooperative or adversarial components), human-centered AI (to design automated systems and machines that can recognize human behaviors and emotions, leverage human expertise in hybrid systems and assist humans towards their goals) and natural language processing for understanding and generating human natural language.

Building on the above strengths, the research agenda for WAII researchers will be expanded to also include fundamental and applied research in topics including statistical learning, data mining, probabilistic models, knowledge discovery, knowledge representation, game theory, optimization and decision making, data science and analytics, affective computing and sentiment analysis.

WAII’s innovative approach to AI research will focus on leveraging our existing strengths to develop and deploy ‘Operational AI’ which is a lightweight, compact AI capability with highly-effective intelligence but requiring minimal computing power and energy, suitable for a host of stand-alone applications.

6.3 Impact

Through the institute’s research agenda, WAII will create foundational breakthroughs and develop and deploy key technologies to accelerate AI innovation that benefits everyone, everywhere.

While sophisticated and customized, these innovations can be compact, secure, reliable, accessible and scalable to different industry receptors--be they small- and medium-size enterprises (SMEs which, taken together, hire the majority of Canadian and Ontario workers) or large corporations--and end users. Such applications will build on existing and evolving computing capacities for stand-alone applications, while also pushing the boundaries in networked AI applications and big data, thereby contributing simultaneously to the foundations and applications of the field. Further, as stated in *The Financial Post*, August 2016, a direction corroborated by leading AI scientists and organizations, “The next generation of AIs, already in development, will be capable of anticipating needs and wants, suggesting solutions, predicting outcomes and identifying our emotions.” Advances in human-machine response will be critical, and the proposed WAII will form a needed complement and node of expertise to other Canadian initiatives.

6.4 Talent

The Pan Canadian Strategy for AI also recognizes the challenge of attracting and retaining key research talent—both faculty and HQP—in Canada to build this research area and related industry
sectors. In turn, the Canadian AI gap over the past 10 years has tended to draw the support of AI- and ICT-invested companies elsewhere. Keeping the need for retention of talent in mind, the planned organizational structure and administration for AI at Waterloo—the proposed institute—will enable the university: 

1. to focus its work further on strategic areas of research strength and industry application;
2. to promote its expertise and development externally at the AI frontier, thereby presenting a stronger AI profile for faculty/student recruitment and industry engagement in targeted areas; and
3. to identify AI-targeted sources of funding. Waterloo is in a prime position globally to capitalize for Canada on AI talent development and industry partnerships: according to the QS Graduate Employability Rankings 2017, Waterloo ranks 22nd globally for graduate employability and first on the “partnerships with employers” indicator, an assessment of both research collaborations and employment-related partnerships.

6.5 Education

Waterloo is well-placed to consolidate its research-driven educational profile in AI under The WAII. Waterloo offers high-level courses in artificial intelligence, pattern recognition, computational intelligence and natural-language understanding, among the top five of other North American universities in terms of sheer number of options. (The other institutions in this category are Carnegie Mellon University, Stanford University, University of Illinois – UC and Massachusetts Institute of Technology.) More than 3,400 undergraduates and 1,200 graduate students have taken these Waterloo courses over the past five years.

7. Facilities and Collaborators

7.1 Institutional Collaborators and Facilities

- Advanced Aging ResearCH Centre (ARCH)
- Waterloo Centre for Pattern Analysis and Machine Intelligence (CPAMI)
- Waterloo Institute for Computer Research
- Waterloo Centre for Theoretical Neuroscience
- Waterloo Centre for Automotive Research (WatCAR)
- Waterloo Centre for Bioengineering and Biotechnology
- Waterloo Cybersecurity and Privacy Institute (forthcoming)
- UW-Schlegel Research Institute for Aging
- Laboratory of Computational Intelligence and Automation
- Adaptive Systems Laboratory
- Mechatronics Vehicle Systems Lab
- Vision and Image Processing lab
- Laboratories of the Centre for Pattern Analysis and Machine Intelligence
- RoboHub, mobile multi-robot-team mapping, coordination and autonomy, including UAV (drone) and quadrotor helicopter applications (to open in 2018).
• Artificial Intelligence Lab
• Health Informatics Lab
• Human Computer Interaction Lab
• Software Engineering Lab
• Bioinformatics Lab
• Systems and Networking Lab
• Machine Learning Lab
• Data Systems Lab
• Scientific Computing Lab

In addition, industry partners have noted the need for a dedicated research space, for which they envision the Waterloo campus as an ideal location and resource to access for augmenting their own technology development. While it is recognized that space is at a premium at Waterloo, there may be opportunities to allocate space at the Faculty/departmental level, with appropriate construction/renovation and equipment costs supported by industry partners. (See Membership section for proposed initial industry affiliate members.)

7.2 External Academic Collaborators

• AGEWELL Inc. Network of Centres of Excellence (NCE), hosted at the University Health Network (UHN) in Toronto, a $35-milion program that includes 29 research centres across Canada and 110 industry, government and not-for-profit partners
• The Vector Institute
• The Montreal Institute for Learning Algorithms (MILA)
• The Alberta Machine Intelligence Institute (Amii)
• IBM T.J. Watson Research Center, New York
8. Budget

A preliminary 5-year budget for The WAI is shown in the table following. For the first 5-year operation of the institute, seed funding has been confirmed through commitments from the Deans of the Engineering and Math faculties and the Provost.

The WAI will seek AI-specific avenues of support and remuneration that go beyond, while still including, existing research funding programs to identified faculty members and teams (e.g., NSERC CREATE, NSERC-SPG for Networks, NSERC-CRD, ORF-RE, OCE, etc.). The WAI will provide support for writing major grant proposals.

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Appendix 1 – WAll Membership

1. Potential Academic Members
(All faculty members listed are involved in AI-related research activity and expressed an interest in being involved in a University-level AI institute.)

**Faculty of Mathematics**
Paulo Alencar Computer Science
Shai Ben-David Computer Science
Raouf Boutaba Computer Science
Forbes Burkowski Computer Science
Charles Clarke Computer Science
Robin Cohen Computer Science
Gordon Cormack Computer Science
Don Cowan Computer Science
William Cowan Computer Science
Khuzaima Daudjee Computer Science
Maura Grossman Computer Science
Urs Hengartner Computer Science
Jesse Hoey Computer Science
Martin Karsten Computer Science
Srinivasan Keshav Computer Science
Kate Larson Computer Science
Edith Law Computer Science
Ming Li Computer Science
Yuying Li Computer Science
Bin Ma Computer Science
Mei Nagappan Computer Science
Jeff Orchard Computer Science
Pascal Poupart Computer Science
Peter van Beek Computer Science
Dan Vogel Computer Science
Justin Wan Computer Science
Stephen Watt Computer Science
Yaoliang Yu Computer Science

Ricardo Fukasawa Combinatorics and Optimization
Chaitanya Swamy Combinatorics and Optimization
Stephen Vavasis Combinatorics and Optimization
Henry Wolkowicz Combinatorics and Optimization

Shoja'eddin Chenouri Statistics
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2. Potential Initial Industry Affiliate Members

Huawei Technologies
Royal Bank of Canada (RBC)
CIBC
Google
Cisco Canada
ProNavigator
Focal Systems
TalkIQ
HockeyTech
ElementAI
Clearpath Robotics
Alpha Healthcare
General Dynamics Land Systems
General Motors (AutoDrive)
Denso
Linamar
Summo Corp.
Aeryon Labs
Kion – Dematic
Miovision
Thalmic Labs
Vidyard
Cardon Rehabilitation
Tremble
Applanix
D2L
Ramp
Engineering Services Inc.
Appendix 2 – Recent and Ongoing AI Project Highlights at Waterloo

The “Tricorder”

Waterloo’s Vision and Image Processing Lab has developed a revolutionary ‘tricorder’ technology, termed Coded Hemodynamic Imaging (CHI), that is the first-of-its-kind to enable touchless imaging of blood flow across the body, and which could lead to improved detection and prevention of a wide range of heart and lung diseases. Current techniques for diagnosing heart failure rely on invasive catheterization to obtain a single-point jugular venous pulse measurement, but CHI enables non-contact imaging of blood flow across entire jugular veins, as one might measure traffic flow across a city. CHI projects light and captures light fluctuations on the skin surface, and relays them to a digital signal processing unit which computes blood-flow patterns. This research was ranked in the Top 5% of all research outputs scored by Altmetric, and received media coverage across the globe, with an appearance on the popular science show Daily Planet on the Discovery Channel.

Conversational Agents

Text messaging apps have become the most popular and most engaging features of smart phones in recent years. In collaboration with Kik Interactive, Artificial Intelligence researchers at the University of Waterloo have developed adaptive and emotionally aware conversational agents for text messaging. Leveraging machine learning and affect control theory, the algorithms automatically adapt to the affective personality of users by recognizing their emotions in short text messages and responding with messages that are emotionally aligned. This work has already led to two patents on adaptive and emotionally aware conversational agents.

Functionally-safe automotive autonomy

In November 2016, Waterloo’s ‘Autonomoose’ became the first autonomous test vehicle licensed to operate on Canada’s public roads. The fleet will grow in 2017 with multimillion dollar support from NSERC, CFI, the Province of Ontario and several private sector partners. The team’s machine learning approach targets perception and prediction in adverse conditions – tackling the complexities of snow, sleet, low light, and reflective
surfaces. A major practical focus is safety assurance – efficiently validating and certifying the safety of machine learning algorithms so we can incorporate AI into safety critical functions.

Resource sharing for better control of forest fires  
Artificial Intelligence Group

Forest fires threaten communities across North America, cost billions of dollars annually, and destroy vast quantities of natural resources. But controlling fires is expensive and local resource demand often outstrips availability. Researchers from Waterloo’s Artificial Intelligence Group have built the first model for wildfire fire resource sharing, using ideas from multi-agent systems and game theory. Developed in partnership with the Ontario Ministry of Natural Resources and in consultation with experts in the field, their analysis has identified the key strategic issues confronting fire-response agencies, and opens up a valuable new application area for the Artificial Intelligence community.

Evolutionary deep intelligence  
Vision and Image Processing Lab

Researchers in Waterloo’s Vision and Image Processing Lab have developed new techniques to obtain highly efficient deep neural network architectures. Their evolutionary deep intelligence approach drives the formation, over successive generations, of highly sparse synaptic clusters. The offspring algorithms, trained on image classification, can achieve state-of-the-art performance despite an up to 125-fold decrease in synapses. Such architectures are ideal for low-power embedded CPUs. This research received the best paper award at the efficient deep learning workshop, held at the NIPS Conference in Barcelona, December 2016.

Identifying cancer through Imaging  
Vision and Image Processing Lab

A team from the Vision and Image Processing Lab was honored with two Magnum Cum Laude awards at the 2016 Annual Meeting of the Imaging Network of Ontario for their work in discovery radiomics, in collaboration with Sunnybrook Health Sciences clinicians. They developed a breakthrough strategy for quicker and more effective cancer identification based on the quantitative identification of tumor biomarkers, tapping into the wealth of information contained within medical imaging archives. The image to the right shows the discovered sequencer, encoding the cancer biomarker data.
Embedded speech engines

The Centre for Pattern Analysis and Machine Intelligence has developed a set of AI based platforms that outperform standard keyword spotting techniques, both theoretically and experimentally. These embedded speech devices, untethered to any cloud-based speech engine, are based on deep learning algorithms and advanced noise suppression techniques; an embedded Natural Language Understanding version of the system is also being tested. A spinoff company, Cognitive Computing Technologies, is targeting automotive environments, cognitive/social robotics, and small office/home appliances.

Autonomy in human-robot teams

As robots move beyond the production line and into shared human environments, efficient and effective communication with human operators will be essential. In a three-year collaboration initiated with Clearpath Robotics, researchers from Waterloo’s Adaptive Systems and Autonomous Vehicles labs will develop machine learning strategies for fully autonomous warehouse robots to automatically elicit human preferences via simple interactions with staff, with no need for expert programming and supervision. Clearpath is one of several robotics companies scaling up in Waterloo Region - founded in 2009 by Waterloo Engineering students, the company now employs over 150 people.

Assistive technologies for the elderly

Waterloo’s Computational Health Informatics Lab are developing technologies to assist persons with cognitive disabilities. The ACT@HOME project is building an emotionally intelligent cognitive assistant to engage and help older adults with Alzheimer's disease to lead more independent and active daily lives. The Do-It-Yourself Smarthome project is connecting end users with developers by building a person-specific logical knowledge base of user needs, assistance dynamics, sensors, actuators and care solutions. These programs are conducted in conjunction with the AGEWELL Inc. Network of Centres of Excellence, a $35 million dollar initiative that includes 29 research centres across Canada and over 110 industry, government and non-profit partners.
Living architecture systems

Waterloo is leading a new $2.5M SSHRC Partnership to explore living architecture that uses curiosity-based reinforcement learning algorithms to continuously generate novel behaviours. With over 40 collaborators across North America, Europe and Asia, the School of Architecture will team up with researchers in the Electrical and Computer Engineering and Knowledge Integration departments to explore ways to generate genuine and sustainable social interaction with autonomous systems, and design buildings that can continuously adapt to create a cleaner and healthier environment.

RoboHub construction begins

The $4.5M RoboHub, supported by CFI, will provide the only multi-robot test facility in the world with autonomous ground, aerial, humanoid and magnetically levitated platforms under one roof. Located at the heart of the new Engineering 7 building, the RoboHub will support a host of research programs into robot coordination and autonomy. For example, Bayesian learning models will enable state estimation for localization and autonomous mapping of intelligent mobile robotics agents and UAVs to enable navigation in unstructured environments. Meanwhile, recurrent neural networks will enhance quadrotor flight modeling, predicting aerodynamics with greater accuracy for precision maneuvering at speed and near obstacles.

Hockey analytics

Hockey is a fast-paced game for which there is increasing demand for data analytics. In partnership with HockeyTech, researchers in Artificial Intelligence and Economics at the University of Waterloo are developing automated algorithms that process low-level position data about each player and the puck and which can recognize events such as shots, passes, puck possession, takeaways, giveaways, and faceoff wins, and then use this data to predict goals, wins and player performance. These new statistics are helping players, coaches, scouts and fans of professional and semi-professional hockey leagues across North America.
May 25th 2017

Senate Graduate and Research Council
University of Waterloo

Re: Establishing the Waterloo Artificial Intelligence Institute

Dear SGRC,

The Faculty of Engineering enthusiastically supports the proposal to establish the Waterloo Artificial Intelligence Institute (WAII) in partnership with the Faculty of Mathematics.

Artificial Intelligence (AI) is the notion of machines that exhibit intelligence and mimic cognitive functions that are usually associated with humans, such as learning, reasoning, predicting, planning, recognizing, and problem solving. With the advent of big data driven by the explosion of computing capacity and speed, AI tools are being increasingly integrated in technological solutions that are central to our everyday life, business, society and the environment.

More than forty faculty members of Waterloo Engineering are engaged in AI related research and will be members of WAII, including eight Canada Research Chairs, two University Research Chairs and two NSERC Industrial Research Chairs. Engineering has been particularly strong in developing “operational AI” which offers lightweight, compact and highly effective intelligence but with minimal computing power and energy requirements, thus suitable for a host of stand-alone applications. To this end, the Department of Systems Design Engineering has invented the world’s first ‘tricorder’ technology (as per Star Trek) for touchless imaging of blood flow across human body while Mechanical and Mechatronics Engineering and Electrical and Computer Engineering developed Canadian academia’s first autonomous test vehicle “Autonomoose” licensed to operate on public roads. The machine learning/AI research programs in medical image analysis, smart robotics, speech recognition and vision systems in these departments are growing very rapidly. Civil and Environmental Engineering are now developing machine learning algorithms to solve problems in construction, transportation networks and water resource management, while Chemical Engineering are applying AI techniques to problems in chemical process modelling and nanomaterial design. The Department of Management Science, who has core expertise in information systems and operations research, has led the development of a graduate collaborative program in Data Analytics.
Our vision, through the WAIL, is to extend the University’s current capabilities beyond Engineering and Mathematics. The University of Waterloo has the potential to be a global leader in both foundational AI research and operational AI, with all faculties developing AI tools to accelerate research in expanding areas including life sciences, climate change, water policy, and healthcare management. This is a unique opportunity for the University to differentiate itself in this field.

In Budget 2017, the federal government announced an investment of $125M for a Pan-Canadian AI Strategy where the Waterloo Region was recognized as one of the four Canadian strategic nodes of expertise. The proposal to establish the WAIL is hence very timely and strategically important. The proposed WAIL will serve as a central contact point for the University’s future AI private and public sector partners, and position the university as the leading developer and translator of AI technologies.

Engineering is committing $50K/year for five years to seed the creation of WAIL. We anticipate that WAIL will heighten our visibility and recognition in this field which in turn will generate additional external research funding to expand research activities and graduate student support.

Yours very truly,

[Signature]

Pearl Sullivan
Professor and Dean
Faculty of Engineering
May 30, 2017

George Dixon and Jeff Casello
Senate Graduate and Research Council
University of Waterloo

Re: Establishment of the Waterloo Artificial Intelligence Institute

Dear Professors Dixon and Casello,

The Faculty of Mathematics enthusiastically requests the Senate Graduate & Research approval to establish the Waterloo Artificial Intelligence Institute (WAI) in partnership with the Faculty of Engineering.

Artificial Intelligence (AI) is a core computer science discipline represented in the Faculty of Mathematics by strong research groups in the David R. Cheriton School of Computer Science (e.g., the AI and the Machine Learning research groups), but also in the Statistics and Actuarial Science department (e.g., classification, pattern recognition, statistical learning, stochastic process models and inference, time series), and the Combinatorics and Optimization department (e.g., discrete and continuous optimization, operations research, algorithmic game theory, etc.). Altogether over 40 faculty in Mathematics will be members of the WAI including CRC, URC and IRC holders, and will contribute their expertise in establishing rigorous mathematical and algorithmic foundations for the science of AI and Machine Learning as well as their applications across many verticals (e.g., health, energy, environment, water, manufacturing, etc.). Our researchers are excited about the potential for multi-disciplinary work with researchers in engineering and other faculties who apply AI to create new technologies, or investigate new application domains.

Waterloo comes 11th worldwide in terms of citation impact for AI research and 1st in Canada according to the most recent release of the Times Higher Education ranking of countries and institutions based on their AI research output. As described in the WAI proposal, Waterloo has an exciting opportunity to form a multidisciplinary and collaborative AI Institute that will maintain our leadership in Canada, improve our world ranking, and better position Waterloo for competing as part of the recently announced Pan-Canadian cluster funding by the federal government.

Mathematics is committing $50K/year for five years as a seed contribution towards the establishment of the WAI. We expect WAI’s activities will create new opportunities for cross-faculty collaborations, for researchers to work with the industry, and for generating external research funding from industry and government at both the provincial and federal levels. I strongly encourage the Council to recommend the establishment of the Waterloo Artificial Intelligence Institute.

