

STRATEGIC PLAN

Final Faculty Update Supplement 2013–2018

2013-2018



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UNIVERSITY OF
WATERLOO





"In Applied Health Sciences, we don't just study problems, we aim to solve them. Addressing increasingly complex health and social challenges — such as social isolation, increased burden of chronic illness, growing health inequities, environmental threats — needs innovative multi-level responses, interdisciplinary collaboration, and strong partnerships with communities, industry and government. All of these are recognized strengths of our Faculty."

Paul Stolee, Interim Dean of Applied Health Sciences



"Scholarship in humanities, social sciences, and creative arts is needed more than ever. Just look at the wicked problems in media headlines, and you will see issues best addressed by the very disciplines found in Waterloo Arts. Our recent growth with new faculty and responsive academic programming opens more avenues for putting research and learning into action and advances our commitment to benefit the peoples, economies, and cultures of Canada and beyond."

Douglas Peers, Dean of Arts



"With new academic and entrepreneurship programming and with research funding reaching new heights, Engineering is delivering on its vision to Educate the Engineer of the Future, pioneering the intelligent, connected, digital, and physical 21st century."

Pearl Sullivan, Dean of Engineering



"Environment continues building on its reputation as Canada's leading post-secondary institution for Environmental teaching and research. In the past five years, we have made progress empowering our student entrepreneurs, championing transdisciplinary problem solving for our planet's greatest challenges of social equity and sustainability, and offering experiential learning all around the world that we're committed to saving."

Jean Andrey, Dean of Environment



"Over the past five years we have continued to increase the depth and scope of the Faculty of Mathematics. We value creativity and innovation across the full range of mathematical disciplines, pure and applied, including such diverse areas as statistics, computer science, artificial intelligence, and business. The language and power of mathematics is the fabric upon which the modern world is built, and Waterloo provides the talent and ideas that Canada needs."

Stephen Watt, Dean of Mathematics



"Scientific enquiry is foundational to innovation. The Faculty of Science aims to create the conditions for curiosity-driven discoveries through cross-disciplinary collisions that often lead to transformative innovations. Their translation and eventual commercialization requires a vibrant innovation ecosystem that promotes entrepreneurship. Science continues to promote activities across the innovation continuum and create the conditions for game-changing accidental collisions between complementary disciplines."

Bob Lemieux, Dean of Science

Message from the Deans

Waterloo's six Faculties form the backbone of the University's mission, providing vibrant research, teaching and learning environments in their respective discipline areas.

Over the five years of the institutional Strategic Plan, Faculties worked either retroactively, or proactively, to align their own strategic plans with the institutional plan. Faculty initiatives drive outcomes in Waterloo's Strategic Plan theme areas of research, academic programming, experiential education, entrepreneurial and international. Our Faculties' efforts are also vital to the theme areas of student experience, robust employer-employee relations, and sound values.

Each year, we have provided updates on our respective Faculties' initiatives and outcomes relevant to theme areas. In this fifth year, our updates provide an important look back on key accomplishments and achievements for the five-year period. Each of our Faculties has made important contributions to achieving Waterloo's goal of being one of the world's most innovative universities.

These achievements have not come without challenges. We have worked to align Faculty strategic plans with the institution's and to balance Faculties' directions with that of the institution. Political and funding environments are frequently in flux. Students, our *raison d'être*, evolve too, and as do their needs and expectations. At Waterloo, we pride ourselves on being flexible and responsive to effectively balance diverse and changing priorities.

Each of our Faculties has accomplished much; yet there is still more to do. As we look forward to working on the next institutional plan, we are already considering how to continue momentum in key areas. We look forward to collaborating with centralized Academic Support Units, under the leadership of the vice president academic and provost, to develop an updated vision for Waterloo's future, and goals and objectives in priority areas, to continue to drive our strategic directions.



PAUL STOLEE
Dean of Applied Health Sciences



DOUGLAS PEERS
Dean of Arts



PEARL SULLIVAN
Dean of Engineering



JEAN ANDREY
Dean of Environment



STEPHEN WATT
Dean of Mathematics



BOB LEMIEUX
Dean of Science

FACULTY OF APPLIED HEALTH SCIENCES

Faculty Summative Report | Fall 2018

The Faculty of Applied Health Sciences' (AHS) 2013–2018 Strategic Plan outlines a vision to be a global leader in health protection and promotion, and advances Waterloo's institutional strategic objectives in the vital areas of creating knowledge and impact, education and training, internationalization, and transformative ideas. In 2017/18, AHS celebrated 50 years of academic and research leadership in promoting interdisciplinary education and research on health and well-being by opening new state-of-the-art teaching and research labs, as well as new facilities to house the Propel Centre for Population Health Research and other integral research units. The Faculty of AHS's interdisciplinary researchers have high rates of scholarly productivity and one of the highest rates of funding per researcher at Waterloo. In this five-year period, sponsored research in the Faculty increased 45 per cent. New AHS programming has increased the number and variety of AHS academic opportunities. Undergraduate full-time equivalent (FTE) enrolment over this five-year span increased by 19 per cent, and graduate enrolment by 17 per cent. The number of international student FTEs accepted into the Faculty has increased dramatically — 276 per cent for undergraduates and 100 per cent for graduate students. At the same time, Waterloo's Recreation and Leisure Studies Department, one of AHS' three academic units, was ranked the top in Canada and among the top 20 internationally by Quaquarelli Symonds (QS) subject rankings. With a focus on enhancing health and quality of life at the individual, community, and population levels. The Faculty of Applied Health Sciences has made great research, academic and teaching strides during the period of this Strategic Plan, and is poised to continue to be a global leader in health protection and promotion.