Sincerely,

Stephen M. Watt
Dean, Faculty of Mathematics
Fakhreddine Karray

Education/Training:

<table>
<thead>
<tr>
<th>Degree</th>
<th>Field</th>
<th>Institution</th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td>PhD</td>
<td>Electrical Engineering,</td>
<td>University of Illinois at Urbana Champaign,</td>
<td>1989</td>
</tr>
<tr>
<td></td>
<td>Systems and Controls</td>
<td>United States</td>
<td></td>
</tr>
<tr>
<td>MEng</td>
<td>Electrical Engineering</td>
<td>University of Tunis, Ecole Nationale d'Ingenieurs de Tunis</td>
<td>1984</td>
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Employment/Affiliations:

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<tr>
<th>Role</th>
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<th>Year</th>
</tr>
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<tbody>
<tr>
<td>University Research Chair Professor</td>
<td>Department of ECE, University of Waterloo</td>
<td>2011-</td>
</tr>
<tr>
<td>Director</td>
<td>Centre for Pattern Analysis and Machine Intelligence, University of Waterloo</td>
<td>2011-</td>
</tr>
<tr>
<td>Professor</td>
<td>Department of ECE, University of Waterloo</td>
<td>2003-</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>Centre for Pattern Analysis and Machine Intelligence, University of Waterloo</td>
<td>2003-2011</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>Department of Systems Design Engineering, University of Waterloo</td>
<td>1999-2003</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>Department of Systems Design Engineering, University of Waterloo</td>
<td>1997-1999</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>Department of Electrical Engineering, Lakehead University</td>
<td>1994-1996</td>
</tr>
<tr>
<td>Research Associate</td>
<td>Faculty of Applied Sciences, U of British Columbia</td>
<td>1990-1994</td>
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Research Funding:

<table>
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<th>Funding</th>
<th>Year</th>
<th>Amount</th>
<th>Role</th>
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<tbody>
<tr>
<td>NSERC Discovery</td>
<td>2015 – 2020</td>
<td>$235,000</td>
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<td>Qatar Foundation</td>
<td>2014 – 2017</td>
<td>1,050,000</td>
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<td>NSERC Strategic Network</td>
<td>“Developing Next generation Intelligent Vehicular Network”</td>
<td>2011 – 2016</td>
<td>5,000,000</td>
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<td>NSERC SPG</td>
<td>(Applied for)</td>
<td>2017 – 2020</td>
<td>$535,000</td>
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<tr>
<td>ORF</td>
<td>(Applied for)</td>
<td>2017 – 2021</td>
<td>$4,000,000</td>
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</tbody>
</table>

Most Significant Contributions:

Fakhreddine Karray has published over the past 30 years more than 450 publications, many of which appeared in major conferences and first tier journals. He has published 12 textbooks and edited monographs and co-authored 16 US patents in various fields of intelligent systems and smart machines. Following is a sample of publications and patents, impact of which has been high on the theoretical research and applied sciences fields.
1. M. Ayadi, M. Kamel and F. Karray, "Survey on Speech Emotion Recognition: Features, Classification Schemes, and Databases," Pattern Recognition, March 2011, vol. 44, no. 3, pp. 572-587. This article (co-authored with a former PhD student and colleague) is the most cited article in the field. It has won the Elsevier’s Pattern Recognition Best Paper Award in 2014. The article has become a major reference for researchers working in the area of speech emotion recognition, a field that is fast becoming important in the design of intelligent human machine interfaces and social robots. Other follow on work has been published by the authors and has won praise from the HMI community.

2. B. Khaleghi, A.M. Khamis, F. Karray, and S.N. Razavi, “Multi-sensor Data Fusion: A Review of the State-of-the-art,” Information Fusion, vol. 14, no. 1, pp. 28-44, 2013. This work has been highly praised by the research community in the area of multi-sensor fusion. It provides state of the art approaches in the field and provides adequate theoretical framework and needed technical tools to deal with the problem of fusing data from various heterogeneous sources. The paper has been the most cited in Elsevier’s Information Fusion for the past three years and is among the most cited in its field.

3. F. Karray and C. de Silva, Soft Computing and Intelligent Systems Design, Theory, Tools and Applications, Addison Wesley Publishing, Aug. 2004. The textbook illustrates developments in the theory of soft computing and applications to intelligent systems. It has been used as a senior undergraduate and graduate textbook for many institutions around the world. The authors have been praised for the quality of the material and its content in both theoretical and applied aspects. A review of the book in 2008 IEEE CI Magazine states:"The textbook represents a comprehensive and cohesive treatment of the state-of-the art consortium of soft computing methodologies and their potential integration, from both the analytical and the practical perspectives."

4. J. Sun, F. Karray and O. Basir, “Knowledge Based Flexible Natural Speech Dialogue System,” United States Patent# 7,386,449, Issued: June 10, 2008. This well-cited patent is at the origin of a commercial product launched the past six years by Vestec Inc. for the design of a powerful speech recognizer (voted by VoIP Evolution portal as one of the top 25 VoIP advances of 2009) and another product used for automated call-centre interface (deployed in 511-service in various states in the US). The product has been deployed in 5 languages in more than 10 countries.

5. M. Niemeijer, B. V. Ginneken, M. Cree, A. Mizutani, G. Quellec, C. Sanchez, B. Zhang, R. Hornero, J. You, A. Mayo, Q. Li, C. Roux, F. Karray, M. Garcia, H. Fujita, and M.D. Abramoff, “Retinopathy Online Challenge: Automatic Detection of Microaneurysms in Digital Color Fundus Photographs”, IEEE Transactions on Medical Imaging, 2010, vol. 29, no. 1, pp.185-195. This novel work in the field of image processing with application to biomedical engineering has won the second prize of the 2009 Retina Online Challenge Microaneurysm Detection. The importance of the work stems from its novel approach in automatically detecting microaneurysm in digital color fundus photographs. This is a very important first critical step in screening for diabetic retinopathy. Karray and his students B. Zhang have been contributors of this important work, and followed up later with more extensive algorithms, some of which are among the highest cited in the area.
**William Melek**

**Education/Training:**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Field</th>
<th>Institution</th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td>PhD</td>
<td>Mechanical Engineering</td>
<td>University of Toronto</td>
<td>2002</td>
</tr>
<tr>
<td>MASc</td>
<td>Mechanical Engineering</td>
<td>University of Toronto</td>
<td>1998</td>
</tr>
<tr>
<td>BSc</td>
<td>Electrical and Computer Engineering</td>
<td>Zagazig University</td>
<td>1994</td>
</tr>
<tr>
<td>PDF</td>
<td>Mathematics, Physics and Computer Science</td>
<td>Ryerson University</td>
<td>2004</td>
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**Employment/Affiliations:**

<table>
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<tr>
<th>Position</th>
<th>Department/University</th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td>Professor</td>
<td>Department of Mechanical and Mechatronics Eng. (MME), University of Waterloo</td>
<td>2016-</td>
</tr>
<tr>
<td>Director</td>
<td>Department of MME, University of Waterloo</td>
<td>2013-</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>Department of MME, University of Waterloo</td>
<td>2010-16</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>Department of MME, University of Waterloo</td>
<td>2004-2010</td>
</tr>
<tr>
<td>Adjunct Professor</td>
<td>Department of Computer Science, Ryerson University</td>
<td>2006-2015</td>
</tr>
<tr>
<td>Researcher</td>
<td>Department of Mathematics &amp; Computer Science, Ryerson University</td>
<td>2003 – 2004</td>
</tr>
<tr>
<td>Artificial Intelligence Division Leader</td>
<td>Alpha Laboratories Inc.</td>
<td>2002-2004</td>
</tr>
<tr>
<td>Research Associate</td>
<td>Department of Mechanical Engineering, University of Toronto</td>
<td>2000 – 2002</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
<td>Engineering Services Inc., Robotics &amp; Automation Division</td>
<td>1998</td>
</tr>
<tr>
<td>Electrical Engineer</td>
<td>Siemens, Cairo Egypt</td>
<td>1995 - 1996</td>
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**Research Funding:**

<table>
<thead>
<tr>
<th>Source</th>
<th>Project Description</th>
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<th>Amount</th>
<th>PI</th>
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<tbody>
<tr>
<td>CFI/ORF</td>
<td>The RoboHub: A Robotic Test Facility for Multi-robot Teams</td>
<td>2015</td>
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<tr>
<td>OCE VIP</td>
<td>Gasoline-powered propulsion for UAV for increased range</td>
<td>2015</td>
<td>$25,000</td>
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<td>OCE VIP</td>
<td>Radio Frequency Protection System for Unmanned Aerial Vehicles</td>
<td>2015</td>
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<td>Contract, York Region</td>
<td>Design of Sewer Infiltration System Contract</td>
<td>2015</td>
<td>$10,000</td>
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<td>Contract, SL Innovation</td>
<td>Design of a hair massaging system</td>
<td>2015</td>
<td>$15,000</td>
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<td>NSERC Discovery</td>
<td>Configuration Optimization and Advanced Docking Design for two classes of Modular and Reconfigurable Robotic Systems</td>
<td>2014-2019</td>
<td>$120,000</td>
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<td>MITACS</td>
<td>Nonlinear Projection Methods for Prediction of Trends in Cancer Incidence and Mortality</td>
<td>2012-2014</td>
<td>$60,000</td>
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<td>NSERC CRD</td>
<td>Development of predicative analytics and business intelligence tools for improved patient management using intelligent decision support systems</td>
<td>2013-2016</td>
<td>$228,000</td>
<td>PI</td>
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<td>OCE VIP</td>
<td>Novel Cargo Unmanned Aerial Vehicle (UAV) for Commercial and Humanitarian Purposes</td>
<td>2017-2019</td>
<td>$150,000</td>
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</table>
Most Significant Contributions:

1. Development of an intelligent modular robot for flexible automation and automotive applications: In this project, Dr. Melek developed Canada’s first open architecture modular and reconfigurable robot setup for automotive applications. This state-of-the-art MRR system has been utilized by the industrial partner; Sterner Automation. Dr. Melek and his research team developed several configuration optimization, path planning, and nonlinear control techniques for MRR. Furthermore, led by Dr. Melek the research team developed CAN communication protocols with smart plug and play connectors for easily reconfiguring the robot and establishing efficient messaging and data exchange between the joints. Finally, a joint-space nonlinear control strategy based on backstepping techniques was developed for position control. In recent years, Dr. Melek also designed two industrial modular and reconfigurable robots complete with advanced path planning, configuration optimization, and nonlinear motion control methodologies. UW Engineering is the only school in Canada and one of a handful in North America with expertise in this research area.

2. Neurofuzzy control of modular and reconfigurable robots: Dr. Melek and his team have developed a practical and intelligent adaptive/learning control architecture for modular and reconfigurable robots that can be easily used in the presence of dynamic parameter uncertainty and unmodeled disturbances. The adaptive control is achieved through a non-traditional knowledge base that updates PID control gains to achieve a desirable response in the presence of unmodeled disturbances. The learning control is realized using a feed forward neural network, and is meant to approximate the unmodeled dynamics of any robotic setup built from the reconfigurable system modules. In collaboration with an industrial partner, Engineering Services Inc., Dr. Melek built an MRR system based on this research which has been extensively used at the University of Waterloo for training graduate and undergraduate students on the design and implementation of nonlinear and intelligent control and configuration optimization methodologies for automation.

3. Intelligent MCU control system for improved ride/stability for vehicles with semi-active suspension: Dr. Melek led a team of 3 professors, 3 graduate students, and 4 engineers in developing an intelligent embedded microcontroller for improved ride/stability for vehicles with semi-active suspension systems. The research team developed novel nonlinear fuzzy controllers for ride comfort, road handling and rollover stability. Advanced extended Kalman filtering techniques for vehicle state estimation were also developed. An artificial neural network structure was proposed to model semi-active magnetorheological dampers. Dr. Melek also developed computational intelligence methods for state estimation in manufacturing, autonomous robotics and electric vehicles control applications. Since 2010, he has developed several novel state estimation and fault tolerance methods for enabling cornering control in passenger electric vehicles and off-road vehicles, i.e., ARGO platform. This research has been supported by Automotive Partnership Canada, NSERC, and General Motors.

4. Non-traditional reasoning and optimization methods for modeling of bioinformatics systems: There is a close correlation between the research in this area and Dr. Melek's core research focus which uses AI methodologies for design and control of MRR. In this research, Dr. Melek developed predictive analytics that can be integrated into the decision support systems for Electronic Medical Records. This research tackles the problem of developing predictive analytics tools to forecast the load on the healthcare system in terms of the projections for new incidences of cancer. These predictive models are used to provide insight into the resources needed by the healthcare system in order to effectively provide the level of care needed. Furthermore, the research in this thrust focuses on developing novel nonlinear optimization tools to enable intelligent allocation of clinical resources in order to meet the healthcare system needs (required number of procedures, wait time requirements, geographic locations, etc.). To support this research, Dr. Melek secured three-year NSERC CRD grant in the amount of $228,000 in 2013 and a MITACS ACCELERATE grant ($60,000) for my former PDF; Dr. Smita Kochroo in 2012. The research in this area has resulted in six awarded/pending patents and several publications including a manuscript in Information Sciences and a book chapter in IEEE-Wiley Encyclopedia in Biomedical Engineering.
Pascal Poupart

Education/Training:

<table>
<thead>
<tr>
<th>Degree</th>
<th>Field</th>
<th>Institution</th>
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<tbody>
<tr>
<td>PhD</td>
<td>Computer Science</td>
<td>University of Toronto, Toronto ON</td>
<td>2005</td>
</tr>
<tr>
<td>MSc</td>
<td>Computer Science</td>
<td>University of British Columbia, Vancouver, BC</td>
<td>2000</td>
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<tr>
<td>BSc</td>
<td>Math and Computer Science</td>
<td>McGill University, Montreal QC</td>
<td>1998</td>
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Employment/Affiliations:

Professor
David R. Cheriton School of Computer Science, University of Waterloo 2016-

Research Funding:

<table>
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<tr>
<th>Sponsor</th>
<th>Project Description</th>
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<th>Amount</th>
<th>Role</th>
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<tr>
<td>Huawei Technologies</td>
<td>Machine Learning for Telecommunication Communication Networks and Natural Language Understanding</td>
<td>2017 – 2019</td>
<td>$526,534</td>
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<td>NSERC Discovery</td>
<td>Lifelong Machine Learning and Sequential Decision Making for Natural Language</td>
<td>2013 – 2019</td>
<td>$264,000</td>
<td>PI</td>
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<td>OCE VIP II</td>
<td>Hockey Game Event Recognition and Data Analytics</td>
<td>2016 – 2017</td>
<td>$341,700</td>
<td>CoI</td>
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<td>Huawei Technologies</td>
<td>Machine Learning Theory and Applications in Communication Networks and Natural Language Processing</td>
<td>2015 – 2016</td>
<td>$257,800</td>
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<td>CFI and ORF</td>
<td>Computational Health Informatics Laboratory</td>
<td>2013 – 2015</td>
<td>$442,330</td>
<td>Co-I</td>
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<td>MITACS</td>
<td>Adaptive and Emotionally Aware Chatbots</td>
<td>2014 – 2015</td>
<td>$135,000</td>
<td>Co-I</td>
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<tr>
<td>NSERC Engage</td>
<td>Adaptive Prompting to Promote Activity for Residents of Retirement Living</td>
<td>2013 – 2014</td>
<td>$44,200</td>
<td>PI</td>
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<tr>
<td>MITACS</td>
<td>Adaptive Dialogue Techniques for Chatbots</td>
<td>2013</td>
<td>$118,834</td>
<td>Co-I</td>
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</tbody>
</table>

236
Most Significant Contributions:

1) Partially observable Markov decision processes (POMDPs) provide a natural and principled framework to model many sequential decision making problems under uncertainty. I developed several new algorithms that exploit problem specific structure to improve scalability. Given the importance of this work, I was invited to give a tutorial on POMDPs at the 2010 Pacific Rim International Conference on Artificial Intelligence in Daegu (Korea), write an article on POMDPs that appeared in the Encyclopedia of Machine Learning (2010) and contribute a chapter on POMDPs for the book Decision Theory Models for Applications in Artificial Intelligence: Concepts and Solutions. I also applied my work on POMDPs in an automated system that guides seniors in the task of handwashing. This work was featured in a special issue of the 2012 ACM Transactions on Intelligent Interactive Systems on the “highlights of the decade”.

2) Reinforcement Learning (RL) is a framework for automated systems to learn and plan simultaneously in a noisy environment. Bayesian techniques can be used to model explicitly the uncertainty about the environment with probability distributions while planning and learning. However, given the apparent complexity of manipulating such distributions, most RL algorithms only compute point estimates, from which it is difficult to quantify the uncertainty. I derived an analytic solution for discrete Bayesian RL and designed a corresponding algorithm. Following this seminal contribution, I was invited to give a tutorial on Bayesian techniques for RL at the 2007 Int. Conference in Machine Learning (ICML), write an article on Bayesian RL that appeared in the Encyclopedia of Machine Learning (2010) and contribute a chapter on Bayesian RL for the book Reinforcement Learning: State-of-the-Art.

3) With the rise of mobile and wearable devices, there is a need for planning techniques that can produce resource efficient policies. While memory and computational power have increased significantly in mobile devices, energy consumption remains an important bottleneck due to limited battery life. My research group developed optimization and compilation techniques that produce controllers with negligible energy consumption for smart-phones. We also developed multi-objective planning techniques that optimize a primary objective subject to constraints on secondary objectives, therefore allowing accuracy to be tradeoff against resources in various regimes. Given the industrial importance of this work, I was invited to give two keynote presentations at the 2014 Pacific Rim International Conference on Artificial Intelligence (PRICAI) and the 2015 International Conference on Technologies and Applications of Artificial Intelligence (TAAI).

4) Sum-product networks were recently proposed as a type of deep neural netwrks with clear semantics and a type of probabilistic graphical model with tractable inference. My research group advanced the understanding of sum product networks (SPNs) by showing that any SPN can be converted into an equivalent Bayesian network without an exponential blow up. We also developed online and distributed algorithms to estimate the parameters of SPNs from large streaming datasets. Furthermore, we extended SPNs to dynamic sum-product networks (DSPNs) for sequence data and to sum-product-max networks (SPMNs) for decision making, where we showed how to learn tractable sequential models and decision-theoretic models for data (i.e., exact sequential inference and exact decision making in linear time with respect to the size of the networks learned from data). This work earned my Master’s student, Han Zhao, the Fall 2015 alumni Gold Medal award and I was invited to give seminars on this topic at Google, Hong Kong University of Science and Technology, National Taiwan University, University of Georgia, McGill University, Université de Montréal, Laval University, Université de Sherbrooke.

5) Boolean satisfiability (SAT) is one of the most important problems in computer science since it is NP-Complete. In collaboration with Vijay Ganesh's research group, I developed a new SAT solver that won the first prize in the main track and the application track of the SAT-2016 competition. My contribution was the development of a machine learning technique for adaptive branching, which was key to improving the state of the art in branching and the overall solver performance.
Curriculum vitae (highlights)

Peter van Beek
Cheriton School of Computer Science
University of Waterloo
Waterloo, Ontario, Canada  N2L 3G1
Tel: 519-888-4567, x35344
vanbeek@cs.uwaterloo.ca

Education

• PhD, 1990, University of Waterloo
• MMath, 1986, University of Waterloo
• BSc (Honours), 1984, University of British Columbia

Research Interests

• Artificial intelligence: constraint programming, scheduling, sequencing, planning

Honours and Awards

• Best Paper Award, Canadian Conference on AI, 2017
• Best Paper Award, Canadian Conference on AI, 2011
• AAAI Fellow, 2008
• Outstanding Performance Award, University of Waterloo, 2007
• Mathematics Faculty Research Fellow, University of Waterloo, 2004-2007
• IBM Canada CAS Fellow, 2003-2008
• Sir Alan Newell Visiting Fellowship, Griffith University, Brisbane, Australia, 2002
• Best Paper Award, Canadian Conference on AI, 2008
• Best Paper Award (Innovative Applications Track), International Conference on Principles and Practice of Constraint Programming, 2001
• Best Paper Award, Canadian Conference on AI, 2001
• Outstanding Paper Award, International Joint Conference on AI, 1995
• Honorable Mention Award for Best Written Paper, AAAI-1992

238
Employment

- Director of Infrastructure, Computer Science, University of Waterloo, 2007-2009.
- Director of Graduate Studies, Computer Science, University of Waterloo, 2002-2004.
- Professor, University of Waterloo, 2000-present.
- Associate Chair (Undergraduate), Computing Science, University of Alberta, 1999-2000.
- Professor, University of Alberta, 1999-2000.
- Associate Professor, University of Alberta, 1995-1999.
- Visiting Professor, EPFL, Lausanne, Switzerland, Fall, 1996.
- Assistant Professor, University of Alberta, Edmonton, Alberta, 1990-1995.