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- › Between 2013–2018, AHS received a total of \$75.5M in research funding with 46.4 per cent from federal sources.
- › AHS's share of federal Tri-Agency funding increased by 9 per cent to \$17.2M between 2013–2018. In the same period, AHS received a total of more than \$11.6M in Canadian Institutes of Health Research (CIHR) funding, \$4.7M in Natural Sciences and Engineering Research Council (NSERC) funding and \$1M in Social Sciences and Humanities Research Council (SSHRC) grants. This represents an increase of 41 per cent from NSERC and 7 per cent from CIHR.
- › Faculty in AHS have received numerous prestigious awards and honours between 2013–2018, including four Canada Research Chairs, five Schlegel Research Chairs, and 10 Early Researcher Awards.
- › Professors Troy Glover, Corey Johnson and Diana Parry were named Fellows of the Academy of Leisure Sciences during this five-year period.
- › Professors David Hammond and Scott Leatherdale were each named as CIHR Applied Public Health Chairs, and both also received the CIHR's Trailblazer Awards.

A VIEW OF THE NEW BUILDING EXPANSION THAT INCLUDES STATE-OF-THE-ART LABS AND TEACHING FACILITIES



- > In 2014/15, Professor Paul Stolee received \$2M in funding as part of a broader \$36.6M network grant for AGE-WELL, launched through the federal Networks of Centres of Excellence Program, to create and evaluate technology to benefit older adults. Stolee and other AHS investigators also received \$2.6M from the Canadian Frailty Network in 2017 to implement tools for risk screening, care co-ordination and patient engagement in decision-making in primary care.
- > Canada Research Chair and Kinesiology Professor Clark Dickerson received an NSERC Discovery Accelerator Supplement in 2015/16 for his work in understanding shoulder tissue mechanical exposures. Together with Professor Marina Mourtzakis, Dickerson also received \$377K from the Breast Cancer Society of Canada to investigate functional capacity in breast cancer survivors.

\$75.5M
research funding
received between
2013–2018

- > Professor Richard Hughson's Vascular Echo project was one of four funded by \$1.4M from the Canadian Space Agency in 2015/16. In 2018, he was part of an interdisciplinary team that received a Spark Program grant from the Centre for Aging + Brain Health Innovation (CABHI) to test the effectiveness of promising new technology.
- > Professor David Hammond was named to the Royal Society of Canada's College of New Scholars, Arts and Scientists in 2015/16.
- > Four AHS faculty were named Fellows of the Canadian Academy of Health Sciences: John Hirdes (2014), Stuart McGill (2015), Richard Hughson (2016), and Susan Horton (2017).
- > Ten Canadian hospitals participated in a project to implement the standardized interRAI Acute Care Comprehensive Geriatric Assessment Instrument with a \$549K grant from the Canadian Frailty Network received by AHS researchers John Hirdes, George Heckman, and Heather Keller in 2017.
- > Professor Plinio Morita, director of the Ubiquitous Health Technology Lab, was named the J.W. Graham Information Technology Emerging Leader Chair in Applied Health Informatics in 2016/17. Morita's work focuses on remote patient monitoring through health sensor technologies and wearables.

- > Professor Lora Giangregorio received the 2015 Bloomberg Manulife Prize for the Promotion of Active Living.
- > In 2017, Professor Mark Ferro received the Early Career Award from the Canadian Society of Epidemiology and Biostatistics.
- > The AHS Faculty's substantial research strengths in chronic disease were recognized with a Canadian Cancer Society Research Institute Capacity Development Award (Sharon Kirkpatrick) and the Award for Excellence in Cancer Research (David Hammond).
- > CIHR awarded Professor Rhona Hanning \$673K over four years to bring healthy, local food to schools in First Nations and Métis communities. Professor Scott Leatherdale received \$1.6M from CIHR in 2017 to continue the COMPASS study, the world's most comprehensive longitudinal study of youth and chronic disease.
- > Recreation and Leisure Studies Professor Heather Mair received a \$250K Connection Grant from SSHRC for a project entitled "Canada 150: Engaging Leisure Legacies/ Creating Leisure Legacies."
- > The Canadian Foundation for Innovation (CFI) and the Ontario Research Fund awarded more than \$4 million to four Waterloo teams in 2015, including Bill McIlroy from Kinesiology for the Advanced Aging ResearCH Centre (ARCH) – now CCCARE – to transform the health and well-being of older adults.

Advancing Technology and Quality of Life

Every day, subtle and simultaneous changes in human metabolic, neurologic, cardiovascular and musculoskeletal systems set us on a course for either health or disease later in life. Researchers in Applied Health Sciences are leveraging technology and developing new ways to assess, predict, and prevent illness and injury. For example, Professors Bill McIlroy, Richard Hughson and Plinio Morita are studying how wearable and remote technology can assess and predict people's health, accelerate rehabilitation, and avoid unnecessary hospital visits. Professor Helen Chen is developing mobile technology that can assess chest pain at home, Professor Diana Parry is investigating the roles online communities play in supporting women with children, and Professor Paul Stolee is helping older adults get faster access to devices that can increase their safety and security.



STUDENTS IN THE FOYER OF THE NEW AHS EXPANSION

- > AHS researchers received more than \$1M in funding for the Centre of Research Expertise for the Prevention of Musculoskeletal Disorders (CRE-MSD), including \$307K over two years from the Ontario Ministry of Labour to lead the redevelopment of provincial guidelines for the prevention of musculoskeletal disorders and \$600K in cash and \$500K of in-kind funding from Defence Research and Development Canada.
- > Professor Richard Wells was named a Fellow of the International Ergonomics Association in 2017.
- > The School of Public Health and Health Systems was one of four Waterloo partners to be awarded \$500K from the Queen Elizabeth II Advanced Scholars program, “Water Security as a Foundation for Healthy Communities and Sustainable Livelihoods” in 2017. The program supports three African doctoral scholars working on climate change and public health issues in Western Zambia.
- > Working with colleagues from three other universities, Professor Kelly Skinner received a \$308K four-year SSHRC Insight grant in 2016 to explore the multiplicity of food and social economies and experiences for Indigenous peoples in the north and urban centres in Manitoba and Ontario.

45% increase in research funding since 2013

STRATEGIC INITIATIVES:

INTERNATIONALIZATION

- > In 2017, Professor Craig Janes, the Canadian Coalition for Global Health Research (which includes Aberystwyth University in Wales, UK), the Western Province Zambia Provincial Medical Office, and the University of Barotseland established the “Zambezi Ecohealth Partnership” (ZEP), an integrated, multi-disciplinary and sustainable knowledge platform that provides evidence for addressing the priority health and well-being problems of Western Zambia.
- > Professor John Hirdes is the senior Canadian researcher for interRAI, a collaborative network of researchers in more than 30 countries involved in supporting the collection and analysis of high quality data for vulnerable persons across a variety of health and social service settings.

- > Professor Paul Stolee was one of two Canadian aging-focused researchers who attended a Canada-Korea joint meeting on scientific collaboration in 2014.
- > In 2015, the School of Public Health and Health Systems signed a Health Educators Climate Commitment with 117 other health-related schools from 14 countries.
- > The School of Public Health and Health Systems established the Global Health Policy and Innovation Research Centre. Funded initially by donor contributions to AHS, the Centre will serve as a hub for interdisciplinary teaching and research in global health practice at the University of Waterloo.
- > The AHS Teaching Champion Team received a Learning Innovation and Teaching Enhancement (LITE) grant to identify barriers and facilitators for high impact teaching.
- > In May 2017, Teaching Fellows teams were established in each of AHS's three academic units to enhance teaching initiatives, graduate student development and innovation in teaching. The teams hold monthly workshops for faculty, teaching staff, sessional instructors, and graduate students in topics such as engagement in large classes, accessibility in the classroom, technology in the classroom, alternative testing methods, group work and mental health. The program had healthy participation in its first year. The Teaching Fellows also rolled out a new Teaching Excellence Fund in February 2018 that rewards innovation in teaching.

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMMING

- > Between 2013–2018, AHS added one new undergraduate program and four new graduate programs. These programs include an Honours Bachelor of Public Health (2014/15), which grew by 53 per cent in terms of FTEs since the first year it was offered; a Master of Health Informatics (2013/14), which saw an FTE growth of 89 per cent; a Master of Health Evaluation (2014/15), whose number of FTEs increased 196 per cent since its first year; a Master of Science in Kinesiology coursework option (2014/15), which grew by 75 per cent; and a Master in Arts in Recreation and Leisure Studies coursework option, which started in 2016/17. A new 2016 course, AHS 100: Foundations of a Healthy Lifestyle, is offered to students in other Faculties and has been able to accommodate almost 250 students so far.

Recreation and Leisure ranked

1st

in Canada (2017 and 2018)

- > The U.K. firm Quaquarelli Symonds ranked Waterloo's Recreation and Leisure Studies Department the top in Canada and in the top 20 internationally, in its 2017 and 2018 subject rankings in the field of hospitality and leisure management. Waterloo also ranked first in Canada and 23rd worldwide in hospitality and tourism management by another firm, the Academic Ranking of World Universities (Shanghai), for the same two years.
- > The Faculty created the AHS Teaching Awards and AHS Teaching Assistant Awards in 2013/14 to recognize and reward teaching excellence. Since then, AHS Teaching Awards have been granted to Luke Potwarka (2014), Christopher Perlman (2015), Joe Quadrilatero and Elham Satvat (2016), and Elena Neiterman (2017).

Aging and Chronic Disease Prevention

Researchers in AHS are tackling some of the most pressing aging-related issues to improve quality of life for older adults and refine healthcare systems, as well as developing new programs to treat and prevent chronic illness. For example, Lora Giangregorio is exploring effective ways for older adults to avoid fall-related fractures, Laura Middleton is investigating how exercise can ward off dementia, Sherry Dupuis is changing the culture of dementia care, and Marina Mourtzakakis focuses on the interrelationship between nutrition, exercise and muscle metabolism for people with cancer. Scott Leatherdale is creating research infrastructure to facilitate large population studies for chronic disease prevention, and David Hammond provides decision-makers with evidence when developing policies regarding tobacco, vaping and cannabis.

LOOKING AHEAD:

- > AHS will continue to support multidisciplinary researchers, clinical experts, and staff who strive to eliminate disease and improve the overall health of individuals through research, educational opportunities, and progressive outreach programs. The Centre for Community, Clinical and Applied Research Excellence (CCCARE) will continue to deliver programs and partnerships that offer greater advances in research and in promoting health in our communities.
- > In line with the UN's Sustainable Development Goals, a growing focus will be placed on global health policy, innovation, and research that enhances the health and well-being of international populations. Through training and mentorship, Waterloo strives to provide the health leadership needed to meet global health challenges. These initiatives will further the University's goals of conducting transformational research and establishing global prominence and internationalization.
- > Finally, consistent with the University's emphasis on student mental health, the Faculty is prioritizing youth mental health as a research focus.