Professional Activities

Journal activities (selected):

Constraints
- Advisory Board Member, 2010–2015
- Editor-in-Chief, 2005 – 2009
- Editorial Board Member, 1995–2004

Artificial Intelligence
- Associate Editor, 2009–2016

ACM Transactions on Intelligent Systems and Technology (ACM TIST)
- Associate Editor, 2010–2016

Journal of Artificial Intelligence Research (JAIR)
- Advisory Board Member, 2002–2004
- Associate Editor, 1999-2001
- Editorial Board Member, 1996–1998

Conference activities (selected):

International Conference on Principles and Practice of Constraint Programming (CP)
- Program Chair, 2005; Conference Co-Chair, 2004; Workshop Chair, CP-2002

Conference of the Association for Artificial Intelligence (AAAI)

Canadian Conference on Artificial Intelligence
- Program Co-Chair, 27th Conference (AI-2014)

International Joint Conference on Artificial Intelligence (IJCAI)
- Area Chair, 2015; Senior program committee member, 2011, 2013; Workshop Chair, 2001
University of Waterloo
Graduate Expedited Proposal
of the
Graduate Diploma in Quantum-Safe Cryptography
Volume I - Proposed Brief
# Table of Contents

Table of Figures .......................................................................................................................... 4  

I. Brief Description and Rationale ................................................................................................. 5  

II. Objectives of the Program ....................................................................................................... 6  

III. Admissions Requirements ...................................................................................................... 6  

IV. Degree Requirements ........................................................................................................... 8  

a. Technical Courses and Milestones ......................................................................................... 8  

b. Professional Courses and Milestones ..................................................................................... 10  

V. Program Structure ................................................................................................................. 11  

VI. Course Descriptions .............................................................................................................. 14  

VII. Mode of Delivery .................................................................................................................. 17  

VIII. Assessment of Teaching and Learning .............................................................................. 17  

a. Teaching Assessment ............................................................................................................... 17  

b. Learning Assessment .............................................................................................................. 18  

IX. Resources .............................................................................................................................. 18  

X. Quality and Other Indicators .................................................................................................. 20  

XI. Projected Enrollment ............................................................................................................. 20  

Appendix A ..................................................................................................................................... 22  

Program Outcomes ....................................................................................................................... 22  

Courses to Outcomes .................................................................................................................... 22  

Courses to Expectations .................................................................................................................. 22  

Appendix B ..................................................................................................................................... 29  

Graduate Studies Program Revision Template ............................................................................ 29  

Appendix C ..................................................................................................................................... 35  

Integration of Technical and Professional Skills ......................................................................... 35
Standards and Certification ........................................................................................................35
Technical Skills ........................................................................................................................35

Appendix D .................................................................................................................................39
Bartholomew, Rachel ................................................................................................................39
Beynon, Wm Douglas ................................................................................................................39
Hurwitz, Marc ...........................................................................................................................39
Jao, David ...................................................................................................................................39
Jennewein, Thomas ....................................................................................................................39
Lutkenhaus, Norbert ....................................................................................................................39
Menezes, Alfred .........................................................................................................................39
Mosca, Michele ..........................................................................................................................39
Weber, J. Mark ............................................................................................................................39
Table of Figures

Table IV-a: Course Alternatives ................................................................. 9
Table V-a: Potential Additional Course Load............................................ 13
Table V-b: Course Offering Schedule....................................................... 14
Table XI-a: Program Outcomes ............................................................... 23
Table XI-b: Courses to Outcomes ............................................................ 24
Table XI-c: Courses to Expectations ......................................................... 26
I. Brief Description and Rationale

Information security is at the core of information and communication technologies (ICT). Organizations around the world go to great lengths to ensure important information is secure and reliable. As new technologies emerge — such as quantum information processing, which poses novel threats to information security — so too does the need to develop innovative strategies to guarantee data security.

Quantum computers will break some of the foundational pieces of our current cybersecurity infrastructure. It is imperative that new cryptography tools designed to be safe in an era with quantum computers be designed, implemented, standardized, tested, and deployed before quantum computers are available to adversaries.

It is therefore critical to develop these cutting-edge tools and train the next generation of Highly Qualified Personnel (HQP) in the field.

The 5-year-old CryptoWorks21 program (NSERC CREATE Training Program in Building a Workforce for the Cryptographic Infrastructure of the 21st Century) have been preparing this new generation of HQP to pioneer a new global infrastructure for quantum-safe cryptography. It is hosted by the University of Waterloo’s Centre for Applied Cryptographic Research (CACR) and the Institute for Quantum Computing (IQC). Since the program inception in 2012, the Program Director, Professor Mosca alongside industry and academic partners and collaborators have developed and delivered two important training programs: a Specialized Technical Skills and a Specialized Professional Skills program. These complementary programs have been preparing students in the CryptoWorks21(CW21) program ready to tackle forthcoming cryptographic challenges. The training programs have brought together researchers, organizations and industry members from a wide range of areas and expertise to ensure Canada’s HQP lead the current market for emerging technology research and development.
II. Objectives of the Program

Security in an era with quantum technologies is a growing concern for government and individuals around the world. The Institute for Quantum Computing at the University of Waterloo provides world renowned education in quantum computing. The proposed Graduate Diploma in Quantum-Safe Cryptography will provide the education necessary to protect against the security challenges posed by quantum advances. Graduates of the diploma program will go on to serve the global community as Highly Qualified Personnel with specialized skills. The Graduate Diploma in Quantum-Safe Cryptography aims to:

- Prepare a new generation of researchers to create quantum-safe tools for the 21st century
- Provide professional knowledge and technical skills for all researchers
- Foster collaboration between young scientists and experts in quantum and cryptographic research
- Enable students to build relationships with cryptographic communities in academia, industry, and government
- Encourage collaboration between students and partners in mathematics, computer science, physics and engineering
- Allow students to study, discuss, and investigate challenges and applications for quantum-safe cryptography

An illustration of the program's Learning Objectives as aligned with the Graduate Degree Learning Expectations can be found in Appendix A (Table XI-a).

III. Admissions Requirements

As a type 2 diploma program there would be no formal admissions procedure into the proposed program, once a student is admitted to a University of Waterloo graduate program they would be eligible to enroll in the Graduate Diploma in Quantum-Safe Cryptography. It is most likely that students who choose to pursue the Quantum-Safe Cryptography Diploma will register in one of the following programs:

MMath Computer Science
MMath Computer Science (QI)
PhD Computer Science
PhD Computer Science (QI)
MMath Combinatorics & Optimization
MMath Combinatorics & Optimization (QI)
PhD Combinatorics & Optimization
PhD Combinatorics & Optimization (QI)
MMath Pure Math
PhD Pure Math
MASc Electrical and Computer Engineering (including Nanotechnology)
MASc Electrical and Computer Engineering (QI)
PhD Electrical and Computer Engineering (including Nanotechnology)
PhD Electrical and Computer Engineering (QI)
MSc Physics (including Nanotechnology)
MSc Physics (QI)
PhD Physics (including Nanotechnology)
PhD Physics (QI)

Students in the above listed programs would indicate their intention to complete the Graduate Diploma by completing the QSC (Quantum-Safe Cryptography) Diploma Enrollment Form developed by CryptoWorks 21. The form will be posted on the CW21 website, available through the CW21 staff and linked from the Graduate Studies Academic Calendar. Students may complete the form at any time throughout their degree, however it is our hope that students interested in completing the diploma would complete the form early on in their graduate career. Once the QSC Diploma Enrollment form is received by the CW21 staff they could then track the students’ progress using QUEST and an internal tracking processes.

UW graduate students indicate on the Graduate Studies Intention to Graduate/Program Completion form that they have completed the Graduate Diploma in Quantum Safe Cryptography. If a student identifies the Graduate Diploma in Quantum Safe Cryptography on their intention to graduate from the GSO would then communicate the students name to CW21 staff at which time the CW21 staff would check that the student has completed all necessary components of the diploma.
IV. Degree Requirements

The Quantum-Safe Cryptography Diploma would require the completion of 4 (0.5) graduate level courses and three milestones. The requirements are divided into 2 areas of expertise; Technical and Professional, with a final milestone to incorporate the technical and professional knowledge.

The overall program requirements will be as follows;

**Technical**

- **2 (0.5) Courses in Quantum Safe Cryptography selected from list of approved courses**
- **1 Milestone in Technical Skills - completion of short modules or course alternatives in each of the skill areas**
  - BE 606 (0.5)
  - BE600 (0.5)

**Professional**

- **1 Milestone in Professional skills**
- **1 Milestone in Integration of Professional and Technical skills**

Please see below for more detailed information of the specific areas of expertise:

a. **Technical Courses and Milestones**

Students must gain knowledge in the following technical skills areas:
- Network security.
- (Conventional) Cryptography.
- Post-quantum cryptography.
- Quantum cryptography theory.
- Implementation of quantum communication.
- Quantum computation.

The default method for achieving the technical skills milestone will be to complete the respective 6 in-class modules. A module will consist of 6 hours of lecture and an assignment. A student can forgo any one of the 6 modules in favor of a listed course alternative in the corresponding skill area. Any graduate courses completed in this way can be used towards the course requirements for the Diploma.
The alternative courses for each technical skill area will be listed in the Graduate Studies Academic Calendar and can been seen in Table IV-a.

*Table IV-a: Course Alternatives*

<table>
<thead>
<tr>
<th>TECHNICAL SKILL AREA</th>
<th>SHORT MODULE</th>
<th>COURSE ALTERNATIVE (Other courses as approved by the CryptoWorks21 Technical Skills Committee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Security</td>
<td>CW21 Network Security module</td>
<td>CS 658, ECE 628</td>
</tr>
<tr>
<td>Cryptography</td>
<td>CW21 Cryptography module</td>
<td>CO 685, CO 687</td>
</tr>
<tr>
<td>Post-Quantum Cryptography</td>
<td>CW21 Post-Quantum Cryptography module</td>
<td>Currently no alternative</td>
</tr>
<tr>
<td>Quantum Cryptography Theory</td>
<td>CW21 Quantum Cryptography Theory module</td>
<td>QIC 890 (topic 2) Applied Quantum Cryptography</td>
</tr>
<tr>
<td>Implementation of Quantum Communication</td>
<td>CW21 Implementation of Quantum Communication module</td>
<td>QIC 890 (topic 3) Implementation of Quantum Communication</td>
</tr>
<tr>
<td>Quantum Computation</td>
<td>CW21 Quantum Computation module</td>
<td>QIC 710/AM 871/ CO 681/CS 768/PHYS 767</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO 481, CS 467, PHYS 467 (acceptable alternatives to milestones however Undergraduate courses cannot be counted towards the Diploma course requirements)</td>
</tr>
</tbody>
</table>

In addition to the technical skills area milestone requirements students must also complete the equivalent of 1.0 graduate level credits (commonly 2 graduate courses) from the list (to be included in the Graduate Studies Academic Calendar) below.

**Quantum-Safe Cryptography Courses** *(choose the equivalent of 1.0 graduate credits from the list below)*
CS 658 (0.5) Computer Security and Privacy
ECE 628 (0.5) Computer Network Security
CO 685 (0.5) The Mathematics of Public-Key Cryptography
CO 687 (0.5) Applied Cryptography
QIC 890 (0.5) Applied Quantum Cryptography (topic 2)
QIC 890 (0.5) Implementation of Quantum Communication (topic 3)
QIC 710/CS 768/AMATH 871/CO 681/PHYS 767 (0.5) Quantum Information Processing
QIC 890 (0.5) Topics in quantum-safe cryptography (topic 19)
Other courses as approved by the CryptoWorks21 Technical Skills Committee

For example, a student could choose to complete CS 658 & QIC 710 satisfying the Technical skill areas of Network Security and Quantum Computation. The student must then participate in the short modules for Cryptography, Post-Quantum Cryptography, Quantum Cryptography Theory and Implementation of Quantum Communication to fulfill the Technical Skills milestone. This method would also use CS 658 and QIC 710 to satisfy the two (0.5) course requirement in the technical portion of the diploma).

These areas represent the breadth of knowledge required to be able to understand and articulate the options for preparing a specific ICT system to be secure in the context of quantum computers. However, technical knowledge is not enough to evolve our ICT infrastructure to be safe in an era with quantum computers. To complement the technical knowledge, we have implemented a training track with 5 professional areas of knowledge.

a. Professional Courses and Milestones

The professional training for those participating in the diploma program will be gained through the completion of the two required courses, BE 600 and BE 606 and satisfaction of two additional milestones.

BE 600 and BE 606 will cover the following topics:

- IP Protection and Management
- Entrepreneurship and Commercialization
- Communication
Management

1 milestone in Standards and Certification will cover the fifth professional skill by the same name. It will be taught by experts in the fields that relate to this particular skill development. In the past, we have experts from National Institute of Standards and Technology, European Telecommunications Standards Institute, Microsoft, United Knowledge and UW. It will be taught over the course of two days with a culminating assignment. The workshop consists of overviewing of the standards, case studies, aligning standards to business models, certification and standards and certification for post-quantum cryptography etc.

The final milestone of the program will bring together the knowledge of technical and professional skills in the Integration of Professional and Technical skills milestone. This milestone will be offered as a two-day seminar with a culminating assignment and will inform students how to apply core concepts in entrepreneurship to a new venture or academic research. Students will use the Lean Launchpad approach to identify and validate problems and to arrive at executable research or a commercial solution.

How each of the courses and milestones will contribute to the program's overall learning outcomes is articulated in Appendix A (Table XI-b & Table XI-c).

Graduate Studies Program Revision Template is located in Appendix B
New milestone forms are located in Appendix C.

V. Program Structure
Students may join the Graduate Diploma on an ongoing basis, without an additional admission process there will be no need for a formal intake period. To earn the Graduate Diploma in Quantum-Safe Cryptography students must complete the equivalent of 4 (0.5) graduate level courses and three milestones. The program must be completed while the student is registered in their primary degree, students would be subject to the University standard timelines for
Masters and Doctoral programs completion. Masters and PhD students would have ample time satisfy the requirements during the course of their studies and are not expected to extend the timelines for their degree completion.

Students may choose to study on a full time or part-time basis to earn their diploma. This will occasionally be dictated by course offering and demands of the student's primary degree requirements.

The diploma program is structured in such a way that a student would be able to count courses completed as part of their graduate degree towards the requirements for the diploma program. Depending on the student's home faculty and graduate degree being sought there will be a different number of courses required above and beyond their degree requirements. Below is a table of the potential number of additional courses required for diploma completion. The information below is based on the current program requirements.

For example, a student in the diploma program could take CS 658 and CS 768. Based on the calendar entry for MMath in Computer Science (link below) the student would satisfy two CS courses from the table of CS approved courses (CS 658 and CS 768). The student would still have to fulfill the CS 800 level course requirement and 1 other from the CS approved list (above the 600 level) along with the milestone and BE 600 and BE 606 requirements for the diploma.
<table>
<thead>
<tr>
<th>Program</th>
<th>Number of Courses required for Degree</th>
<th>Potential number of courses that could be used towards Diploma (maximum 2)</th>
<th>Additional courses required for Degree</th>
<th>Additional courses required for Diploma (minimum 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMath Computer Science</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>MMath Computer Science (QI)</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PhD Computer Science (entry from Masters)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>PhD Computer Science (QI) (entry from QI Masters)</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Combinatorics and Optimization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMath Combinatorics &amp; Optimization</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MMath Combinatorics &amp; Optimization (QI)</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>PhD Combinatorics &amp; Optimization</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PhD Combinatorics &amp; Optimization (QI)</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Pure Math</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMath Pure Math</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PhD Pure Math</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Electrical and Computer Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASc Electrical and Computer Engineering</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>MASc Electrical and Computer Engineering</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>MASc Electrical and Computer Engineering (QI)</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PhD Electrical and Computer Engineering (entry from Masters)</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>PhD Electrical and Computer Engineering (Nanotechnology) (entry from Masters)</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>PhD Electrical and Computer Engineering (QI) (entry from a)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSc Physics</td>
<td>4</td>
<td>1+</td>
<td>&lt;3</td>
<td>~2</td>
</tr>
<tr>
<td>MSc Physics (Nanotechnology)</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>MSc Physics (QI)</td>
<td>4</td>
<td>1+</td>
<td>&lt;3</td>
<td>~2</td>
</tr>
<tr>
<td>PhD Physics (entry from Masters)</td>
<td>4</td>
<td>1+</td>
<td>&lt;3</td>
<td>~2</td>
</tr>
<tr>
<td>PhD Physics (Nanotechnology) (entry from non-NANO Masters)</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>PhD Physics (QI) (entry from QI Masters)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
The Offering schedule for the Quantum-Safe Cryptography courses delivered at UW is below.

Table V-b: Course Offering Schedule

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>QIC 710/AM 871/CO</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>681/CS 768/PC 767</td>
<td>X</td>
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<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QIC 890 (topic 3)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>QIC 890 (topic 19)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS 658</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ECE 628</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO 685</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CO 687</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td>X</td>
<td></td>
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<tr>
<td>CO 481/CS 467/PHY 467</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total courses</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

VI. Course Descriptions

QIC 710 Quantum Information Processing (0.50) LEC

(Cross-listed with AMATH 871, CO 681, CS 768, PHYS 767)

Review of basics of quantum information and computational complexity; Simple quantum algorithms; Quantum Fourier transform and Shor factoring algorithm: Amplitude amplification, Grover search algorithm and its optimality; Completely positive trace-preserving maps and Kraus representation; Non-locality and communication complexity; Physical realizations of quantum computation: requirements and examples; Quantum error-correction, including CSS codes, and elements of fault-tolerant computation; Quantum cryptography; Security proofs of quantum key distribution protocols; Quantum proof systems. Familiarity with theoretical computer science or quantum mechanics will also be an asset, though most students will not be familiar with both.
QIC 890 Topics in Quantum Information (0.50) LEC

2 Applied Qtm Cryptography
3 Impltn of Qtm Communication
19 Topics in Quantum-Safe Crypto

CS 467 LEC, TST 0.50 Introduction to Quantum Information Processing
Basics of computational complexity; basics of quantum information; quantum phenomena; quantum circuits and universality; relationship between quantum and classical complexity classes; simple quantum algorithms; quantum Fourier transform; Shor factoring algorithm; Grover search algorithm; physical realization of quantum computation; error-correction and fault-tolerance; quantum key distribution. [Offered: W]

CS 658 Computer Security and Privacy (0.50) LAB, LEC
Security and privacy issues in various aspects of computing. Specific topics include: comparing security and privacy, program security, writing secure programs, controls against program threats, operating system security, formal security models, network security, Internet application security and privacy, privacy-enhancing technologies, database security and privacy, inference data mining, security policies, physical security, economics of security, and legal and ethical issues. (Note: Knowledge of operating systems equivalent to that obtained from CS 350 is assumed.)

CO 481 LEC, TST 0.50 Introduction to Quantum Information Processing
Basics of computational complexity; basics of quantum information; quantum phenomena; quantum circuits and universality; relationship between quantum and classical complexity classes; simple quantum algorithms; quantum Fourier transform; Shor factoring algorithm; Grover search algorithm; physical realization of quantum computation; error-correction and fault-tolerance; quantum key distribution. [Offered: W]

CO 685 The Mathematics of Public-Key Cryptography (0.50) LEC
An in-depth study of public-key cryptography, including: number-theoretic problems - prime generation, integer factorization, discrete logarithms; public-key encryption; digital signatures; key establishment; secret sharing; and security definitions and proofs.

**CO 687 Applied Cryptography (0.50) LEC**
A broad introduction to cryptography, highlighting the major developments of the past twenty years, including symmetric ciphers, hash functions and data integrity, public-key encryption and digital signatures, key establishment, and key management. Applications to internet security, computer security, communications security, and electronic commerce will be studied.

**ECE 628 Computer Network Security (0.50) LEC**

**PHYS 467 LEC, TST 0.50 Introduction to Quantum Information Processing**
Basics of computational complexity; basics of quantum information; quantum phenomena; quantum circuits and universality; relationship between quantum and classical complexity classes; simple quantum algorithms; quantum Fourier transform; Shor factoring algorithm; Grover search algorithm; physical realization of quantum computation; error-correction and fault-tolerance; quantum key distribution. [Offered: W]

**BE 600 Management and Leadership (0.50)**
This course provides students with the opportunity to develop a range of soft skills and the business acumen necessary to maximize the likelihood of business success. Topics include communication and interpersonal skills, leadership, and negotiation skills. A range of applied
approaches are used, including integrated cases, simulations, and interaction with the local business community. MEng and GDip students only.

**BE 606 Entrepreneurship and innovation (0.50)**
This course introduces students to the theory underlying entrepreneurship, venture creation and innovation management, as well as its practical implications. Topics covered include introduction to entrepreneurship and innovation, the dynamics of innovation, corporate entrepreneurship and commercialization, venture creation and the management of high-performance innovative teams.

**VII. Mode of Delivery**
All instruction in the Quantum-Safe Cryptography program will be given face-to-face. The courses will be delivered in either the traditional weekly format or as intensive block courses. Block courses will be offered in the Spring terms, lasting between 1 and 2 weeks. The courses will have a credit weight of 0.5 and therefore require a total of 36 hours of lectures. It is reasonable to expect the lectures to be delivered over the course of 4-5 full days. This block course format may prove challenging for some students as it could affect their other registration during the spring term, however Table 3 indicates that there are significantly less course offerings in the Spring terms. Similarly, the intensive instruction model is growing in popularity at several Canadian Universities and the CryptoWorks21 has already implemented the equivalent of a 0.5 credit professional skills course in past spring terms in a 1-week period.