FACULTY OF ARTS

Faculty Summative Report | Fall 2018

The Faculty of Arts has experienced considerable growth during the period of the 2013–2018 Strategic Plan, fulfilling objectives of their own 2014–2019 Faculty Strategic Plan and contributing significantly to achievements in the institutional plan. Building capacity in the professoriate, among technical staff, with new infrastructure, and in key leadership appointments has allowed Arts to substantively expand programming in a variety of areas, while also addressing key issues in diversity and equity. Arts has strategically developed undergraduate and graduate course and program offerings in response to changing needs and priorities, including the 2018 transformation and renaming of the Stratford Campus to the Stratford School of Interaction Design and Business. Additionally, Arts supports vital efforts on campus, such as designing programming to build communication skills in Waterloo students across all the Faculties, and proactively encouraging institutional efforts towards reconciliation with Indigenous communities

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- › Arts researchers received \$53.2M in research funding from all sources between 2013–2018, half of which (\$26.1M, 49.1 per cent) came from the Tri-Councils.
- › Between 2013–2018, four Arts faculty were named to the Royal Society of Canada: Geoffrey Fong, Colin MacLeod, Eric Helleiner, and James Walker. John Turri, Karen Collins, and Chris Eliasmith were named members of the Royal Society of Canada College of New Scholars, Artists, and Scientists.
- › New faculty members joining Arts over the past five years helped to increase channels for interdisciplinary research collaborations and contributed to overall success with funding and awards, including seven Ontario Early Researcher Awards won between 2013–2018.
- › Paul Thagard won a 2013 Killam Prize, and Eric Helleiner received a 2017 Killam Research Fellowship, both awarded by the Canada Council for the Arts.
- › Arts researchers established 92 international research partnerships between 2013–2018.
- › Other national award winners include Bessma Momani (Fellow, Pierre Elliot Trudeau Foundation), Chris Eliasmith (Natural Sciences and Engineering Research Council John C. Polanyi Award), and two Order of Canada recipients: James Walker and John English.



Building and Diversifying Arts' Research and Teaching Capacity

Over the past five years, Arts has increased multidisciplinary research activity with internal and external partners. Arts faculty members lead and participate in research projects and centres across campus, such as the Games Institute, the Water Institute, and the Archives Unleashed project. In addition to hiring 117 new full-time faculty members since 2013, the Faculty has hired more specialized staff in areas such as data analysis, digital production, advancement, and communications — providing vital supports that enable and disseminate research impact. New and young faculty members in a range of Arts disciplines opened more channels for interdisciplinary research and teaching, and contribute to our excellent record of success with research funding and national honours and awards.

Arts researchers received

\$53.2M

in research funding
between 2013–2018

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMMING

- › Developed by Centre for Teaching Excellence and Arts instructors between 2016–2018, WatCV responds to the Strategic Plan goal to “improve employability of all University of Waterloo students, regardless of discipline” by integrating exercises in a course to help students translate and represent their classroom and experiential learning in employment interview situations.
- › Arts Teaching Fellows ran online and in-person initiatives, including a Pedagogy Picnic series of talks in which professors shared proven teaching innovations; regular blog posts with insights and useful links; an online newsletter; and a video series on optimizing LEARN. The Teaching Fellows focused on strategies for accessibility, diversity, and inclusivity in Arts teaching and learning in all their efforts.

- › The Faculty of Arts introduced 375 new and restructured undergraduate courses between 2013–2018 that respond to curricular changes and improvements while also offering more opportunities for students to engage deeply and critically with new and emerging issues of the 21st century.
- › The Master of Public Service (MPS) has dedicated significant effort to generating co-op and post co-op employment through networking with senior government bureaucrats in Ottawa and Toronto. With excellent alumni employment rates, MPS has established itself among Canada’s top public administration professional programs.
- › In development for over three years, Arts First is a course-based program that ensures all students embark on their undergraduate studies with strong foundational skills in communication and analysis. After running successful pilot courses in winter 2018, Arts First will begin in 2018/19 with approximately 1,000 incoming Arts students taking ARTS 130 (Inquiry and Communication) and ARTS 140 (Information and Analysis). Faculty from all Arts disciplines will teach over 40 course sections, with a limit of 25 students per section. Each year, four topical theme areas will guide the syllabi. The 2018 themes include Borders and Belonging; Inequality: the Haves and Have-Nots; After the Digital; and Truth and Lies.
- › The English Language Proficiency Exam (ELPE) is being phased out as communication programming and replaced by programming developed by the Steering Committee, English Language Competency Initiative (SCELCI). The ongoing pedagogical leadership of Arts faculty members has been crucial in both the design and delivery of communication courses for numerous cohorts in Applied Health Sciences, Arts, Engineering, Environment, Mathematics, and Science.
- › By 2015, plan standardization across Arts undergraduate disciplines was completed and implemented, making program requirements and course selection more transparent and flexible for students. Standardization facilitates greater interdisciplinary learning by enabling students to combine majors and minors more easily.

375 new and restructured courses over the last five years



STUDENTS IN THE FACULTY OF ARTS MULTIDISCIPLINARY GLOBAL ENGAGEMENT PROGRAM.

- > Over the past five years, the Faculty of Arts launched more skills-based minors to give students more opportunities to combine career-focused learning with major studies. This suite of minors includes Human Resources Management; International Trade; Digital Arts Communication; Public Policy and Administration; and Visual Culture in a Global Context.
- > In close collaboration with campus partners, Arts graduate programming offers more graduate professionalization workshops and other initiatives to build skills and knowledge mobilization for both alternative-academic and non-academic career pathways. In 2018, the consistently high quality of the Arts Three Minute Thesis presentations illustrates the strengthening professionalization in graduate programming.
- > The Bachelor of Global Business and Digital Arts (GBDA) launched in 2012 with close to 100 first-year students; by September 2017, there were 581 GBDA students enrolled in all years. Along with the graduate program, the employment rate for Stratford School alumni is now at 91 per cent. Many alumni are hired with companies like Amazon, Google, Scotiabank, Telus Digital, Deloitte and some of Waterloo’s startup companies.

- > History introduced Indigenous Histories as a new field of specialization in the History PhD program, representing another step toward indigenization at Waterloo.

STRATEGIC INITIATIVES:

INTERNATIONALIZATION

- > Over the past five years, more than 470 Arts students travelled abroad to study with many of Waterloo's 50+ partner universities around the world. Through collaborative efforts across the Faculty, and together with campus partners, Arts continues to facilitate internationalization experiences for students. In addition, undergraduate and graduate programs attract increasingly more international students to Waterloo.
- > Since 2015, Global Governance graduate students have the option to internationalize their learning even more with the University of Warwick double degree partnership program. As well, students gain professional experience with the program’s partnership with Global Affairs Canada, wherein students travel to Ottawa each year to present their research on new and emerging trends that could impact foreign policy.

Building a Sense of Community

The Arts Student Union conducted a survey in 2012 and determined that students would benefit from additional space. This became a key objective in the 2014 Arts Strategic Plan and was achieved by September 2016 when the Hagey Hall Hub opened. The Hub offers three floors of study, project, and social space for students and other community members. The space also represents Waterloo's commitment to collaboration, with funding support coming from students, faculty, staff, alumni, retirees, and friends. Students report high satisfaction with the new space: *"I love that the Hagey Hall Hub has become the home to all Arts students on campus. Before, we didn't really have a single place on campus where everyone would be, or where events would happen. With the Hub, it's easy to find my community."* – student, Alyssa Boss

- > Arts played a collaborative leadership role with several notable research, teaching, and community projects responding to the truth and reconciliation calls to action. Arts also helped to facilitate territorial acknowledgment on Waterloo campus, launched the Indigenous Speakers Series in partnership with the Waterloo Indigenous Student Centre, and the dean and an associate dean, along with others in Arts, are members of the working groups developing the University's Indigenization Strategy.

19% increase in full-time faculty over the last five years

STRATEGIC INITIATIVES:

EXPERIENTIAL EDUCATION

- > From 2013 to 2018, 12,435 co-op work terms have enabled Arts students to apply their learning and gain real world experiences with more than 1,550 different companies and organizations in Canada and beyond.
- > The Global Engagement Seminar, a donor-supported senior undergraduate pilot program, launched in 2018, offering top students from any Waterloo Faculty an applied capstone experience. With mentorship of a faculty member and a high-profile leader from the private or public sector, students examine an identified global problem using methods from across their disciplines before proposing solutions at a public summit. The inaugural class of 19 students from five Faculties tackled the theme of Global Populism and Democratic Futures.

1,550 employers hired Arts co-op students in five years

STRATEGIC INITIATIVES:

SOUND VALUES

- > With 340 full-time faculty members by September 2018, Arts continues to reach near gender parity with a current ratio at 54 per cent male and 46 per cent female professors.

LOOKING AHEAD:

- > The Faculty of Arts creates the conditions for more multidisciplinary research collaboration, and, where appropriate, supports interdisciplinary initiatives. Hiring priorities and programming initiatives will support the University's Indigenization Strategy, and will expand Waterloo's reach and opportunities to contribute to the University's leadership in artificial intelligence.
- > The Arts First program will ensure all of the Faculty's first-year students have foundational skills in communication and information analysis. Having recently doubled the budget for student engagement initiatives, Arts will continue to dedicate resources to initiatives, such as midterm outreach, to support student success.
- > The cross-campus, multidisciplinary Global Engagement program is poised to grow and provide more opportunities for Arts students to collaborate with their counterparts in other Faculties in tackling real-world complex issues.
- > With the planned 2020 launch of the Honours Arts Co-op, the Waterloo commitment to experiential and co-operative education will be extended to all students on the main campus in the Faculty of Arts.

FACULTY OF ENGINEERING

Faculty Summative Report | Fall 2018

Waterloo's Faculty of Engineering developed its Vision 2015 Strategic Plan in 2011, and Waterloo's institutional Strategic Plan was developed in 2013–2018, with largely consistent goals and objectives. Engineering's Strategic Plan focused on building human infrastructure and resource capacity to continue to create and implement exceptional academic programming, entrepreneurial and experiential education opportunities for a growing and increasingly diverse population of undergraduates. At the same time, the Faculty has continued to build an aggressive research portfolio with outstanding opportunities for faculty and graduate students. Particular areas of development include auto manufacturing, artificial intelligence (AI) and robotics, nanotechnology, internet of things (IoT), and information and communication technologies. These efforts have resulted in numerous faculty academic and teaching awards, recognition through international ranking programs, new and innovative business and development opportunities, and increased enrolment of highly qualified students from diverse communities for entrance to Waterloo's Engineering programs.

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- > Waterloo was named the number one Engineering school in Canada and 51st in the world by the US News' Global University Subject-area Rankings. The University was listed 60th in the world for Engineering and Technology by the 2018 QS World University Rankings by Subject.
- > Engineering's research income for 2017/18 was \$72.5M, bringing its total funding to more than \$310M over the five years spanning 2013/14 to 2017/18.
- > Industry funding rose to \$17.0M in 2017/18, the highest amount ever, an increase of 92.4 per cent from 2013/14.
- > Funding from Natural Sciences and Engineering Research Council (NSERC) programs increased to \$24.5M in 2017/18, an increase of 53.5 per cent from 2013/14, another new high for the Faculty.
- > In the 2017/18 NSERC Strategic Partnership Grants (SPG) Network competition, two out of three grants awarded nationally are led by engineering professors. Each SPG Network grant is for five years and worth more than \$5M.
- > Engineering was awarded \$40.6M from prestigious Ontario Research Fund (ORF) awards, including 27 Early Researcher Awards, six Research Excellence projects, and \$16.7M in Research Infrastructure projects.