**VIII. Assessment of Teaching and Learning**

a. **Teaching Assessment**
To ensure the students are receiving the highest quality instruction and course content, the course registrants will be polled electronically with a number of specific and open ended questions. The responses will be collated and analyzed to inform future course content and instruction. As enrollment in the proposed Graduate Diploma in Quantum-Safe Cryptography increases there may be some merit in employing more formalized course evaluations, however
the current practice used by the CryptoWorks21 program could be used until such a change becomes necessary.

b. Learning Assessment

Each of the required courses will employ a number of different evaluation tools. Students will be expected to demonstrate the knowledge they have gained through completion of quizzes, written assignments, possible short research papers, and mock course proposals. Some of the technical courses will contain a final examination; the evaluation tools will be chosen at the discretion of the instructor.

The diploma program will include new graduate diploma seminar milestones to provide students the necessary training in Quantum-Safe Cryptography. The milestones will be evaluated by diploma faculty members and recorded as complete on the student’s transcript.

IX. Resources

The majority of the resources required to run the Graduate Diploma in Quantum-safe Cryptography are already in place and would not put any additional strain on the current funding model.

Teaching of the course material would continue to be offered by the existing faculty, in some cases with support from postdocs or visitors. Four of the five professional skills will be covered by courses to be offered by Conrad (and delivered as two 0.5 credit courses). CBET would be required to run additional sections of BE 600 and 606 for the diploma students. CBET has agreed to schedule the additional sections, enrollment in these sections will be controlled by permission numbers issued by CBET. The resources required to offer the special sections of BE600 and BE606 are between $42k and $90k per year. Mark Weber from CBET and Michele Mosca from CW21 have agreed on CBET’s teaching commitments. CW21 will compensate CBET via internal charge out to cover the cost of the per credit cost. A fraction of a CW21 staff person is needed to manage the administrative overhead.
It is unlikely that additional sections of the other listed alternative courses would be required as we are anticipating a small cohort of students to register in select courses over the course of their degree. Additionally, the students will have the freedom to enroll in the courses at any point during their degree meaning it is unlikely a large group of diploma students will enroll in the same course at the same time. Historically enrollment in the listed alternative courses is below the set cap (~5-15 students) which should allow for the registration of a few diploma students each offering. Similarly, there is no additional space, equipment or TA and Technical staff required for the diploma program.

The current CW21 staff members will take on the administrative tasks associated with the diploma program. Specifically, the staff will take on the tracking of students' progress through the program and communication with the Graduate Studies Office. There will be very little required of staff members in the departments associated with the diploma program. In some cases, staff in IQC and Conrad Business would be required to schedule an additional section of a course or issue permission numbers, these staff members are aware of this possibility and have no concerns with the work.

The CryptoWorks21 program will provide the necessary additional funding. CryptoWorks21 is currently funded by NSERC as well as matching funds from various university sources. In the course of 6-year grant period, CW21 have matching funds from the Provost office ($60k in year 1 and $120k for the subsequent years), Dean of Math ($20k in year 1 and $30k for the subsequent years), Dean of Science (same as Math), Dean of Engineering ($5k in year 1 and $10k for the subsequent years) and IQC ($15k in year 1 and $50k in subsequent years). We also have matching funds from our partner institutions ($30k in year 1 and $60k in subsequent years). The total of the matching funds contributes to a 100% match of NSERC CREATE grant.

Any additional funding will come from external sources. We are in the process of negotiating a substantial initial contribution of 2-3 years from a major sponsor (≥$100k per year), and are
continuing to explore various other industry and government contributions. There is widespread interest in this program from industry and government. This diploma aligns e.g. with the aims of a Cybersecurity NCE application we are participating in, as well as the Cybersecurity and Privacy Initiative underway at UW.

In addition to several other requests currently being pursued, there is sufficient balance in the current CryptoWorks21 matching funds to fund the first year of the program if needed.

X. Quality and Other Indicators
The city of Waterloo has attracted high caliber professionals in the field of cryptography in quantum context for several years. The Faculty involved with the proposed Quantum Safe Cryptography Graduate Diploma are highly visible leaders in the global community (as illustrated by their Curriculum Vitae in Appendix D). The caliber of the Faculty designing and instructing the program speaks to the overall quality of the program. The Faculty and Instructors represent a wide range of academic expertise that combine to cover the breadth of skills being taught in the program. As well as the current primary Faculty members, the program will call on guest speakers to give lectures and allow the students to receive the most relevant and up-to-date instruction available in the field.

XI. Projected Enrollment
Since its inception in 2012 the existing CryptoWorks 21 program has grown in population from 23 to 64 students. Applications to the current program are further evidence of the increased interest and need for a formalized program in Quantum Sake Cryptography. In its first year of existence the CW21 program received a total of 37 applications (from graduate students and postdoctoral fellows) since October 2013 CW21 has received an additional 229 applications (from graduate and postdoctoral fellows) with 161 of those applications received in the past 2 years. These numbers are a clear indication of the demand for programming specializing in Quantum-Safe Cryptography. It is our expectation that with a specific credential attached to the specialized training the program will attract a small class, about 15 students, in year one of
the program. Based on the existing CW21 program enrolment, we anticipate a 50/50 split
between domestic and International students.

Considering the growth rate of the CW21 program we anticipate enrollment to grow steadily
with each academic cycle. Admission to the Graduate Diploma in Quantum Safe Cryptography
would be granted to any student already admitted to a University of Waterloo graduate
program. It is most likely that students who choose to pursue the Quantum-Safe Cryptography
Diploma will be registered in the programs we listed in the admissions section.

Demand for experts in Information Protection increases each day with the growing cases of
compromised security. As demand grows we will be offering a credential not widely available in
the academic community. Market demand should ensure strong initial enrollment from current
University of Waterloo students and have the potential attract students to enroll at the
University to have access to this unique diploma program.
Appendix A

Program Outcomes
Courses to Outcomes
Courses to Expectations
<table>
<thead>
<tr>
<th>PROGRAM OUTCOMES</th>
<th>1. Depth and Breadth of Knowledge</th>
<th>2. Research and Scholarship</th>
<th>3. Level of Application of Knowledge</th>
<th>4. Professional Capacity/Autonomy</th>
<th>5. Level of Communications Skills</th>
<th>6. Awareness of Limits of Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>To understand how cryptography is used to protect our cyber systems</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>To understand the impact quantum technologies will have on current cyber infrastructure</td>
<td>x</td>
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<tr>
<td>To understand both the quantum and classical solutions to the quantum threat, and their respective strengths and weaknesses</td>
<td>x</td>
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<tr>
<td>To understand the current state of implementation of quantum computing and of quantum-safe cryptography</td>
<td>x</td>
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<tr>
<td>To understand the challenges of turning new technology into commercializable products and services</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>To understand the challenges of bringing new cryptographic methods to wide-scale deployment</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>To be able to communicate the problem and opportunity posted by emerging quantum technologies to a range of relevant stakeholders</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>To understand standards and certification and their role in wide-scale deployment of new cryptographic technology</td>
<td>x</td>
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<td>x</td>
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</table>
### Courses and Key Learning Experiences

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>Milestones</th>
<th>Elective Courses (2 of the following required)</th>
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<tbody>
<tr>
<td>BE606</td>
<td>BE600</td>
<td><a href="#">BE606</a> Technical Skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="#">BE600</a> Standards &amp; Certification</td>
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<tr>
<td></td>
<td></td>
<td><a href="#">CS658/E</a> Integration of Technical Skills</td>
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<tr>
<td></td>
<td></td>
<td><a href="#">CE628</a> Professional Skills</td>
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<tr>
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<td><a href="#">CO685/C</a></td>
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<td><a href="#">O687</a></td>
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<td><a href="#">QIC890</a> (topic 2)</td>
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<td><a href="#">QIC890</a> (topic 3)</td>
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<td><a href="#">QIC891</a> (topic 5)</td>
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<td></td>
<td></td>
<td><a href="#">QIC710/C</a> O481/CS4 67/PHYS4 67</td>
</tr>
</tbody>
</table>

**Courses & Key Learning Experiences**

- **To understand how cryptography is used to protect our cyber systems**
  - BE606
  - BE600
  - Technical Skills
  - Standards & Certification
  - Integration of Technical and Professional Skills
  - CS658/E
  - CE628
  - CO685/C
  - O687
  - QIC890 (topic 2)
  - QIC890 (topic 3)
  - QIC891 (topic 5)
  - QIC710/C O481/CS4 67/PHYS4 67

- **To understand the impact quantum technologies will have on current cyber infrastructure**
  - BE606
  - BE600
  - Technical Skills
  - Standards & Certification
  - Integration of Technical and Professional Skills
  - CS658/E
  - CE628
  - CO685/C
  - O687
  - QIC890 (topic 2)
  - QIC890 (topic 3)
  - QIC891 (topic 5)
  - QIC710/C O481/CS4 67/PHYS4 67

- **To understand both the quantum and classical solutions to the quantum threat, and their respective strengths and weaknesses**
  - BE606
  - BE600
  - Technical Skills
  - Standards & Certification
  - Integration of Technical and Professional Skills
  - CS658/E
  - CE628
  - CO685/C
  - O687
  - QIC890 (topic 2)
  - QIC890 (topic 3)
  - QIC891 (topic 5)
  - QIC710/C O481/CS4 67/PHYS4 67

- **To understand the current state of implementation of quantum computing and of quantum-safe cryptography**
  - BE606
  - BE600
  - Technical Skills
  - Standards & Certification
  - Integration of Technical and Professional Skills
  - CS658/E
  - CE628
  - CO685/C
  - O687
  - QIC890 (topic 2)
  - QIC890 (topic 3)
  - QIC891 (topic 5)
  - QIC710/C O481/CS4 67/PHYS4 67

- **To understand the challenges of turning**
  - BE606
  - BE600
  - Technical Skills
  - Standards & Certification
  - Integration of Technical and Professional Skills
  - CS658/E
  - CE628
  - CO685/C
  - O687
  - QIC890 (topic 2)
  - QIC890 (topic 3)
  - QIC891 (topic 5)
  - QIC710/C O481/CS4 67/PHYS4 67
| New technology into commercializable products and services | | | | | | | | |
|---|---|---|---|---|---|---|---|
| To understand the challenges of bringing new cryptographic methods to wide-scale deployment | x | x | x | x | x | | |
| To be able to communicate the problem and opportunity posted by emerging quantum technologies to a range of relevant stakeholders | x | x | x | | | | |
| To understand standards and certification and their role in wide-scale deployment of new cryptographic technology | x | x | | x | | | |
### Courses and Key Learning Experiences

<table>
<thead>
<tr>
<th>Core Courses</th>
<th>Milestones</th>
<th>Elective Courses (2 of the following required)</th>
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<tbody>
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<td>BE606</td>
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<tr>
<td><strong>1. Depth and Breadth of Knowledge</strong></td>
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<tr>
<td>A systematic understanding of knowledge and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their academic discipline, field of study, or area of professional practice;</td>
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<tr>
<td><strong>2. Research and Scholarship</strong></td>
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<tr>
<td>A conceptual understanding and methodological competence that:</td>
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<tr>
<td>I) Enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline;</td>
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ii) Enables a critical evaluation of current research and advanced research and scholarship in the discipline or area of professional competence;

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iii) Enables a treatment of complex issues and judgments based on established principles and techniques; and,

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On the basis of that competence, has shown at least one of the following:

i) The development and support of a sustained argument in written form; or

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ii) Originality in the application of knowledge.

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3. Level of Application of Knowledge

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Competence in the research process by applying an existing body of knowledge into the critical analysis of a new question or of a specific problem or issue in a new setting.

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4. Professional Capacity/Autonomy

a. The qualities and transferable skills necessary for employment requiring:

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i) The exercise of initiative and of personal responsibility and accountability;

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27

266
| ii) Decision-making in complex situations; | x | x | x | x |
| b. The intellectual independence required for continuing professional development; | x | x |  | x |
| c. The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and | x | x |  | x |
| d. The ability to appreciate the broader implications of applying knowledge to particular contexts. | x | x |  | x |
| 5. Level of Communications Skills | | | | |
| The ability to communicate ideas, issues and conclusions clearly. | x | x |  | x |
| 6. Awareness of Limits of Knowledge | | | | |
| Cognizance of the complexity of knowledge and of the potential contributions of other interpretations, methods, and disciplines. | x | x |  | x | x | x | x | x | x |
Appendix B

Graduate Studies Program Revision Template
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: Mathematics

Program: Graduate Diploma (GDip) in Quantum-Safe Cryptography

Program contact name(s): Michele Mosca

Form completed by: Jessica Parris

a. 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).

See attached program proposal, including the SGRC Course/Milestone-New/Revision/Inactivation forms.

Is this a major modification to the program? Yes

Rationale for change(s):

See attached program proposal.

Proposed effective date: Term: Winter Year: 2018

Current Graduate Studies Academic Calendar (GSAC) page (include the link to the web page where the changes are to be made):

No current GSAC content (new program). Content will be located in the Department of Combinatorics and Optimization section of the GSAC:

https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-combinatorics-and-optimization
### Graduate Diploma (GDip) in Quantum-Safe Cryptography

#### Program information

- **Delivery mode**
  - On-campus
- **Program type**
  - Diploma
- **Study option(s)**
  - Coursework

#### Admission requirements

- **Minimum requirements**
  - The Graduate Diploma (GDip) in Quantum-Safe Cryptography is offered in conjunction with existing master's or doctoral degrees. To be eligible for the GDip in Quantum-Safe Cryptography, students have to be enrolled in a master's or doctoral program in a department that already offers an approved graduate degree.
  - Students from any faculty may indicate their intent to enroll in the GDip in Quantum-Safe Cryptography by completing the QSC (Quantum-Safe Cryptography) Diploma Enrollment Form, available on the Cryptoworks 21 website.

#### Degree requirements

**Coursework option:**

- **Courses**
  - To receive the GDip in Quantum-Safe Cryptography, students must successfully complete 4 one-term (0.50) graduate level courses, 2 required courses and 2 elective courses:
    - Required courses:
      - BE 600 Management and Leadership
      - BE 606 Entrepreneurship and Innovation
    - Elective courses (choose 2 from the following list):
      - CO 685 The Mathematics of Public-Key Cryptography
      - CO 687 Applied Cryptography
      - CS 658 Computer Security and Privacy
      - ECE 628 Computer Network Security
      - QIC 710/AMATH 871/CO 681/CS 768/PHYS 767 Quantum Information Processing
      - QIC 890 Topic 2 Topics in Quantum Information: Applied Quantum Cryptography
      - QIC 890 Topic 3 Topics in Quantum Information: Implementation of Quantum Communication
Current Graduate Studies Academic Calendar content: | Proposed Graduate Studies Academic Calendar content:

- QIC 890 Topic 19 Topics in Quantum Information: Topics in Quantum-Safe Cryptography
- Other courses as approved by the CryptoWorks 21 Technical Skills Committee.

- **Link(s) to courses**
  - Combinatorics and Optimization (CO) courses
  - Graduate course search

- **Diploma Seminar 1 – Technical Skills**

Students must complete 6 in-class modules (or the listed course alternative), a module will consist of 6 hours of lecture and an assignment. Students can forgo any one of the 6 modules in favor of a listed course alternative in the corresponding skill area. Any graduate courses completed in this way can be used towards the course requirements for the GDip.

<table>
<thead>
<tr>
<th>TECHNICAL SKILL AREA</th>
<th>SHORT MODULE</th>
<th>COURSE ALTERNATIVE (other courses as approved by the CryptoWorks21 Technical Skills Committee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Security</td>
<td>CW21 Network Security module</td>
<td>CS 658, ECE 628</td>
</tr>
<tr>
<td>Cryptography</td>
<td>CW21 Cryptography module</td>
<td>CO 685, CO 687</td>
</tr>
<tr>
<td>Post-Quantum Cryptography</td>
<td>CW21 Post-Quantum Cryptography module</td>
<td>Currently no alternative</td>
</tr>
<tr>
<td>Quantum Cryptography Theory</td>
<td>CW21 Quantum Cryptography Theory module</td>
<td>QIC 890 Topic 2 Applied Quantum Cryptography</td>
</tr>
<tr>
<td>Implementation of Quantum Communication</td>
<td>CW21 Implementation of Quantum Communication module</td>
<td>QIC 890 Topic 3 Implementation of Quantum Communication</td>
</tr>
<tr>
<td>Quantum Computation</td>
<td>CW21 Quantum Computation module</td>
<td>QIC 710/AMATH 871/CO 681/CS 768/PHYS 767</td>
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<tr>
<td></td>
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<td>CO 481, CS 467, PHYS 467</td>
</tr>
<tr>
<td>Current Graduate Studies Academic Calendar content:</td>
<td>Proposed Graduate Studies Academic Calendar content:</td>
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<td>-------------------------------------------------</td>
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<tr>
<td>(acceptable alternatives for milestones, however, Undergraduate courses cannot be counted towards the GDip course requirements)</td>
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## Diploma Seminar 2 – Standards and Certification

Completion of a 2-day workshop with culminating assignment.

This milestone will focus on the importance of standards and certification when introducing new technologies to the marketplace and the avenues for standardization and certification of quantum-safe cryptographic technologies.

Students will develop an understanding of several components of these topics including:

- Standards
- Relevance
- Importance for deployability
- Competitiveness
- Large-scale adoption
- Compliance organizations and development

## Diploma Seminar 3 – Integration of Professional and Technical Skills

Completion of a 2-day workshop with culminating assignment.

This seminar will inform students how to apply core concepts in entrepreneurship to a new venture or academic research. Students will use the Lean Launchpad approach to identify and validate problems and to arrive at executable research or a commercial solution. The intended learning outcomes for the milestone are:

- Define the lean canvas and explain its purpose.
- Distinguish and summarize the difference between the product and market, understand their fit and articulate the definition of: key metrics, unique value proposition, unfair advantage, channels, customer segments, cost structure and revenue streams.
- Construct customer profiles; engage in customer development and product market validation for an academic project or new venture.
- Develop an applicable intellectual property strategy to their product and idea.
- Assemble a pitch and be able to effectively present and articulate their business idea or research project clearly.
- Provide alternative views to expand and support their research and testing.

How will students currently registered in the program be impacted by these changes?
Section will expand to accommodate content. Please include details here.

**Departmental approval date** (mm/dd/yy):
**Reviewed by GSO** (for GSO use only) □ date (mm/dd/yy):
**Faculty approval date** (mm/dd/yy):
**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):
**Senate approval date** (mm/dd/yy) (if applicable):
Appendix C

New Milestones

Integration of Technical and Professional Skills

Standards and Certification

Technical Skills
Faculty: Math
Effective term: Term/Year Spring 2017
Course ☐ New ☐ Revision ☐ Inactivation ☐
Milestone ☒ New ☒ Revision ☐ Inactivation ☐

New milestone title: Graduate Diploma Seminar

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/heldwith:

Rationale for request:
Integration of Technical and Professional Skills
This seminar will inform students how to apply core concepts in entrepreneurship to a new venture or academic research. Students will use the Lean Launchpad approach to identify and validate problems and to arrive at executable research or a commercial solution. The intended learning outcome for the milestone:
• Define the lean canvas and explain its purpose.
• Distinguish and summarize the difference between the product and market, understand their fit and articulate the definition of: key metrics, unique value proposition, unfair advantage, channels, customer segments, cost structure and revenue streams.
• Construct customer profiles; engage in customer development and product market validation for an academic project or new venture.
• Develop an applicable intellectual property strategy to their product and idea.
• Assemble a pitch and be able to effectively present and articulate their business idea or research project clearly.
Provide alternative views to expand and support their research and testing.

Prepared by: Date: Click here to enter a date.
Faculty: Math  
Effective term: Term/Year Spring 2017

Course ☐ New ☐ Revision ☐ Inactivation ☐  
Milestone ☒ New ☒ Revision ☐ Inactivation ☐

New milestone title: Graduate Diploma Seminar

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/heldwith:

Rationale for request:

Standards and Certification Seminar

This milestone will focus on the importance of standards and certification when introducing new technologies to the marketplace and the avenues for standardization and certification of quantum-safe cryptographic technologies.

Students will develop an understanding of several components of these topics including:  
• Standards  
• Relevance  
• Importance for deployability  
• Competitiveness  
• Large-scale adoption  
• Compliance organizations and development

Prepared by: Date: Click here to enter a date.
Faculty: Math
Effective term: Term/Year Spring 2017

Course ☐ New ☐ Revision ☐ Inactivation ☐
Milestone ☒ New ☒ Revision ☐ Inactivation ☐

New milestone title: Graduate Diploma Seminar

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/heldwith:

Rationale for request:

Technical Skills Seminar

The goal of this seminar is to teach Quantum and Crypto students about the Technical Skills required to become Highly Qualified Personell (HQP) in the quantum safe cryptography. The seminars will cover the following technical skills areas:

- Network security.
- (Conventional) Cryptography.
- Post-quantum cryptography.
- Quantum cryptography theory.
- Implementation of quantum communication.
- Quantum computation.

Prepared by:
Date: Click here to enter a date.
Appendix D
Curriculum Vitae

Bartholomew, Rachel
Beynon, Wm Douglas
Hurwitz, Marc
Jao, David
Jennewein, Thomas
Lutkenhaus, Norbert
Menezes, Alfred
Mosca, Michele
Weber, J. Mark
Curriculum Vitae

a) **NAME:** (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)
Bartholomew, Rachel
Industry Professional
Member of the Graduate Faculty: no

b) **DEGREES:** designation, institution, department, year
MBA  Entrepreneurship and Technology, University of Waterloo, 2014.
BBA  Information Technology Management, York University, 2013.

c) **EMPLOYMENT HISTORY:** dates, rank/position, department, institution/firm
Nov. 2016-present  Manager of Innovation, Meridian Credit Union
Aug. 2016-present  Co-Founder, Servii.io
April 2016-Oct. 2016  Business Development Manager, Advanced Chemical Technologies
July 2015-Nov. 2015  Product Development Manage, 4D Virtual Space
April 2014-Aug. 2015  Entrepreneurial Advisor and Instructor, Conrad Centre for Business, Entrepreneurship and Technology
April 2013-Jan. 2014  Head of Marketing and Finance, TebMed

d) **HONOURS:** (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)
Certifications:
2014  Project Management Professional
2014  Technical Sales
2014  Fundamentals of Management Consulting
2016-present  Chartered Investment Manager
e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES:** past 7 years only (eg. executive and editorial positions but not memberships in societies)

f) **GRADUATE SUPERVISIONS:** masters, doctoral, postdoctoral - completed/in progress

g) **GRADUATE COURSES:** past 7 years, by year

1. **EXTERNAL RESEARCH FUNDING:** past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

2. **INTERNAL RESEARCH FUNDING:** This includes university funds, SSHRC minor grants awarded through the University,

h) **PUBLICATIONS:** The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored .................................................................................................................................
- Books edited ....................................................................................................................................... 
- Chapters in books ...................................................................................................................................
- Papers in refereed journal .....................................................................................................................
- Papers in refereed conference proceedings. ..........................................................................................
- Technical reports .................................................................................................................................
- Abstracts and/or papers read .................................................................................................................
- Others (workshops presented) .............................................................................................................

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.
Curriculum Vitae

a) **NAME**: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)
   Beynon, Wm Douglas
   Industry Professional
   Member of the Graduate Faculty: no

b) **DEGREES**: designation, institution, department, year
   BASc  Mechanical Engineering, University of Waterloo, 1970.

c) **EMPLOYMENT HISTORY**: dates, rank/position, department, institution/firm
   2015-present  Director and CEO, Advanced Chemical Technologies
   2013-present  President, Keiretsu Forum, Waterloo Chapter
   2009-present  President, Beynon Enterprises
   2009-present  Entrepreneur-in-Residence, the Conrad Business, Entrepreneurship & Technology Centre, University of Waterloo
   2012-present  Facilitator, Innovators Alliance
   2011-2014  CEO, Technology Convergence Inc.
   2010-2011  Co-CEO Brandlogo Communications Inc.
   2009-2010  Co-CEO Square Foot Media, Inc.
   2003-2009  Founder and Chair of the Advisory Council, Conrad Business Entrepreneurship & Technology Centre, University of Waterloo
   1999-2012  Member, Innovator’s Alliance
   1993-1998  Founder and Board Member, Environmental Business Network, Waterloo/Guelph
   1993-1998  Vice President Waterloo Region, OCETA
   1987-1993  Co-Founder and Member, Executive Development Group, Waterloo
   1983-2009  Managing Partner, Beynon Howes
   1983-1985  Manager, Reed Medical Group
1977-1983  Vice President R&D, Organizational Systems Inc.
1977-1978  Visiting Professor, Business, University of Kansas
1976-1977  Assistant Professor, Commerce, Simon Fraser University

d) **HONOURS:** (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)

e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES:** past 7 years only (eg. executive and editorial positions but not memberships in societies)

**Executive**
2013-present  Board Member, SponsorsOne Inc.
2003-2012  Board Member & Chair, BLOOM (formerly the Ontario Centre for Environmental Technology Advancement - OCETA)
2012-present  Board Member, Electrical Contacts Limited (ECL)
2012-present  Board Member, Ubiquity Solar Inc
2012-present  Board Member, PinPoint Cayman Holdings Inc

f) **GRADUATE SUPERVISIONS:** masters, doctoral, postdoctoral - completed/in progress

g) **GRADUATE COURSES:** past 7 years, by year

h) **EXTERNAL RESEARCH FUNDING:** past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

*Type: C-Granting councils; G-Government; F-Foundations; O-Other
** Purpose: research, travel, publication, etc.

2. **INTERNAL RESEARCH FUNDING:** *This includes university funds, SSHRC minor grants awarded through the University, etc.*

i) **PUBLICATIONS:** *The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters*
contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored ..........................................................................................................................
- Books edited .............................................................................................................................
- Chapters in books ....................................................................................................................
- Papers in refereed journal ....................................................................................................... 
- Papers in refereed conference proceedings ...........................................................................
- Technical reports ....................................................................................................................
- Abstracts and/or papers read ....................................................................................................
- Others (workshops presented) .................................................................................................

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.
Curriculum Vitae

a) NAME: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Hurwitz, Marc
Assistant professor, tenured
Member of the Graduate Faculty: yes

b) DEGREES: designation, institution, department, year

Ph.D. Cognitive Neuroscience, University of Waterloo, 2010.
MBA Wilfrid Laurier University, 2000.
MSc Applied Mathematics, University of Guelph, 1988.
MSc Nuclear Physics, McMaster University, 1984.
BSc Theoretical Physics, University of Guelph, 1983.
Certified Employee Benefit Specialist, 2005.

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm

2014-present Associate Director, Undergraduate Studies & Lecturer, Conrad Business, Entrepreneurship and Technology Centre, University of Waterloo.
2002-2014 Assistant Professor & Instructor, Wilfrid Laurier University.
2006-present Founding partner, Chief Insight Officer, FlipSkills Consulting & Flip University.
2006-2014 Consulting partner, Thinkx IC.
1997-2006 Assistant Vice President Marketing & Communications, AVP Web Integration (Group Benefits), Manulife Financial.
1997-1999 Training Manager (HRIS); Performance Improvement Consultant (Wealth Management), Manulife Financial.

d) HONOURS: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)


e) SCHOLARLY AND PROFESSIONAL ACTIVITIES: past 7 years only (eg. executive and editorial positions but not memberships in societies)
f) GRADUATE SUPERVISIONS: masters, doctoral, postdoctoral - completed/in progress

NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:

g) GRADUATE COURSES: past 7 years, by year

h) 1. EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

*Type: C-Granting councils; G-Government; F-Foundations; O-Other

** Purpose: research, travel, publication, etc.

2. INTERNAL RESEARCH FUNDING: This includes university funds, SSHRC minor grants awarded through the University, etc]

i) PUBLICATIONS: The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers.

Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored ................................................................. 2
- Books edited ................................................................. 0
- Chapters in books ......................................................... 3
- Papers in refereed journal ............................................. 9
- Papers in refereed conference proceedings ..................... 8
- Professional Publications ............................................. 2
- Abstracts and/or papers read ......................................... 0
- Others (workshops presented) .................................... 23

   2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Books authored:


Chapters in Books:


Papers in refereed Journals:


Papers in refereed conference proceedings:


c. Professional Publications:


Others (workshops presented):

1. US Department of Defense
2. U.S. military
3. Schlegel Villages
4. Strategic Capabilities Network
5. Desire-2-Learn
6. Mennonite Economic Development Association
7. Institute for Performance and Development (formerly: Canadian Society of Training & Development)
8. Conference Board of Canada
9. Leadership Waterloo
10. Association for Talent Development (formerly ASTD)
11. EngineeringCareerCoach.com
12. NAV Canada
13. ILA
14. CPA Canada
15. CPA Ontario
16. Institute for Public Administration Canada
17. Global Project Management Institute
18. Canadian Food Inspection Agency
19. Seth Hospitality
20. Microsoft
21. University of Waterloo
22. City of Edmonton
23. Cambridge Food Ban
Curriculum Vitae

a) **NAME**: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Jao, David Y.

Associate professor, not tenured

Member of the Graduate Faculty: yes

b) **DEGREES**: designation, institution, department, year

Ph.D. Department of Mathematics, Harvard University, Cambridge, MA, 2003

S.B., Mathematics, Massachusetts Institute of Technology, Cambridge, MA, 1998

c) **EMPLOYMENT HISTORY**: dates, rank/position, department, institution/firm

2014-present- Director, Centre for Applied Cryptography Research (CARC)

2011-present- Associate Professor, Department of Combinatorics & Optimization,

University of Waterloo

2006-2011- Assistant Professor, Department of Combinatorics & Optimization,

University of Waterloo

2003-2006- Post-doctoral Researcher, Microsoft Research

d) **HONOURS**: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)

Ontario Ministry of Research and Innovation, Early Researcher Award, 2009

Sigma Xi, The Scientific Research Society, Full membership, 2007

Harvard University, Certificate of Distinction in Teaching, 2003

National Defense Science and Engineering (NDSEG) Graduate Fellowship, 1999

National Science Foundation, NSF Graduate Research Fellowship, 1999

Massachusetts Institute of Technology, Jon A. Bucsela Prize in Mathematics, 1998

Top 25 in the William Lowell Putnam Mathematical Competition, 1997

Barry M. Goldwater Scholarship, 1996.

e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES**: past 7 years only (eg. executive and editorial positions but not memberships in societies)

Program Committee membership:
PQCrypto, 2014-2016
ICISC, 2009-2016
TAMC, 2013
IMACC, 2011
SAC 2010

Refereeing activities
ANTS XII
Math. Comp.
IWSEC 2011
RAIRO ITA
Des. Codes & Crypt.
Graphs & Combinatorics,
Pairing 2010
Canada J. Math
J. Cryptology
ARITH-17.

f) GRADUATE SUPERVISIONS: masters, doctoral, postdoctoral - completed/in progress
Completed: 10 MMath, 1 Ph.D,
In progress: 1 MMath, 5 Ph.D, 8 PDF

NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:
Youngho Yoo (current)
Dhinakaran Vinayagamurthy (current)
Jason LeGrow (current)
Christopher Leonardi (current)
Luis Ruiz-Lopez (current)
Gabriel Gauthier-Shalom (current)
Zhe Liu (current)
Geovandro C.C.F. Pereira (current)
Javad Doliskani (current)
Jean-François Biasse (current)
Kassem Kalach (current)
Reza Azarderakhsh (current)
Luca De Feo (current)
Patrick Longa (current)
Vladimir Soukharev (Dec. 2016)
Jason LeGrow (Apr. 2016)
Christopher Leonardi (Apr. 2016)
Luis Ruiz-Lopez (Aug. 2015)
Anirudh Sankar (Aug. 2015)
Dieter Fishbein (Apr. 2014)
Yik-Siong Kok (Apr. 2013)
Gurleen Grewal (Apr. 2012)
Vladimir Soukharev (Dec. 2010)

**g) GRADUATE COURSES:** *past 7 years, by year*

**Lectures:**

C&O 250—Introduction to Optimization (Winter 2017)
C&O 456—Introduction to Game Theory (Fall 2016)
Math 239—Introduction to Combinatorics (Fall 2016, Winter 2015, Fall 2010, Fall 2009, Spring 2009, Fall 2008, Fall 2007)
C&O 789—Lattice-based Cryptography (Fall 2015)
C&O 485/685—Public-Key Cryptography (Fall 2015, Fall 2014, Fall 2013, Fall 2010, Fall 2009, Fall 2008, Fall 2007)
Math 145—Algebra, Advanced Level (Fall 2014, Fall 2013, Fall 2011)
h) 1. EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

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<td>2011-2013</td>
<td>NSERC Collaborative</td>
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<td>$66,000/year</td>
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<td>2009-2014</td>
<td>Ontario Ministry of Research</td>
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<td>$30,000/year</td>
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<td>&amp; Innovation Early Research Award</td>
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*Type: C-Granting councils; G-Government; F-Foundations; O-Other, m

** Purpose: research, travel, publication, etc.

2. INTERNAL RESEARCH FUNDING: This includes university funds, SSHRC minor grants awarded through the University, etc.]

i) PUBLICATIONS: The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored..............................................................................................................................
- Books edited .................................................................................................................................
- Chapters in books ............................................................................................................................ 1
- Papers in refereed journal ................................................................................................................. 7
-Papers in refereed conference proceedings ............................................................. 18
-Technical reports ...........................................................................................................
-AAbstracts and/or papers read ........................................................................................
-Others (workshops presented) ......................................................................................... 22
-Patents ............................................................................................................................. 7

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

**Chapters in Books:**


**Papers in refereed Journals:**


**Papers in Refereed Conference Proceedings:**


Others (workshops presented):


PIMS Workshop on Abelian Varieties in Cryptography, University of Calgary, AB, May 2015.


Canadian Mathematical Society Summer Meeting (Number Theory special session), University of Regina, SK, Jun. 2012.
Workshop on Elliptic Curve Cryptography, INRIA (Nancy, France), Sep. 2011.
CANS 2016, Universit`a degli Studi di Milano, Milan, Nov. 2016.
PQCrypto 2011, National Taiwan University, Nov. 2011.
Curriculum Vitae

a) NAME: rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Jennewein, Thomas
Associate Professor, Tenured
Member of the Graduate Faculty, Yes

b) DEGREES: designation, institution, department, year

Doctorate Equivalent, Experimental Physics-Quantum Optics, University of Vienna, 2002
Masters Equivalent, Experimental Physics-Quantum Optics, University of Innsbruck, 1997
BSc, Experimental Physics, University of Innsbruck, 1995

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm

2015-Present  Full Professor, Physics and Astronomy, University of Waterloo
2009-2015  IQC Associate Professor, Physics and Astronomy, University of Waterloo
2004-2009  External Lecturer, Physics, University of Vienna
2004-2009  Senior Scientist, Institute for Quantum Optics, Austrian Academy of Sciences
2007-2008  Research Visitor, Physics, University of Brisbane, University of Queensland
2003-2004  Engineering Consultant, Berata GmbH
1999-2003  University Assistant, Experimental Physics, University of Vienna
1999-2000  Army Service, Austrian Army
1997-1999  University Assistant, Experimental Physics, University of Innsbruck, Leopold Franzens Universitat
d) **HONOURS:** *(F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)*

Early Researcher Award, 2011
International Research Fellowship of the Australian Research Council, 2007

e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES:** *past 7 years only (eg. executive and editorial positions but not memberships in societies)*

**International Collaboration:**
Sept. 2010   Collaborator, Spain, Collaborated with Adan Cabello at the University of Seville on experiments on qutrit protocols and fundamental experiments, as well as loop-hole free Bell-tests using photon converters.

July 2011-Aug. 2012 Collaborator, Italy, Collaborated with Paolo Villoresi at University of Padova on investigation of adaptive optics for quantum communications in free space.

Sept. 2011   Collaborator, Australia, Collaborated with Daniel Terno at Macquarie University on photonic quantum information in curved space time; testing the coupling between orbital angular momentum and spin; foundations of quantum physics.

Jan. 2012   Collaborator, Italy, Collaborated with Alberto Tosi at the Polytechnic University of Milan in an experimental study of advanced single-photon detectors and arrays, such as entangled photons from GaAs samples, and a two-photon single-photon spectrometer and interferences.

Jan. 2012   Collaborator, Australia, Collaboration with Tim Ralph at the University of Queensland on photonics quantum information in curved spacetime.

Sept. 2012   Collaborator, United States, Collaboration with Sae-Woo Nam at NIST on GHZ-entangled photon triplets generated from cascaded SPDC, and on future data acquisition and time-tagging devices.

Aug. 2012   Collaborator, Austria, Collaboration with Anton Zeilinger and Rupert Ursin at the University of Vienna on the European quantum satellite project "Space-QUEST", and quantum Teleportation over 144 km, and continuous collaboration on quantum satellites in space.
Sept. 2013  Collaborator, Poland, Collaborated with Piotr Kolenderski at the Nicolaus Copernicus University in Torun on experimental implementations of spectrally pure photons from SPDC.

May 2013  Collaborator, United Kingdom, Collaboration with Ivette Fuentes at the University of Nottingham, and her group, on entanglement in relativistic settings.


f) GRADUATE SUPERVISIONS: masters, doctoral, postdoctoral - completed/in progress

Completed:  8 Master, 5 Ph.D., 8 PDF
In Progress:  1 Master, 4 Ph.D., 3 PDF

NAME OF STUDENTS  supervised within the past seven years, title of thesis of project, year of first registration and year of completion:

- Jennifer Fernick (Master), Components for Free Space Communications, 2014-Present
- Nigar Sultana (Master), Detectors for Telecom Photons based on a NFAD, 2013-Present
- Evan Meyer-Scott (Master), QKD in challenging and novel scenarios, 2009-2011
- Catherine Holloway (Master), Quantum Cryptography in standard telecom infrastructure, 2010-2012
- Chris Pugh (Master), Adaptive optics for quantum communications, 2011-2013
- Nick Gigov (Master), A embedded system for satellite based QKD, 2011-2013
- Thomas Lutz (Master), Entangled Photon sources with Frequency Uncorrelated Spectra, 2012-2013
- Aimee Heinrichs (Gunther) (Master), Two Photon Absorption Enhanced by Entanglement, 2011-2013
- Rolf Horn (Ph.D.), Novel waveguide sources of entanglement, 2009-2011
- Deny Hamel (Ph.D.), High efficient sources of entangled photons, 2010-2013
- Jean Phillippe Bourgoin (Ph.D.), Towards satellite quantum key distribution, 2010-2014
- Evan Meyer Scott (Ph.D.), Quantum Key Distribution with Device Independence,
2011-Present
• Catherine Holloway (Ph.D.), Quantum Satellite Payload Demonstrator, 2013-Present
• Elena Anisimova (Ph.D.), Single Photon Detectors suitable for Space Environment, 2013-Present
• Sarah Kaiser (Ph.D.), Quantum Entanglement Experiments with Airborne Platform, 2013-Present
• Chris Pugh (Ph.D.), Quantum Communications with and Airborne Platform, 2013-Present
• Jean-Phillippe Bourgoin (PDF), Free Space QKD, 2014-Present
• Jeongwan Jin (PDF), Novel encoding schemes for free space QKD, 2014-Present
• Audrey, Dot (PDF), Photon creation and interaction in nonlinear media, 2012-2014
• Rolf Horn (PDF), Waveguided photon pair sources, 2011-Present
• Brendon Higgins (PDF), Advancing quantum communications with satellites, 2010-2015
• Krister Shalm (PDF), Entanglement of photon triplets, 2010-2012
• Piotr Kolenderski (PDF), Photonics materials for quantum entanglement, 2010-2013
• Zhizhong Yan (PDF), Integrated course for quantum key distribution, 2010-2012
• Hannes Hubel (PDF), Advanced entangled photon sources, 2009-2010

g) GRADUATE COURSES: past 7 years, by year
2015 PHYS 768/QIC 890 Implementation of Quantum Communications
2013 PHYS 768/QIC 890 Implementation of Quantum Communications
2013 PHYS 769 Reading Course on the Implementation of Quantum Communications
2013 QIC 891 Special Topic on Quantum Communication
2011 PHYS 771/768/QIC 890 Implementation of Quantum Communications

h) EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)
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<tr>
<th>Year</th>
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<th>Type*</th>
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<td>2015-2018</td>
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<td>O</td>
<td>250,000</td>
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<td>2011-2015</td>
<td>Ministry of Research and Innovation – Early Researcher Award</td>
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<td>Type</td>
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<td>O</td>
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<td>O</td>
<td>50,000</td>
<td>Research</td>
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<td>O</td>
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<td>O</td>
<td>250,000</td>
<td>Research</td>
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<td>2010-2011</td>
<td>Canadian Space Agency</td>
<td>O</td>
<td>95,000</td>
<td>Research</td>
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</table>
2009-2011 Institut de Ciencies Fotoniques (ICFO) O 40,000 Research
2009-2010 NSERC – Quantum Works C 40,000 Research
2010 Department of Foreign Affairs and International Trade – Canada O 10,000 Research
2010 Defense Research and Development Canada C 50,000 Research

*Type: C-Granting councils; G-Government; F-Foundations; O-Other

** Purpose: research, travel, publication, etc.

2. INTERNAL RESEARCH FUNDING: This includes university funds, SSHRC minor grants awarded through the University, etc.

<table>
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<th>Year</th>
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<th>Type*</th>
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<th>Purpose**</th>
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<td>2009</td>
<td>UW</td>
<td>O</td>
<td>440,000</td>
<td>Startup Grant</td>
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i) PUBLICATIONS: The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original
publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored .............................................................................................................. 0
- Books edited .................................................................................................................. 0
- Chapters in books .......................................................................................................... 5
- Papers in refereed journal ....................................................... 49 (2 submitted, 3 under review)
- Papers in refereed conference proceedings ................................................................. 2
- Technical reports ......................................................................................................... 0
- Abstracts and/or papers read ....................................................................................... 0
- Others (workshops presented) ..................................................................................... 66

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Book Chapters:
Published, Elsevier Inc.