ELUCID LABS, AN AI MEDICAL STARTUP FOUNDED BY ALUMNUS FARNOUD KAZEMZADEH, LEFT, PROFESSOR ALEXANDER WONG, RIGHT, AND ALUMNUS IMAN KHODADAD, WAS NAMED ONE OF THE 20 MOST INNOVATIVE TECHNOLOGY COMPANIES BY THE CANADIAN INNOVATION EXCHANGE.

- > Waterloo Engineering will host one of the three nodes of the Ontario Advanced Manufacturing Consortium (AMC), through the support of \$11.7M from Ontario's Ministry of Research, Innovation and Science. The first Additive Manufacturing Lab in Canada (MSAM-3D Printing), a major facility in AMC, was developed with \$8.9M support from FedDev and \$6.2M from Ontario. Lab Director Professor Ehsan Toyserkani's industry partnerships led to \$32M from the NSERC/CFI Strategic Network for Holistic Innovation in Additive Manufacturing (HI-AM).

\$310M+
in total research
funding received over
last five years

- > Over the past five years, Engineering has intensified efforts to build world-class research facilities equipped with the most advanced research equipment and tools. This has resulted in 43 NSERC Research Tools and Instruments awards, each worth between \$5.3M and \$20.6M from the Canada Foundation for Innovation (CFI). In addition, Engineering received \$32.6M in federal funding from the Post-Secondary Institutions Strategic Investment Fund and \$36M from private donors for the construction of Engineering 7, which opened in fall 2018.
- > Professor Philip Beesley received a major Social Sciences and Humanities Research Council (SSHRC) Partnership Grant in Living Architecture Systems for \$2.5M.
- > Three faculty members were named Members of the Order of Canada, and one elected to the Order of Ontario.
- > Three Electrical and Computer Engineering faculty members were named Fellows of the Royal Society of Canada, the nation's highest academic honour. Professor K. Hipel received the RSC Centenary and Miroslaw Romanowski Medals, while Professor Z.W. Chen received the Royal Society of Canada Rutherford Memorial Medal. Another six were appointed to the Royal Society of Canada College for New Scholars, Artists and Scientists.

- > Engineering received many prestigious international awards, including election to the U.S. National Academy of Engineering, six new Fellows of the Institute of Electric and Electronics Engineering, and an Engineering Emmy Award.
- > Seven faculty members were named Fellows of the Canadian Academy of Engineering and another four were appointed Fellows of the Engineering Institute of Canada. Five received Engineering Medals from Professional Engineers of Ontario (PEO), including three Research & Development Awards, an Engineering Excellence Award, a Young Engineer Award, and the Engineers Canada Support of Women in the Engineering Profession Award.
- > Engineering was successful with its Phase 1 Canada Excellence Research Chair (CERC) application, one of only 11 selected nationally for Phase 2. The Waterloo CERC in Human-Centred Robotics and Machine Intelligence, which will be funded at \$10M over seven years, will be the first Artificial Intelligence (AI) and Robotics CERC in Canada.

11 Canada Research
Chairs awarded
over five years

Artificial Intelligence Leader

Engineering is a national leader for digital technology integration. The past five years have strategically focused on developing operational artificial intelligence. More than \$16M has been secured to create new research chairs, including the Canada 150 Research Chair in Intelligent Robotics (Kerstin Dautenhahn), the Canada Excellence Research Chair in Human-Centred Robotics and Machine Intelligence, the Loblaw Chair in AI (Fakhri Karray), and the Cisco Research Chair in 5G Systems (Catherine Rosenberg). Elite teams have achieved commercial success, including Waterloo spinoff Euclid Labs — recognized as one of Canada's top 20 startups in 2017. Meanwhile, Engineering is addressing the demand for new AI talent via a collaborative graduate program in Data Analytics, and a new AI option offered to all 14 undergraduate engineering programs.



ANNE BORDELEAU, DIRECTOR OF WATERLOO'S SCHOOL OF ARCHITECTURE, AND SCOTT WALBRIDGE, DIRECTOR OF WATERLOO'S ARCHITECTURAL ENGINEERING PROGRAM, LOOK AT THE TYPE OF MODEL THAT COULD BE CREATED BY STUDENTS IN ENGINEERING'S NEWEST PROGRAM.

- > Engineering faculty received five prestigious NSERC awards, including two E.W.R. Steacie Memorial Fellowships, two Synergy Awards for Innovation and the John C. Polanyi Award.
- > Engineering was awarded a Canada 150 Research Chair in 2018, one of the 24 chairs awarded nationally in celebration of Canada's 150th anniversary. Valued at \$2.5M over seven years, the Chair will be held by U.K. social robotics pioneer Professor Kerstin Dautenhausen in the area of Intelligent Robotics.
- > Eleven new Canada Research Chairs were awarded to Engineering between 2013–2018 for a total of 24.
- > Engineering is a key participant of two Innovation Superclusters — Supply Chains and Logistics Excellence powered by Artificial Intelligence (SCALE.AI) and Advanced Manufacturing. As one of three co-founders of SCALE.AI, Engineering will establish the Waterloo SCALE.AI Technology Centre in 2018.
- > The Tsinghua University–Waterloo Joint Research Centre for Micro/Nano Energy & Environment Technology was officially launched in March 2018 in Beijing, China to advance nanotechnology, energy, and pollution control technologies. This is the first joint international centre for Waterloo.