Papers in Refereed Journal:


Papers in Refereed Conference Proceedings:

Presentations:
“Schroedinger’s cat and the quantum internet”, invited seminar at the Jet Propulsion Laboratory, Pasadena, USA. September 1, 2016.
“Entangled photon triplets and heralding single photons.”, seminar at the Physics Department, Nanjing University, China, 27. November 2015.
“Satellite based bridges for a global quantum internet.”, invited presentation at the Quantum Workshop of NASA - Langley,
“Satellite Quantum Communications.”, Invited presentation at the ETSI workshop on Post-Quantum Cryptography, Seoul, South Korea, October 5. - 6. 2015.
“Entangled Photon Triplets.”, Invited talk at the international conference “Quantum Physics of Nature” (QUPON), Vienna, Austria, 18. - 22. May 2015,
“Towards a global quantum internet.”, Invited presentation at the University of Toronto Aerospace Team, Toronto, Canada. 15. May 2015.
“Tools for a quantum internet.”, invited presentation at the APS meeting of New York State, Fredonia University, USA, 25. April 2015.


(2014). Optical Implementations of Quantum Communications. Lecture within the “Advanced Doctorate Program on Quantum Information Science” funded by the European Commission, held at the ITS, Lisbon, Portugal, Lisbon, Portugal.


(2013). Optical Implementations of QKD. QKD Summer-School at IQC, Waterloo, Canada.


(2012). Quantum communication and fundamental physics experiments with satellites. Canadian Association of Physicists Annual Conference, Calgary, Canada.


(2012). Quantum communication with satellites. Canadian Aeronautics and Space Institute Astro Conference, Montreal, Canada.

(2012). Towards Quantum Smart Phones. IQC and Industrial Partners work group talk, Waterloo, Canada.


(2012). Fundamental physics experiments with quantum communication satellites. American Association for the Advancement of Science Annual Meeting, Vancouver, Canada.


(2011). Qutrit experiments based on the 200 year old concepts of Young’s interference. CIFAR meeting, Calgary, Canada.


(2010). From Schrodinger's Cat to Quantum Technologies. COMDEV seminar, Cambridge, Canada.


**Conference Publications:**


Jennewein, Thomas


**Journal Article:**

Curriculum Vitae

a) **NAME**: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Lütkenhaus, Norbert,
Full Professor, Tenured
Member of the Graduate Faculty, Yes

b) **DEGREES**: designation, institution, department, year

Intermediate Degree, Vordiplom Physik, RWTH Aachen, 1989
Master Degree, Diplom Physik, LMU München, 1993
Ph.D. Physics, University of Strathclyde, 1996
Habilitation, University Erlangen-Nürnberg, 2003

c) **EMPLOYMENT HISTORY**: dates, rank/position, department, institution/firm

1996-1997 Research Assistant, Institut für Theoretische Physik, Universität Innsbruck, Austria
1997-2000 Senior Scientist (Research Fellow) in the group of Prof. K.-A. Suominen, Helsinki Institute of Physics, Finland
2000-2005 Project Leader, MagiQ Technologies Inc., New York, USA
2001-2005 Leader of an independent Emmy-Noether Research Group, Institute of Optics, Information and Photonics
2006-2011 Associate Professor, University of Waterloo
2011-Present Professor, University of Waterloo

d) **HONOURS**: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)

Karl Otto Foster Stipend (book stipend), 1991
DAAD stipend for postgraduate studies, 1993-1996
Emmy-Noether Stipend (German Research Council – grant for independent research group), 2001-2005
Outstanding Performance Award, University of Waterloo, 2009
Outstanding Referee Award, American Physical Society, 2015

e) SCHOLARLY AND PROFESSIONAL ACTIVITIES: past 7 years only (eg. executive and editorial positions but not memberships in societies)

Scientific Publishing
Referee in Peer-Review System for:
Divisional Associate Editor (Editorial Board Member) for Physical Review Letters (PRL) (2016-2019)

Referee Activities for Funding Agencies
National Science Foundation (NSF), USA (since 2007)
Netherlands Organization for Scientific Research – Dutch National Science Foundation (NWO) (since 2008)
Alberta Ingenuity New Faculty Award Proposal (2010)
European Research Council (ERC) (since 2010)
Vienna Science and Technology Fund (WWTF) (2010)

Conference Organization
Member of Conference Committee
Member of Programme Committee, International Conference on Quantum Information (ICQI), Ottawa, June 6-8, 2011.
Member of Programme Subcommittee, Quantum Information and Cryptography, 2011 IQEC/CLEO Pacific Rim. Conference, Sydney, Australia, August 28 – September 1, 2011.
Member of Programme Committee, Quantum-Physics-Based Information Security (SPIE Security & Defense), Prague, September 19-22, 2011.
Member of Programme Committee, QCrypt 2011: First Annual Conference on Quantum Cryptography, Zurich, Switzerland, September 12-16, 2011.
Co-chair Programme Committee, CLEO/QELS 2012.
Programme Committee Quantum Information Processing (QIP 2013), Tsinghua University, Beijing, January 21-25, 2013.
Programme Committee Member, Conference on Quantum information and Quantum Control, Toronto, August 12-16, 2013.
Member of Programme Committee, Quantum-Physics-Based Information Security, SPIE International Symposium on Security & Defense, Dresden, Germany, September 23-26, 2013.
General Co-Chair, CLEO/QELS 2014.
Quantum Information and Measurement (QIM) Program Committee 2014.
Programme Committee Chair QCrypt 2014.
Program Chair, International Conference on Quantum Communications (QCMC), Singapore, July 4-8, 2016
Member of Programme Committee, Protection of Long-Lived Systems (PLLS), Darmstadt, Germany, July 18-19, 2016
Member of Programme Committee, SPIE Security and Defence, Edinburgh, Scotland, September 26-29, 2016
Co-Organizer of Conference/Workshops
Local Organizing Committee, Cross Border Workshop, Waterloo, June 3-5 2010
Organizer of International Summer School on QKD, Waterloo, July 29 – August 2, 2013.
Co-Organizer, QCYP 2013, Waterloo, August 5-9, 2013.
Co-Organizer, 1st Workshop for Quantum Repeaters and Networks, Pacific Grove, California, May 15-17, 2015.
Chair of Organization, QKD Summer School, Waterloo, Canada, August 17-21, 2015

Project Coordination/Leadership
Coordinator des FET-IST EU-Proposals “Continuous Variable Communication Networking (COCONET) in 5. Framework programs.” (not funded)
As Key Researcher responsible for the theory subproject of the IST EU-consortium “Secure Communication based on Quantum Cryptography” (6th Framework)
Coordination of Collaboration between the Institute for Quantum Computing and Institute of Photonic Sciences (ICFO), Barcelona
National Institute of Informatics, Tokyo
Standardization Agency ETSI, Nice
Canadian Coordinator of the joint research grant between France and Canada (NSERC, Canada and ANR, France)
2009-2013-Lead PI for Office of Naval Research project at IQC 2013-2016
Other Activities and Experiences

Member Advisory Board for the UK Quantum Communication Hub (since 2015)
Vice-Chair of ETSI QKD-ISG (QKD Standards effort) (since 2014)
Member of Steering Committee, QCrypt (since 2015)
Launch and leadership of R&D group to develop commercial Quantum Key Distribution product. (MagiQ Technologies)
Advisor to MagiQ Technologies

Patents in the area of quantum information technology

External PhD Examiner

Vadim Makarov, Dept. Physics, University of Trondheim, Trondheim, Norway, April 30, 2007.
Mark Godfrey, Department of Electrical Engineering, University of Bristol, Bristol, UK, June 30 – July 1, 2010.
Lars Lydersen, Department of Electronics and Telecommunications, Norwegian University of Science and Technology, Trondheim, Norway, September 19, 2011.
Vedran Dunko, Physics Department, Herriot-Watt University, Edinburgh, September 24, 2012.
Khabat Heshami, Physics Department, University of Calgary, April 17, 2013.
Normand Beaudry, Physics Department, ETH Zurich, September 19, 2014.
Li Xikun, Centre for Quantum Technologies: National University of Singapore, May 4, 2016

f) **GRADUATE SUPERVISIONS**: masters, doctoral, postdoctoral - completed/in progress

Completed: 11 Master, 9 Ph.D., 9 PDF
In Progress: 3 Master, 0 Ph.D., 7 PDF

**NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:**

Marco Piani (PDF), 2007-2010
William Matthews (PDF) 2009 – Present
Xionfeng Ma (PDF), 2008-2010
Oleg Gittsovich (PDF), 2010-2013
Ryo Namiki (PDF), 2013- Present
Yanbao Zhang (PDF), 2013-Present
Patrick Coles (PDF), 2014-Present
Filippo Miatto (PDF), 2015-Present
Dave Touchette (PDF), 2015-Present
Michael Epping (PDF), 2016-Present
Geir Ove Myhr (Ph.D.), Public Communications Protocols in QKD, 2005-2010
Hauke Häseler (Ph.D.), Entanglement verifications with applications in quantum communication, 2005-2010
Agnes Ferenczi (Ph.D.), Symmetries in Quantum Key Distribution, 2007-2013
Nathan Killoran (Ph.D.), Benchmarking Quantum Communication Protocols, 2008-2012
Juan Miguel Arrozola (Ph.D.), Non-Linear Entanglement Witnesses, 2011-2015
Normand Beaudry (Master), Squashing Models for Optical Measurements in Quantum Communication, 2009-2011
Varun Narasimhachar (Master), Squashing Models and Security Proofs of QKD schemes, 2009-2011
David Pitkanen (Master), Linear Optics Implementation of Channels, 2009-2011
William Stacey (Master), Simplified Trusted Repeater Nodes, 2012-Present
Luke Govia (Master), Josephson Photo Multipliers, 2012-2013
Sumeet Katri (Master) (Oct. 2014 - 2016) Symmetric Extendability of Quantum States and the Extreme Limits of Quantum Key Distribution
Benjamin Lovitz (Master) (Sept. 2015 - present)
Jie Lin (Master) (Sept. 2015 - present)
Christian Mastromattei (Master) (Sept 2015-present)

Incompleted Degrees:
Matthias Heid (on hold)
Ivan Dynov (switched programs)
Razieg Annabestani (switched supervisors)
Sergei Mikheev (not completed)
Electra Eleftheriadou (PDF) (not completed)

g) GRADUATE COURSES: past 7 years, by year
2010 Electrodynamics Theory, PHYS 441B
2010 Applied Quantum Cryptography, QIC 890/PHYS 768
2011 Quantum Physics I, PHYS 234
2012 Applied Quantum Cryptography, QIC 890/PHYS 768
2014 Applied Quantum Cryptography, QIC 890/PHYS 768
2015 Quantum Physics I, PHYS 234
Summer School:
Undergraduate School on Experimental Quantum Information Processing (USEQIP), Lectures on QKD, IQC, Waterloo, ON, June 8, 2009.
Canadian Quantum Information Summer School, Fields Institute, Lectures on QKD, Toronto, August 21, 2009.
Undergraduate School on Experimental Quantum Information Processing (USEQIP), Lectures on QKD, IQC, Waterloo, ON, May 31, 2010.
Quantum Information and Coherence, Glasgow, Scotland, August 2 – August 6, 2011.
Sommeruniversität der Studienstiftung des deutschen Volkes, Gebot und Verbote in der Quantenmechanik, Neubeuern, Germany, August 7-20, 2011.
Summer School on Quantum Physics and Quantum Information, Olomouc, Czech Republic, July 22-26, 2013.
Heidelberg Graduate Days, Heidelberg, Germany, April 6-12, 2014.
International Summer School on QKD, Waterloo, Ontario, August 17-21, 2015.

h)1. **EXTERNAL RESEARCH FUNDING:** *past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)*

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<td>2013-2016</td>
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<td>O</td>
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<td>2015-2020</td>
<td>Army Research Laboratory</td>
<td>O</td>
<td>$440,000 (USD)</td>
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<td>2016</td>
<td>Australian Research Council</td>
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2. INTERNAL RESEARCH FUNDING: *This includes university funds, SSHRC minor grants awarded through the University, etc.*]

i) PUBLICATIONS: The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:
- Books authored ........................................................................................................................................ 0
- Books edited .......................................................................................................................................... 0
- Chapters in books .................................................................................................................................. 4
- Papers in refereed journal ..................................................................................................................... 102
- Papers in refereed conference proceedings .......................................................................................... 31
- Technical reports ................................................................................................................................. 0
- Abstracts and/or papers read ................................................................................................................ 0
- Others (workshops presented) .............................................................................................................. 123
2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Chapters in Books:
chapter 'Probabilistic Quantum Computation and Linear Optical Realizations', pages 349-358
chapter 'Theory of Quantum Key Distribution (QKD)', pages 271-284

N. Lutkenhaus, Scottish University Summer School, E. Andersson and P. Öhberg (eds.), Quantum Information and Coherence, Scottish Graduate Series, DOI: 10.1007/978-3-319-04063-9_5, © Norbert Lutkenhaus, Cham ; New York : Springer, [2014]

Papers in Refereed Journal:


H. Häselert, N. Lütkenhaus, Quantum benchmarks for the storage or transmission of quantum light from minimal resources, Physical Review A 81, 060306(R) (2010).


C. Wittmann, J. Fürst, C.Wiechers, D. Elser, H. Häselert, N. Lütkenhaus, G. Leuchs, Witnessing effective entanglement over a 2km fiber channel, Optics Express 18, 4499 (2010).


X.F. Ma**, N. Lütkenhaus, Improved Data Post-Processing in Quantum Key Distribution and Application to Loss Thresholds in Device Independent QKD, Quantum Information & Computation, 12, 203-214 (2012)


J.M. Arrazola*, N. Lütkenhaus, Quantum fingerprinting with coherent states and a constantnt mean number of photons, Phys. Rev. A, 89, 062305 (2014)

C. Panayi, M. Razavi, X.F. Ma, N. Lütkenhaus, Memory-assisted measurement-device-independent quantum key distribution, New Journal of Physics, 16 (2014).


S. Muralidharan, L.S. Li, J. Kim, N. Lütkenhaus, M. D. Lukin, L. Jiang, Optimal architectures for long distance quantum communication, Scientific Reports 6, 20463 (2016).
Jelezko, B. Keimer, J.P. Kotthaus, G. Leuchs, N. Lütkenhaus, U. Maurer, T. Pfau, M. B.
Schönhammer, A. Ustinov, P. Walther, H. Weinfurter, E. Welzl, R. Wiesendanger, S. Wolf,
A. Zeilinger, P. Zoller, Quantum Technology: From research to application, Applied
Physics B, 122, 130, (2016)
D. Luong, L. Jiang, J. Kim, N. Lütkenhaus, Overcoming lossy channel bounds using a
P. J. Coles, E. M. Metodiev, N. Lütkenhaus, J.P. Bourgoin, Numerical Approach for
Unstructured Quantum key Distribution, Nature Communications, 7, 11712, (2016)
Rev. A 93, 06, 062311 (2016)
R. Namiki, L. Jiang, J. Kim, N. Lütkenhaus. (2016). Role of syndrome information on a
one-way quantum repeater using teleportation-based error correction. Physical Review
A. In Press

Papers in Refereed Conference Proceedings:
H. Häselar, J. Rigas, O. Gühne and N. Lütkenhaus, Verifying Entanglement in Quantum
M. Heid and N. Lütkenhaus, Security of coherent state quantum cryptography against
collective attacks under Gaussian channel noise, pages 177-180, Proceedings of the
904020-00-5.
O. Gühne, N. Lütkenhaus, Nonlinear entanglement witnesses, covariance matrices and
M. Razavi, H. Farmanbar, and N. Lütkenhaus, Long-distance quantum communication
with multiple quantum memories, OFC’08 Technical Digest, Paper JWA48, San Diego,


Other:

Invited Talks:
Spring Meeting, American Physical Society, Denver, March 5-9, 2007.
International Conference on Quantum Optics and Quantum Information, Vilnius (Lithuania), September 20-23, 2008.
Demonstration of SECOQC Network, Vienna, October 8-10, 2008.
Quantum Key Distribution, Quantum Information Science, Vienna, VA, April 23-25, 2009.
Laser Physics 2010, Foz do Iguacu, Brazil, July 5-9, 2010 (declined).
The Tenth International Conference on Quantum Communication, Measurement and Computation (QCMC), The University of Queensland, Brisbane, Australia, July 19-23, 2010.
Updating Quantum Cryptography and Communication 2010 (UQCC), Tokyo, October 18-20, 2010.
Max Planck Institute (MPL) Winter Retreat, Scheffau, Austria, February 28 to March 4, 2011.
International Conference on Quantum Information (ICQI), Ottawa, June 6-8, 2011.
2011 DAMOP Annual Meeting, Atlanta, Georgia, June 15-17, 2011.
Frontier in Optics (FiO) 2011 - APS/DLS Annual Meeting, San Jose, California, October 18-20, 2011.
Quantum Information and Measurement (QIM), Berlin, Germany, March 19-21, 2012.
Tsinghua-Aarhus CTIC Workshop on Quantum Information Science, Tsinghua University, Beijing, May 21-27, 2012.
CIFAR Quantum Information Processing Meeting, Ottawa, November 14-16, 2012
Summer School on Quantum Physics and Quantum Informatio, Olomouc, Czech Republic, July 20-25, 2013.
QANAS 2013, Agra, India, November 27-December 1, 2013.
Workshop for Quantum Repeaters and Networks, Asilomar, Pacific Grove, May 15-17, 2015
Trustworthy Quantum Information Workshop, Ann Arbor, June 28-July 1, 2015
Workshop on Quantum Key Distribution Standardization, Jinan, Shandong Province, China, May 31 - June 4, 2016
Protection of Long-Lived Systems Conference, Darmstadt, Germany, July 18 – 19, 2016
Frontiers in Optics/Laser Science Conference, Rochester, New York, USA, October 17-21, 2016
Seminars:
ICFO, Barcelona (Acin, Lewenstein, Calsamiglia), October 13-17, 2008.
Talk at Institute for Photonic Sciences (ICFO), Squashing Models for Optical Measurements in Quantum Communication, November 2008.
IQC-NII Meeting, Tokyo, February 14-21, 2009.
ETH, Zurich, March 20 –April 3, 2011.
Retreat of Division Leuchs, Max-Planck Institute for the Physics of Light, Schloss Ringberg, October 7-12, 2012.
Talk at the University of Toronto, May 9, 2014.
Talk at Tsinghua University, October 31, 2014.
Retreat of the Leuchs Division, Max Planck Institute for the Science of Light, Schloss Ringberg, December 1-2, 2015
Tsinghua University, Beijing, China, May 30, 2016

Preprints:
X.F. Ma, T. Moroder, N. Lütkenhaus, Quantum key distribution secure against the efficiency loophole, (5 pages, 2 figures ) arXiv:0812.4301.
S. Muralidharan, J. Kim, N. Lütkenhaus, M. D. Lukin, L. Jiang, Ultrafast and fault-tolerant quantum communication across long distances, arXiv:1310.5291v1

Peer Reviewed Conference Contributions

Peer Reviewed Reviews:

Contributions for the wider audience, Reviews

Other Preprints of Research Group led by N. Lutkenhaus:

Other Publications of Research Group led by N. Lutkenhaus:


M. Piani, J. Watrous; All entangled states are useful for channel discrimination, Phys. Rev. Lett. 102, 250501 (2009).


M. Piani, J. Watrous, All entangled states are useful for channel discrimination, Phys. Rev. Lett. 102, 250501 (2009).


Curriculum Vitae

a) NAME: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Menezes, Alfred
Full professor, tenured
Member of the Graduate Faculty: yes

b) DEGREES: designation, institution, department, year
Ph.D. Combinatorics & Optimization (C&O), University of Waterloo, 1992.
MMAth, Combinatorics & Optimization, University of Waterloo, 1989.

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm
Jul. 2003-present
Full Professor, Department of C&O, University of Waterloo. Cross appointment to David R. Cheriton School of Computer Science
Sept. 2011-Aug. 2015
Chair, Department of C&O, University of Waterloo
Associate Professor, Department of C&O, University of Waterloo
(On leave from September 2000-August 2001)
Apr. 2009-Jul. 2013
Consultant, Research in Motion, Ontario, Canada
Consultant, Certicom Corp., Ontario, Canada
Senior Cryptographer & Director of Research, Certicom Corp., Ontario, Canada
Consultant, Certicom Corp., Ontario Canada
Associate Professor (tenured), Discrete and Statistical Sciences, Auburn University
Assistant Professor, Discrete and Statistical Sciences, Auburn University

d) HONOURS: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)
Distinguished Teaching Award, University of Waterloo, 2012
Faculty of Mathematics Award for Distinction in Teaching, University of Waterloo, 2010
Faculty of Mathematics Faculty Fellow, University of Waterloo, 2005-2008
Hall Medal, Institute of Combinatorics and its Applications, 2001
Auburn University Sigma Xi Research Award, 1995
Auburn University Book Author Award, 1994
Outstanding Achievement in Graduate Studies, University of Waterloo, 1992
Ontario Graduate Scholarship, 1990-1992

e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES:** past 7 years only (eg. executive and editorial positions but not memberships in societies)

**Centre for Applied Cryptographic Research**

- Sept. 2011: Managing Director

**Service to University of Waterloo**

- July 2008-June 2010: C&O Department Tenure and Promotion Committee
- Mar. 2009-Jan. 2010: Dean of Mathematics Nominating Committee
- Sept. 2009-Aug. 2011: C&O Department Executive Committee
- Jan. 2010-Aug. 2010: Associate Chair for Graduate Studies, Department of C&O
- Sept. 2011-Aug. 2015: Chair, Department of C&O

**Conference Organization**

- 2008-present: Steering Committee Member for the Annual ECC workshop
- Sept. 2012: Scientific Committee Member for ECC 2012
- Sept. 2011: Scientific Committee Member for ECC 2011
- 2007-2013: Steering Committee Member for annual Pairing conference
- Sept. 2013: Scientific Committee Member for ECC 2013
- Oct. 2014: Scientific Committee Member for ECC
- Sept. 2014: Program chair (with D. Aranha) for LATINCRYPT 2014

**Program Committee Member**

- 2010: PKC
- 2010: Africacrypt
- 2010: Latincrypt
- 2010: IWSEC
2010 ISC
2010 Indocrypt
2011 Eurocrypt
2011 Asiacrypt
2013 SAC
2015 Latincrypt
2015 SECITC
2016 Mycrypt

Reviewer of Grant Applications
2002-present Member of NSERC College of Reviewers
2010, 2012 NSERC
2010 Netherlands Organization for Scientific Research
2011 European Research Council
2013 FWO

Editorial
1999-present Accreditation board member of Computer & Communications Security Abstracts
2005-present Editorial board member of Contributions to Discrete Mathematics
2006-present Editorial board member of Journal of Mathematical Cryptology
2012–present Editorial board member of Advances in Mathematics of Communication
2015–2018 Associate Editor IEEE Transactions on Information Theory

Refereeing-Conferences
2010 Crypto
2013 Asiacrypt
2013 Eurocrypt
2016 SAC
2016 ACNS

Other
2005-2010 Technical Advisory Panel, Center for Information Security and Cryptography

2005-present Advisory Board Member, Xtreme Mobility

2014-present Security Leadership Team, InfoSec Global

2015-present Scientific Advisory Board Member, ZebraPet

f) GRADUATE SUPERVISIONS: masters, doctoral, postdoctoral - completed/in progress
Completed: 30 M.A., 6 Ph.D. 9 PDF
In progress: 3 M.A.

NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:


Gora Adj (Ph.D) (CINVESTAV, Mexico), Jul 2016 (with F. Rodríguez-Henríquez)

Kenwrick Mayo (M.Math) Aug 2015

Michael Wesolowski (M.Math) Apr 2015

Marie-Sarah Lacharitée (M.Math) Apr 2014

Danielle Drainville (M.Math) Dec 2012

Edward Knapp (Ph.D.) Dec 2012

Dale Brydon (M.Math) Apr 2012

Kewei Yu (M.Math) Aug 2011


Sanjit Chatterjee, Oct 2007–Oct 2010

g) GRADUATE COURSES: past 7 years, by year

Lectures:

Winter 2017 Applied Cryptography (CO 487)

Fall 2016 Mathematics of Public-Key Cryptography (CO 485/685)

Fall 2016 Algebra (Math 135)
h) **EXTERNAL RESEARCH FUNDING:** past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

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<td>NSERC Strategic</td>
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<td>NSERC Discovery</td>
<td>C</td>
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<td>Research</td>
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*Type: C-Granting councils; G-Government; F-Foundations; O-Other

** Purpose: research, travel, publication, etc.

2. **INTERNAL RESEARCH FUNDING:** *This includes university funds, SSHRC minor grants awarded through the University, etc.*

i) **PUBLICATIONS:** *The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page.*
numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored 4
- Books edited 6
- Chapters in books 7
- Papers in refereed journal 82
- Papers in refereed conference proceedings 53
- Technical reports (Industry Standards) 3

Abstracts and/or papers read
- Others (workshops presented) ................................................................. 37

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Books edited:


Chapters in Books:


Papers in refereed Journals:

“Challenges with assessing the impact of NFS advances on the security of pairing-based cryptography”, to appear (with P. Sarkar and S. Singh).

“Another look at tightness II: Practical issues in cryptography”, to appear (with S. Chatterjee, N. Koblitz and P. Sarkar).


“Cryptocash, cryptocurrencies, and cryptocontracts”, Designs, Codes and Cryptography, 78 (2016), 87-102 (with N. Koblitz).


“Weakness of $\mathbb{F}_{36\cdot1429}$ and $\mathbb{F}_{24\cdot3041}$ for discrete logarithm cryptography”, Finite Fields and Their Applications, 32 (2015), 148-170 (with G. Adj, T. Oliveira and F. Rodríguez-Henríquez).


“Generalizations of Verheul’s theorem to asymmetric pairings”, Advances in Mathematics of Communication, 7 (2013), 103-111 (with K. Karabina and E. Knapp).


“Another look at security definitions”, Advances in Mathematics of Communications 7 (2013), 1-38 (with N. Koblitz).


Papers in refereed conference proceedings:

Selected Areas in Cryptography (SAC 2014), Montreal, Aug 2014.


Selected Areas in Cryptography (SAC 2011), Toronto, Aug 2011.
Others (workshops presented):
CINVESTAV, Mexico, Jul 2016.
Indian Statistical Institute, Kolkata, Mar 2016.
Auburn University Mathematics Club, Auburn, Feb 2012.
Curriculum Vitae

a) NAME: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Mosca, Michele, Faculty, Academic University Research Chair, Tenured
Member of the Graduate Faculty, Yes

b) DEGREES: designation, institution, department, year

Ph.D. Mathematics, University of Oxford, United Kingdom, 1999
MSc. Mathematics and Foundations of Computer Science, University of Oxford, United Kingdom, 1996
B.Math, Combinatorics & Optimization and Pure Mathematics, University of Waterloo, Canada, 1995
(Semester Abroad) Mathematics, Budapest Semesters in Mathematics, Hungary, 1994

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm

2012-Present  Director, CryptoWorks 21, NSERC CREATE
2012-Present  University Research Chair, University of Waterloo
2010-Present  Fellow, Quantum Information Program, Canadian Institute for Advanced Research (CIFAR)
2009-Present  Full Professor, Department of Combinatorics & Optimization, University of Waterloo
2002-2016  Deputy Director, Institute for Quantum Computing
2001-Present  Researcher, Perimeter Institute for Theoretical Physics
2001-Present  Member, Guelph-Waterloo Physics Institute
2001-Present  Cross-appointed Faculty Member, Department of Physics, University of Waterloo
1999-Present  Member, Centre for Applied Cryptographic Research, University of Waterloo
2003-2009  Associate Professor, Department of Mathematics, St. Jerome’s University and Department of Combinatorics & Optimization, University of Waterloo (joint appointment)

2003-2010  Scholar, Quantum Information Program, CIFAR

1999-2003  Assistant Professor, St. Jerome’s University and University of Waterloo (joint appointment)

1998-1999  Robin Gandy Junior Research Fellow, Wolfson College, University of Oxford, United Kingdom


d)  HONOURS: (F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)

University Research Chair, University of Waterloo, 2012-Present

Queen Elizabeth II Diamond Jubilee Medal, 2013

Canada’s top 40 under 40, 2010

Canadian Institute for Advanced Research (CIFAR) Fellow QIP program since 2010, Scholar since 2003

Waterloo Region 40 under 40: “Honoring those making a difference in our region”, 2010

Invited Speaker, AAAS Science and Technology Workshop “Plug into Canada”, organized by the Canadian Embassy, January 2005

Visiting Fellow at King’s College, University of Cambridge, October 2005

Canada Research Chair (Tier 2), 2002-2012

Premier’s Research Excellence Award, Ontario, 2000-2005

Fellow of the Institute for Combinatorics and its Applications, 2000-Present


e)  SCHOLARLY AND PROFESSIONAL ACTIVITIES: past 7 years only (eg. executive and editorial positions but not memberships in societies)

2008-2011  Initiating Quantum Cryptography Summer School for Young Scientists (QCSYS)

2010-2013  Director, Quantum Information Collaborative Graduate Program
2000-present  Associate Editor, Quantum Information and Computation
2016      Cybersecurity and Privacy Steering Committee
2015-2016  Member of UW Math Research Activity Committee
2011-2017  Member of UW Senate,
2014-2015  Member of UW Board of Governors Building & Properties Committee
2014-2015  Member of UW VP University Relations Search Committee
2012-2013  Member of UW Math CERC search committee
2012-2013  Member of UW Combinatorics and Optimization Tenure and Promotion Committee
2011-2013  Member of UW VP Research Advisory Committee on University Centres and Institutes
2012-2015  Member of UW Board of Governors Executive Committee
2013-2016  Member of UW Senate Finance Committee
2011-2015  Member of UW Board of Governors
2011-2012  Member of UW Senate Executive Committee
2016      Co-organizer of the fourth ETSI workshop on quantum-safe cryptography in partnership with IQC, Toronto, ON
2016      Co-organizer of the Quantum Computer Science Workshop Banff International Research Station for Mathematical Innovation and Discovery, Banff, Alberta
2015      Co-organizer of the third ETSI workshop on quantum-safe cryptography in partnership with IQC hosted by SK Telecom, Seoul Korea
2015      Co-organizer of the Quantum Programming Languages and Circuit Workshop, Waterloo Canada
2015      Co-organizer, Dagstuhl seminar on "Quantum Cryptanalysis", Leibniz-Zentrum fur Informatik, Dagstul Seminar 15371
2014      Co-organizer of the Fields Institute Workshop on Quantum Optimization
2014      Program Committee Chair, PQCrypto 2014 Waterloo
2014      Co-organizer of the second ETSI workshop on quantum-safe cryptography in Partnership with IQC
2014      Co-organizer of the Post-Quantum Cryptography Summer School
2013 Program Committee Member, AfricaCrypt 2013, Cairo, Egypt
2013 Program Committee Member, PQCrypto 2013, Limoges, France
2013 Co-organizer of the first ETSI workshop on quantum-safe cryptography
2013 Co-organizer, Dagstuhl seminar on “Quantum Cryptanalysis”, Leibniz-Zentrum Fur Informatik
2012 Co-organizer, 3 day CIFAR workshop on quantum information processing, Ottawa
2012 Advisory member, 2nd AQuA Student Congress on Quantum Information & Computation
2012 Co-organizer and paelist of a session at the Congress 2012 of the Humanities and Social Sciences, Waterloo
2012 Co-organizer, 3-day workshop on Recent Progress in Quantum Algorithms, Waterloo
2011 Program Committee Member, IndoCrypt 2011, India
2011 Program Committee Member, PQCrypto 2011, Taipei, Taiwan
2011 Program Committee Member, TQC2011, Madrid, Spain
2011 Co-organizer, Dagstuhl seminar on “Quantum Cryptanalysis”, Leibniz-Zentrum Fur Informatik
2011 Co-organizer, Quantum Key Distribution (QKD) Summer School, IQC, Waterloo
2010 Program Committee Member, AfricaCrypt 2010, Cairo, Egypt
2010 Program Committee Co-Chair, Asian Conference on Quantum Information Science (AQIS2007), Kyoto, Japan
2010 Co-organizer, “Theory and Realisation of Practical Quantum Key Distribution 2010” workshop, IQC, Waterloo

f) GRADUATE SUPERVISIONS: masters, doctoral, postdoctoral - completed/in progress

Completed: 3 PDF, 14 Ph.D., 16 Masters.
In Progress: 5 PDF, 7 Ph.D., 1 M.Eng, 2 M.Sc., 1 M.Math

NAME OF STUDENTS supervised within the past seven years, title of thesis of project, year of first registration and year of completion:

P. Tysowski (PDF), Post-Quantum Cryptography, 2016-present
Z. Liu (PDF), Post-Quantum Cryptography, 2016-present
J. Doliskani (PDF), Post-Quantum Cryptography, 2016-present
G. Pereira (PDF), Post-Quantum Cryptography, 2016-present
J-F. Biasse (PDF), Quantum Cryptography, 2014 –2015
K. Kalach (PDF), Quantum Cryptography, 2014 – 2015
F. Song (PDF), Quantum Cryptography, 2013 – 2016
V. Gheorghiu (PDF), Quantum Algorithms Circuits, 2013 –present
K. Lee (PDF), Quantum Algorithms, 2012-2014
D. Gosset (PDF), Quantum Information, 2011 – 2014
S. Garnerone (PDF), Quantum Information, 2011 – 2014
Lin Chen (PDF), Quantum Information, 2011-2013
Zhengfeng Ji (PDF), Quantum Information, 2011 – 2016
M. Kieferova (Ph.D.), Quantum Circuits, 2014 – present
V. Russo (Ph.D.), Quantum Computational Complexity, 2012 – present
S. Raeisi (Ph.D.), Quantum Information, 2011 – 2015
V. Kluchnikov (Ph.D.), Quantum Circuits, 2011-2014
J. Smith (Ph.D.), Quantum Algorithms, 2007-2012
I. Mashhad (Ph.D.), Quantum Information, 2008-2012
M. McKague (Ph.D.), Quantum Cryptography, 2005-2010
J. Fernick (M.Eng), Post-quantum Cryptography and Satellite QKD, 2014 – 2015
A. Parent (M.Sc.), Quantum Circuits, 2014 – 2016
O. Di Matteo (M.Sc.), Quantum Circuits, 2014 – 2015
S. Arunachalam (M.Math), Quantum Algorithms and Quantum Cryptography, 2012-2014
M. Amy (M.Math), Quantum Circuits, 2011-2012
A. Parent (M.Sc.), Quantum Circuits, 2011-2014
S. Jeffery (M.Math), Quantum Algorithms and Complexity, 2009-2011
g) GRADUATE COURSES: past 7 years, by year

2016  Topics in Quantum Safe Cryptography
2015  Topics in Quantum Safe Cryptography
2014  Abstract Algebra

  Introduction to Quantum Computation
2013  Linear Algebra I

  Introduction to Quantum Computation
2012  Applied Matrix Algebra
2011  Applied Matrix Algebra

  Introduction to Quantum Computation

h) 1. EXTERNAL RESEARCH FUNDING: past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)

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<td>Canada Research Chairs Program</td>
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*Type: C-Granting councils; G-Government; F-Foundations; O-Other

** Purpose: research, travel, publication, etc.
2. INTERNAL RESEARCH FUNDING: This includes university funds, SSHRC minor grants awarded through the University, etc.]

<table>
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refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) Life-time summary (count) according to the following categories:

- Books authored ................................................................. 1
- Books edited ................................................................. 0
- Chapters in books ......................................................... 6
- Papers in refereed journal ........................................... 55
- Papers in refereed conference proceedings .................. 0
- Technical reports ............................................................. 0
- Abstracts and/or papers read ......................................... 0
- Others (workshops presented) ........................................ 123

2) Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.

Books Authored:


Papers in Refereed Journals:

18. [IM11a] **L. Ioannou and M. Mosca, “Public-key cryptography based on bounded quantum
[arXiv:0903.5156]


Chapters in Books:


Other:

Published Monographs


Other Refereed Conference Contributions (Without Proceedings)

(2007).


Reprints and Submitted Papers


Other Reports


Invited Research Talks, Outreach Talks and Workshops/Conferences, and Distinguished Lectures


33. “Cybersecurity in a quantum world, will we be ready?” Keynote speaker, Quantum Cryptography Summer School for Young Scientists (QCSYS), Waterloo, ON, August 10, 2015
34. “Cybersecurity in a quantum world: will we be ready?” Max Planck Symposium on Foundation of Cyber Security and Privacy, Munich, Germany, July 7, 2015.
35. “If X and Y are bigger than Z, you’re in trouble”, Executive Summit, Toronto, ON, Dec 5, 2016.
38. “As we enter a new quantum era”, Public Lecture Series, Perimeter Institute, Waterloo, ON, Oct 5, 2016.
http://www.conferenceboard.ca/Libraries/NETWORK_PUBLIC/CCIO_Agenda_Sept2015.sflb
http://www.conferenceboard.ca/Libraries/NETWORK_PUBLIC/cite_agenda_sept2015.sflb
46. “Cybersecurity in a quantum world: will we be ready?” Google, Kitchener, ON, June 16, 2015.
49. “Cybersecurity in a quantum world: will we be ready?” SERENE RISC workshop, Ottawa, ON, April 23, 2015.
52. Undergraduate School on Experimental Quantum Information Processing (USEQIP 2014) May 2014.
56. “Quantum software and quantum-safe cryptography”, Institut Transdisciplinaire d'Information Quantique (INTRIQ) meeting, Bromont, Canada, May 2014.
63. “Unconditionally-secure and reusable public-key authentication”, Workshop on Quantum Computer Science, Montreal, October 2011.
64. “Cryptography in a Quantum World”, The Internet Engineering Task Force Meeting (IETF 81), Quebec City, August 2011.
75. “Quantum Computing and Cryptography”, Invited online talk for students at BITS Pilani, India, March 2014.

Schools and Introductory Workshop Presentations

84. 11th Canadian Summer School on Quantum Information, Jouvence, Quebec, June 6-11, 2011.
87. 9th Annual Canadian Summer School on Quantum Information, Toronto, Canada, August 2009
Curriculum Vitae

a) NAME: (rank, status (tenured, contract, Member of Graduate Faculty/Core member of program etc.)

Weber, J. Mark

Associate Professor, tenured

Member of the Graduate Faculty: yes

b) DEGREES: designation, institution, department, year


MBA, Wilfrid Laurier University, 1999.