- > The Waterloo Artificial Intelligence Institute, a joint venture of the Engineering and Mathematics Faculties, was launched in April 2018 to foster campus-wide research in artificial intelligence.

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMMING

- > Engineering doubled enrolment in the Mechatronics Engineering program, and launched two new undergraduate programs in Biomedical Engineering and Architectural Engineering. Engineering also introduced a new Artificial Intelligence option that began in fall 2018.

88% of first-year students had incoming high school averages of 90% or higher

- > The calibre of students continues to rise. In 2017, 88 per cent of first-year students had incoming high school averages of 90 per cent or higher, and 53 per cent had averages of at least 95 per cent.

Dynamic Teaching in Engineering

Engineering education at Waterloo is increasingly more dynamic. Launched in 2017, the five-year, \$1M NSERC Chair in IDEAs (Engineering Ideas Clinic™), held by Professor Sanjeev Bedi, provides core funding for the innovative program. The Clinic has implemented activities of various sizes for 35 courses. IDEAs is a new teaching pedagogy which has impacted 11 different programs, and been delivered to 3,000 unique students throughout the year. It hit a home run with Engineering Days, which are events characterized by multi-day immersion of student teams working on large, hands-on, open-ended engineering design problems. Modeled on the “hackathon” concept, students embrace the intensity and bring forward a large spectrum of new ideas to solving these challenging real world problems. The IDEAs Clinic™ delivered nine Engineering Days for eight different programs, reaching 700 first-year students and 195 second-year students.

- > Engineering’s undergraduate enrolment has increased by approximately 20 per cent over the plan period. At the same time, the number of female students increased by more than 70 per cent, and the number of international students increased by more than 75 per cent.
- > Professor G. Stublely, also the Associate Dean, Teaching, won the 3M National Teaching Award — the most prestigious national prize for teaching in 2017.

STRATEGIC INITIATIVES:

EXPERIENTIAL EDUCATION

- > Engineering continues to establish records for co-op employment, most recently with 8,814 co-op work terms in 2017/18, an increase of 14.5 per cent from 2013/14, while consistently maintaining employment rates above 98 per cent.
- > Waterloo Engineering and the University’s Co-operative Education and Career Action office received the 2015 Labour Award from the Rotman School Creative Destruction Lab.

STRATEGIC INITIATIVES:

ENTREPRENEURIAL

- > The Conrad Centre, now known as the Conrad School of Entrepreneurship and Business, launched an Option in Entrepreneurship for engineering students, which then led to a minor offering for all University of Waterloo students.
- > Howard Armitage, founding director of the Conrad Centre, was recognized with the Waterloo Award, the City of Waterloo’s highest honour.
- > Since March 2017, the Palihapitiya/Lau Venture Creation fund has awarded \$150K to three Engineering Capstone Design teams: VivaSpire, Vena Medical and SannTek.

- > Since March 2014, \$300K in funds have been awarded to 30 Engineering student teams who pitched their projects at the Norman Esch Entrepreneurship Awards for Capstone Design competition.
- > Elucid Labs, an AI medical startup founded by a faculty member and graduate students from the Vision and Image Processing Lab (VIPS), was named one of the 20 most innovative technology companies for 2017 by the Canadian Innovation Exchange (CIX).
- > Voltera V-One, a custom circuit board printer developed as a Capstone Design project by Alroy Almeida, Katarina Ilic, James Pickard and Jesús Zozaya, became the first Canadian startup to win the prestigious top prize in the 2015 International James Dyson Award competition.
- > Medella Health, co-founded by a nanotechnology engineering student, captured an international runner-up award in the 2016 James Dyson Award competition. The smart contact lens that monitors glucose levels was the third project with its genesis in Capstone Design to win a top prize in three years.
- > Matthew Bailey, Aaron Grant, and Stephen Lake, Mechatronics Engineering alumni who founded startups in their graduating year, were named to the prestigious Forbes 30 Under 30 2017 list.

LOOKING AHEAD:

- > Fall 2018 will see the launch of the new Architectural Engineering program, a one-of-a-kind studio-based teaching program that merges technology with hands-on design. The co-op program has admitted more than 90 students with at least 50 per cent women.
- > Engineering is a co-leader of the AI-powered SCALE.AI Innovation Supercluster and one of three AMC nodes to support the Next Generation Manufacturing Supercluster (NGM Canada). The Multi-Scale Additive Manufacturing lab will play a key role in a wide range of promising projects, such as developing special inks for 3D printing advanced sensors, and new materials with antimicrobial surface properties.
- > In November 2018, Engineering will begin constructing the Autonomous Vehicle and Research Intelligence Lab (AVRIL), supported by the Canada Foundation for Innovation and the Ontario Research Fund.

FACULTY OF ENVIRONMENT

Faculty Summative Report | Fall 2018

In 2013, the Faculty of Environment launched its five-year Strategic Plan, co-ordinating with Waterloo's institutional Strategic Plan with shared values of innovation, high quality, and an outward-focused perspective. Waterloo's Faculty of Environment is Canada's largest centre for environmental research and teaching, with more than 3,000 undergraduate and graduate students. Its robust research program addresses some of the most critical issues of our time: climate change, sustainability, water security, and urban change. The Faculty of Environment added several new Research Chairs between 2013–2018 and received industry funding for a new centre on climate adaptation and to support knowledge mobilization and best practices on residential flooding. With eight bachelor degree programs, the Faculty provides an engaging and challenging suite of undergraduate programs, two of which are ranked in the top 100 programs in the world. Robust experiential opportunities, including leadership in the United Nations climate change assessment reports and conferences, field experiences, and international coursework provide engaging opportunities for Environment students. By design, Environment's approach in both research and pedagogy is highly interdisciplinary and transdisciplinary, integrating natural and social sciences, policy, and business in ways that address pressing environmental problems and issues. The Faculty of Environment's approach to research and pedagogy arises from and is reinforced by the academic backgrounds of its faculty complement. Approximately one-half of Environment's Faculty members have degrees in more than one discipline, and the 270 degrees that faculty members have earned represent many different fields of study.