BA, Honours Psychology, University of Waterloo, 1994.

c) EMPLOYMENT HISTORY: dates, rank/position, department, institution/firm

Jan. 2014-present  Eyton Director, Conrad Business, Entrepreneurship & Technology Centre, University of Waterloo.

July 2012-present  Associate Professor, Conrad Business, Entrepreneurship & Technology Centre, University of Waterloo.

May 2005-present  President, Weber Consulting Inc.

Sept. 2010-July 2012  Associate Professor, School of Environment, Enterprise and Development (SEED) & School of Accounting and Finance (SAF), University of Waterloo. Also Director of the Graduate Diploma in Social Innovation.

Sept. 2010-July 2012  Associate Professor, Management Department, University of Toronto.

July 2003-August 2010  Assistant Professor, Organizational Behavior & Management Departments, Rotman School of Management and University of Toronto.

2005  Visiting Professor, Organizational Behavior Department, INSEAD.

2003  Visiting Lecturer, Ross School of Business, University of Michigan.

2002  Instructor, Kellogg School of Management, Northwestern University.

May 1995-Aug. 1999  Senior Manager, Mennonite Savings and Credit Union
May 1989-Aug. 1994  Director & Assistant Director, Silver Lake Mennonite Camp
Dec. 1988-Dec. 1991  Trustee, Waterloo County Board of Education

d) **HONOURS:** *(F.R.S., F.R.S.C., Governor Generals Award, honorary degree, etc...)*

University of Waterloo Outstanding Performance Award, 2016
Finalist, Society for Experimental Social Psychology Dissertation Award, 2014
Finalist, Seventh Martin E.P. Seligman Award for Outstanding Dissertation Research in Positive Psychology, 2005
Finalist Award for Exemplary Dissertation Research in Positive Psychology, 2005
Rotman Excellence in MBA Teaching Awards, 2004-2009
Finalist Society for Experimental Social Psychology Dissertation Award, 2004
Social Sciences and Humanities Research Council of Canada Doctoral Fellowship, 2004
Best Paper, OB Division, Administrative Sciences Association of Canada, 2004
Ontario Graduate Scholarship (declined to study part-time), 1999
McGill Major Graduate Fellowship (declined), 1997
Arnold Edinborough Post-Graduate Award, 1997
Ontario Graduate Scholarship (declined to study in Quebec), 1997
Valedictorian, Faculty of Arts, University of Waterloo, 1994
Dean's Honor List, University of Waterloo, 1989-1994
Top 4th Year Student and Top Graduate Psychology Student, SJU, 1994
1st Place Canadian National Public Speaking Championship, 1992-1993
9th Place & 10th Place World Public Speaking Championship, 1993, 1991
5th Place North American Debating Championship, 1992
7th Place World Universities Debating Championship, 1991

e) **SCHOLARLY AND PROFESSIONAL ACTIVITIES:** *past 7 years only (eg. executive and editorial positions but not memberships in societies)*

Ad-hoc Reviewer
Academy of Management Review
Journal of Personality and Social Psychology
Personality and Social Psychology Review
Organizational Studies
Organizational Science
Journal of Experimental Social Psychology
Group Processes and Intergroup Relations
Organizational Behavior and Human Decision Processes
Journal of Economic Psychology
Journal of Behavioral Decision Making

f) **GRADUATE SUPERVISIONS:** masters, doctoral, postdoctoral - completed/in progress

g) **GRADUATE COURSES:** *past 7 years, by year*

2012  Applied Business Leadership Skills for Entrepreneurs (MBET), University of Waterloo

2011  Teaching on Module 1 and Module 2 of the Graduate Diploma in Social Innovation (GDSI), University of Waterloo.


h) **1. EXTERNAL RESEARCH FUNDING:** *past 7 years only, by year, indicating source (granting councils, industry, government, foundations, other); amount; principal investigator; purpose (research, travel, publications, etc...)*

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*Type: C-Granting councils; G-Government; F-Foundations; O-Other

** Purpose: research, travel, publication, etc.

2. **INTERNAL RESEARCH FUNDING:** *This includes university funds, SSHRC minor grants awarded through the University, etc.*]
i) **PUBLICATIONS:** The Publications should be listed in the categories shown below and include the following information: books authored, books edited (a list of the chapters contributed by the editor must follow each title), chapters in books (other than those listed in the above category), papers in refereed journals, papers in refereed conference proceedings, technical reports, abstracts and/or papers read, and others. Each title must show the names of the authors in the order in which they appear in the original publication and inclusive page numbers. Publications submitted, but not yet accepted, must be listed separately within the various categories.

1) **Life-time summary (count) according to the following categories:**
- Books authored................................................................................................................
- Books edited ....................................................................................................................
- Chapters in books.............................................................................................................
- Papers in refereed journal .............................................................. 12 (1 under review)
- Papers in refereed conference proceedings .................................................................
- Technical reports .............................................................................................................
- Abstracts and/or papers read ..........................................................................................
- Others (workshops presented) ........................................................................................

2) **Details for past seven (7) years same categories as above: books, chapters in books, papers in refereed journals.**

**Papers in refereed Journals:**
Weber, J. M. Individuals matter, but the situation’s the thing: Improve organizational outcomes through situation design. Organizational Dynamics.
Kramer, L. & Weber, J. M. (2012). This is your portfolio on winter: Seasonal affective disorder and risk aversion in financial decision-making. Social Psychological and Personality Science, 3(2), 193-199.1
FOR APPROVAL*

Centre for Contact Lens Research Name Change

Motion: That the Senate recommends to the Board of Governors the following name change:
“Centre for Contact Lens Research (CCLR)” to “Centre for Ocular Research & Education (CORE)”

Rationale: When establishment of the CCLR was first proposed in 1988, we were partnering with a
group of contact lens manufacturers (all in the US at the time) to conduct almost exclusively clinical
contact lens research. For many years this relationship worked well and the CCLR continued to grow in
terms of revenue generation, personnel and graduate student support.

In the last 10 years we have seen a number of our key industry partners merge and consolidation of the
contact lens industry globally, resulted in fewer research projects of the type we were typically
conducting. This has led to us having to explore opportunities with new research partners and a need to
expand our core capabilities, particularly in our basic science laboratories.

During consultation with these external partners, it became increasingly apparent that our name (and
the associated perception of our capabilities) has limited potential projects and new partnerships. We
now have a very broad range of capabilities that extend far beyond basic and clinical research on
contact lens-related topics. These include biomaterial engineering, microbiology, toxicology, cell biology,
tear film &ocular surface research, qualitative research, educational websites, biomaterial development
and drug delivery.

We spoke with several key individuals within the University and there was support that we look at a
change in our name and branding that would allow us to attract research projects in new fields and with
new sponsors. At that time, we engaged an agency to work closely with our Senior Administration Team
during a strategic review that was both internal and external. This company conducted extensive
interviews with internal stakeholders in the CCLR and at UW and with external collaborators, as well as
with our current industry partners.

With feedback from these interviews, the agency worked with us to develop a new name and branding
that better reflects the broad range of capabilities that our research centre offers to our internal and
external research partners. We believe that this will open the door to future opportunities with new
research partners and consolidate the future growth of our research enterprise.

* Pending approval by Senate Graduate & Research Council on 12 June 2017
FANS

CIHR:
The CIHR Project scheme results for last fall’s second pilot completion:
- Alfred Yu (ECE) $493,425 over 5 years
- Michael Wallace (Stats-New investigator) $255,000 over 5 years
- Dave Hammond (SPHHS) $100,000 over 1 year (bridge grant)

Stats:
CIHR boosted the budget for this competition by $100M by funneling funds from the Foundation scheme and funds from the deferred project competition (put off until the fall) so overall success rates higher than recently experienced (not, however, sustainably higher unless more $ come from the feds)
- Full grants: 16.5% success rate nationally; 7% for UW
- All grants (including the 1-yr bridge grants): 20.7% success rate nationally; 10.3 % for UW

Total funding for FY 17-18 for Discovery Grants (includes subatomic physics grants): $20.2M (first time we have exceeded $20M), a 4% increase over last year.
Success rate for renewals: 94.4% (another record high)
Success rate for early career researchers: 78.3% (down a bit from last year’s 83.3%, but still way above national average of 69%)

RTIs:
- Again – UW success rate well above the national average.
- 18 RTI grants out of 44 (about 41%) . National average was about 32%
- 1 of 8 of the new RTI Operations and Maintenance of $150,000 for one year. NB – this differed from earlier report where we expected 2 years of funding.
- Total amount = $2.27M

International Research Project Highlights
- **Ehab El-Saadany (Electrical & Computer Engineering), Texas A&M Engineering Experiment Station/Qatar National Research Fund**
  Ehab was awarded $86,475.60USD ($114,000CAD) as a subaward from Texas A&M through the Qatar National Research Fund for his project “Hybrid AC/DC Islanded Micro-grids in Qatar: Planning, Operation and Cybersecurity.” Ehab and his colleagues are hoping to assist Qatar in meeting their renewable energy deployment target of 2% by 2020 by developing a hybrid AC/DC micro-grid to meet local energy demands and reduce high electricity consumption that leaves a high carbon footprint.

- **International Research Partnerships Grants – China - February 2017 competition**
  In the first round of the IRPG-China pilot program, 11 projects were awarded, totaling $455,169 ($205,300 being from the Global Prominence and Internationalization Theme/IRPG fund with the remaining $249,869 being matching funds from the Chinese partner institutions/other external sources). Similarly to the IRPG and IRPG-EU programs, this funding is to provide the resources for partnership building and collaboration with researchers/institutions in China.

- **Roy Brouwer (Economics, The Water Institute), Queen Elizabeth Advanced Scholars Award**
  Roy has been awarded $498,690 from Community Foundations Canada for the Queen Elizabeth Advanced Scholars program for his project “Water Security as a Foundation for Healthy
Communities and Sustainable Livelihoods.” Roy and his team aim to significantly increase the local and global academic and professional capacity related to sustainable water resources management in five LMICs in direct support of developing (i) climate smart agricultural systems for food security (India and Pakistan), (ii) climate-proof public health services under increasingly severe drought and flood conditions (Zambia) and (iii) safe water supply and sanitation facilities to improve the poor health status of mothers and infants (Kenya and Uganda).

- **Richard Kelly (Geography and Environmental Management), Japan Aerospace Exploration Agency (JAXA)**
  Richard has been awarded approximately $100,000CAD for a two year research project funded by the Japan Aerospace Exploration Agency. Richard’s project “Maintenance and Development of the JAXA GCOM-W1 AMSR2 Snow Depth and Snow Water Equivalent Algorithm” will aim to map the presence of snow on the Earth’s surface and quantifying how much water is stored in snow to develop applications concerned with the global water and energy cycles, regional or global climate change, and water resource management.

- **Fereidoun Rezanezhad (Earth and Environmental Sciences), Qatar University/Qatar National Research Fund**
  Four researchers, with Fereidoun being the lead PI, from the Department of Earth and Environmental Sciences are the co-recipients of a $672,000 USD ($904,000CAD) grant from the Qatar National Research Fund (QNRF) to study the fate of groundwater pollutants in arid regions. The Waterloo team, all members of the Water Institute, are part of a consortium including researchers from Qatar University, United Arab Emirates University, Utrecht University, Helmholtz Centre for Environmental Research, and Université Libre de Bruxelles. Over the next three years the project funded by QNRF will use new experimental column systems developed in the Ecohydrology Research Group at the University of Waterloo to determine how hydrocarbons behave in soils experiencing high evaporation and high salinities, that is, conditions that are typical for coastal aquifers in Qatar.

- **Jesse Hoey (Computer Science) – Digging Into Data Challenge (Joint SSHRC and NSERC Initiative)**
  Jesse has been awarded approximately $199,504CAD from a combined contribution of SSHRC and NSERC funds for the Digging Into Data Challenge program. Jesse’s research aims to explore the social and psychological mechanisms of self-organized collaboration, focusing on the open, collaborative software development platform GitHub. He and his team will provide new data-driven theoretical insights into what motivates self-organized collaborations and what determines their success. The project will provide empirical validation of sociological theory and formal answers to important social science questions about collaboration. It will expose novel research questions by expanding a theoretical model of small groups to the network level.

- **Elizabeth English (School of Architecture) – Water Window Challenge (partnership between the Global Resilience Partnership (GRP) and Z Zurich Foundation of Zurich Insurance)**
  Dr. English was awarded $249,600 USD for a project entitled Development of Amphibious Homes for Marginalized and Vulnerable Populations in Vietnam. The project will pilot the use of low cost amphibious houses, used in flood-prone areas of Louisiana, USA for decades, by adapting the design for the local communities in the Mekong Delta.

- **Philippe Van Cappellen (Earth and Environmental Sciences) – WaterWorks2015 ERA-NET Cofunded Call (Canadian budget supported by NSERC)**
Three Water Institute members – Philippe Van Cappellen (earth and environmental sciences), Nandita Basu (earth and environmental sciences and civil and environmental engineering) and Roy Brouwer (economics) – received $543,900 CAD to address persistent, long-term pollution created by excess fertilizers in the lakes, rivers and wetlands in several parts of the world. The interdisciplinary project entitled **Legacies of Agriculture Pollutants (LEAP)** is one of six international projects receiving a combined total of $1.84 million CAD over three years. The Natural Sciences and Engineering Research Council of Canada (NSERC) is the Canadian funding partner organization, alongside the International Development Research Centre (IDRC), supporting the international research collaborations through the European Commission Water Joint Programming Initiative.

**Institutional**

In terms of recently submitted applications, the following CRCs were submitted for the April 2017 competition:

1. 8 CRC applications for a total of $7,600,000 submitted on April 25, 2017
   - 4 Tier 1s; total requested amount = $5,600,000
   - For the Tier 1 applications: 1 = advancement; 1 = renewal; 2 = new
   - 4 Tier 2s; total requested amount = $2,000,000
   - For the Tier 2 applications: 1 = new; 3 = renewal.

2. CRC results from October 2016 (total 14 funded for total of $10,200,000):
   - 13/14 applications successful = 92.9% success rate; 94.8% funding rate
   - Tier 1: 3/3 funded; $4,200,000 requested/funded = 100% funding and success rate
   - Tier 2: 10/11 funded; $5,500,000 requested and $5,000,000 funded = 90.9% funding and success rate
   - 1 international nomination submitted (out of cycle) – $500,000 requested/funded = 100% funding and success rate

3. 2 affiliated CFI-JELFs submitted for a total of = $593,643 (total CFI-JELF envelope requested = $234,000)

**Research Partnerships**

David Blowes – Earth Sciences – “Valuing Diversity in Agro-Ecosystems: The Interplay of Natural Habitat, Integrated BMPs and Field Cropping Systems on GHG Emissions and Carbon Stocks” – 5 year project
- Agriculture and Agri-Food Canada
Partners include: University of Ottawa, Carleton University and the University of British Columbia

Total Value: $1,877,420 cash and $559,000 in-kind

Sanjeev Bedi – Mechanical & Mechatronics Engineering – “NSERC Chair in Immersive Design Engineering Activities (IDEAs)” – 5 year project
- NSERC - $1,000,000
- Desire to Learn - $125,000 and $125,000 in-kind
- Skyjack - $125,000 and $182,000 in-kind
- ANSYS - $125,000 and $111,250 in-kind
- Rockwell Automation - $125,000 and $125,000 in-kind
- Quanser - $32,500 and $92,000 in-kind

Total Value: $1,532,500 cash and $635,250 in-kind

Amir Khajepour – Mechanical & Mechatronics Engineering – ‘NSERC Industrial Research Chair – “Holistic Vehicle Control” – 5 year project
- NSERC - $1,000,000
- General Motors - $1,000,000 cash and $3,000,000 in-kind

Total Value: $2,000,000 cash and $3,000,000 in-kind

Weihua Zhuang – Electrical & Computer Engineering – NSERC CRD “Software-Defined Networking for Service-oriented 5G Networks” – 3 year project
- NSERC - $386,550
- Huawei Technologies - $385,515 cash and $90,000 in-kind

Total Value: $772,065 cash and $90,000 in-kind

Duane Cronin – Mechanical & Mechatronics Engineering – NSERC DND “Transparent Armour Ballistic Performance Modeling and Optimization” – 3 year project
- NSERC - $326,000
- DRDC - $90,000 and $121,850 in-kind
- General Dynamics Land Systems - $50,700 and $39,000 in-kind
- NRC - $50,700 and $60,000 in-kind
- Preclo Inc. - $50,700 and $45,000 in-kind

Total Value: $568,100 cash and $265,850 in-kind

Jonathan Blay – School of Pharmacy – “Studies on botanical oils from Algae Dynamics” – 3 year project
Algae Dynamics Corp. - $390,000 and $140,000 in-kind

Kinesiology:
Lora Giangregorio: $25K for a SPOR (strategy for patient oriented research) collaboration grant

Insight Grants:

Key takeaways: The amount awarded to Waterloo increased by $1,421,610 from last year and our average awarded total exceeds the national average by more than $40,000

Connection Grants – February 2017 round:
We submitted 4 and received 3 = 75% success rate for a total of $99,950

**Tri-Agency Monitoring Review: Feb 2017 Briefing Note on Findings**
A team of four from the Tri-Agency (CIHR) came on site to do a full monitoring review. They chose a sample of 100 tri-agency projects and requested supporting documentation for 100 transactions across these projects.
Their draft report has not been received yet but an initial overview of key findings was discussed during a debrief meeting held on site on the final day of the review (John Thompson was the senior OR representative at that meeting).

Key findings were

**Good Practices**

1. All previous recommendations from previous monitoring visits had been completed
2. Clear understanding across the university of the roles and responsibilities of the different parties involved in the administration of research grants – (there is a “Roles and Responsibilities” document on our website)
3. Significant amount of training is provided to those involved in the administration of research grants – Research Finance training and compliance team provided initial and/or refresher training to over 150 administrators last year
4. Effective compliance review framework and training and compliance team in place. Metrics are collected and results fed back through communication channels and into future training.
5. Accounting systems and chart of accounts supports appropriate reporting of research grants and grant-holders are provided with timely financial reports in sufficient detail.
6. Annual Form 300 statement of grants are consistently submitted on time through the online system
7. Effective policies and procedures are in place regarding Ethics compliance, both animal and human.

**Areas of Improvement**

1. Graduate Studies Fund (GGSF) – managed by Graduate Studies and their equivalent to GRF. No signing authority, use of fund for ineligible items, no written policy, no segregation of duties
2. Authorization Issues
   a. Institutional Awards – certain tri-agency awards e.g. GRF, GGSF, CFREF, CRC etc. are institutional awards to the President so need a formal delegation to either VP Research or Deans (for CRCs). We put this in place for the CRCs back in Feb 2016 (although the President needs to formally sign this memo) and we have a memo being checked by the tri-agency which will then go to the President to do the formal delegation for the GRF. Grad Studies are doing a separate memo for the GGSF
   b. CRC Admin Fees – annual expense for these fees ($5k or $10k) need to be authorized by the Deans (who now have signing authority). We will organize an annual email approval for each Dean to authorize
   c. Internal Charges – some internal charges (about 40% of those samples – mainly telephone charges and UW retail services) were not authorized by the PI or delegate
3. Hospitality – some hospitality invoices from third party providers and internal charge providers (e.g. UW club) did not have sufficient detail e.g. date of event, number of attendees, purpose of event etc. The vast majority of hospitality charges resulting from a reimbursement of an individual had this level of detail as the training and compliance team review these expenses and ensure this information is provided – they don’t see low dollar value third party invoices or internal charges.
4. NCE-CWN – managed by CWN – lack of segregation of duties, transactions not signed by a designated signing authority, no oversight role by UW beyond high level central finance oversight – about 40% of transactions had issues but nothing major. This was an area that we knew we were likely not fully compliant but CWN was not rolled into the compliance review
framework because it would have required additional resources and training which did not make sense given they are closing down as of March 2017. We confirmed that if we were awarded a future NCE we would fully adhere to the tri-agency guidelines for administering an NCE. It should be noted that there were no issues raised at our last monitoring review in 2010 regarding the administration of the NCE and CWN did have financial policies and procedures in place but they just didn’t always follow them.

**Next Steps**

1) Draft report will be sent within the next month or so
2) De-brief meeting via conference call will be held with VP Research and VP Admin and Finance
3) Waterloo will have one month to respond to the issues raised and propose an agreed plan of action
4) Tri-agency will review and agree action plan
5) Final report will be sent and Waterloo will have 2 years to implement any agreed actions