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- > The Faculty of Environment has added four University Research Chairs since 2013: Claude Duguay, Dan Scott, Olaf Weber, and Thomas Homer-Dixon who will join effective January 2019. Since 2013, Environment has also added four new Canada Research Chairs (CRC): Christine Dow, Natural Sciences and Engineering Research Council (NSERC) (new Tier 2) CRC in Glacier Hydrology and Ice Dynamics; Sarah Burch Social Sciences and Humanities Research Council (SSHRC), CRC (Tier 2) in Sustainability Governance and Innovation; Brian Doucet SSHRC (new Tier 2) CRC in Urban Change and Social and Social Inclusion; and Maria Strack NSERC (new Tier 2) CRC in Ecosystem and Climate. They join tier 1 CRC Jennifer Clapp, a researcher in global food security and sustainability, bringing Environment's total to five Canada Research Chairs.

GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT STUDENTS AARON AND TINA TAKING EQUIPMENT FROM THE ECOLOGY LAB, TO THE CREEK ON CAMPUS TO COLLECT WATER SAMPLES AND MEASURE STREAM FLOW FOR THEIR ENVIRONMENTAL HYDROLOGY LAB COURSE.



Building the Graduate Program

Several years ago the Faculty of Environment made a commitment to increase its graduate studies capacity. Several initiatives were implemented. The Dean's Doctoral Initiative (DDI), which provides guaranteed funding for highly qualified domestic PhD students has continued into its fourth year. To foster a stronger sense of identity and community, graduate students have been organized into 17 research clusters. In 2014, when the DDI began, the total graduate enrolment was 531. By 2018, the Faculty had 650 students enrolled in Environment graduate programs.

- > Environment has deep expertise in the cryosphere, including polar regions. Ellsworth LeDrew and the Polar Data Catalogue team are tracking the impact of climate change on the Antarctic via satellite mapping. Claude Duguay leads observation and model-based research into observed changes in Arctic lakes and water bodies. Richard Kelly explores the nature of snow mass accumulation for water resources and improving satellite observation methods to estimate snow mass. Chris Fletcher explores how snow cover affects atmospheric dynamics within regional and large-scale climate systems. Environment's recently hired CRC Christine Dow continues her work on the hydrodynamics of Antarctic ice shelves.
 - > The Faculty of Environment is a leading hub of research on natural hazards and climate resilience in sectors ranging from agriculture to transportation. One example is a study by Professor Dan Scott which revealed that if global warming projections prove accurate, only six of the previous Winter Olympics host cities will be cold enough to reliably host the games by the end of this century. The report was shared with the media in 2014 and updated for 2018.
 - > The Faculty continues its impactful research on flooding. Environment received \$4.3M funding from Intact Financial to launch the Intact Centre on Climate Adaptation (ICCA). Partners for Action (P4A) received \$1.1M funding from the Co-operators and Farm Mutual Reinsurance Plan for programs to enhance knowledge mobilization and best practices for making new residential communities flood-resilient.
- > Two Environment Canada Research Chairs were awarded major national honours. Professor Jennifer Clapp was awarded a Trudeau Fellowship to support her research on global environmental sustainability, food security and the financialization of the food system as well as Canada's highest academic honour, being named to the Royal Society of Canada. Sarah Burch was chosen as one of Canada's Top 40 under 40 by Caldwell.
 - > Researchers Claude Duguay and Merrin Mcrae are playing leadership roles in the Global Water Futures Canada First Research Excellence Fund project on campus, a seven-year initiative bringing together risk management, climate change, land use and water resource forecasting to address water issues in Canada. They are joined by eight other faculty members and contribute to Environment's world-class water expertise in the classroom, and through research with organizations such as the Water Institute.
 - > As Canada and the world urbanizes, Environment researchers across all departments work on transitioning communities to become more sustainable. This transdisciplinary work includes mass transit planning with Jeff Casello, sustainable finance with Olaf Weber, using big data for healthier cities with Leia Minaker and Susan Elliott, sustainability law with Neil Craik and Marie-Claire Cordonier Segger and creating socially and environmental equitable neighbourhoods and businesses with Sarah Burch.
 - > From 2013–2018, Environment graduate students consistently received many of the top scholarships from granting agencies in the social and natural sciences. These include multiple NSERC, SSHRC, and Tri-Agency grants, as well as Ontario Trillium Scholarships, Queen Elizabeth II Diamond Jubilee Scholarships among others.

\$37.3M

in Environment research funding over five years, with a 25% increase in 2017/18



ENVIRONMENT STUDENT AUJAS USES A TOTAL STATION, AN ELECTRONIC/OPTICAL INSTRUMENT USED FOR SURVEYING AND BUILDING CONSTRUCTION, AS PART OF HIS GEOMATICS FIELDWORK.

- > With significant activity in the oil and gas sector in Canada, Environment researchers including Maria Strack, Jonathan Price and Rich Petrone work with industry and government to mitigate the ecological impacts of energy extraction, and restore peatlands in western Canada to their natural state.
- > Funding for the Faculty has remained steady (close to \$7M) for the past five years. However, 2018 saw Environment raise approximately \$9.4M. This represents roughly a 25 per cent increase, and a record for the Faculty.

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMMING

- > The Faculty is committed to integrating Indigenous ways of knowing and teaching in its research. Neil Craik has taught aboriginal law the last five years as part of ENV401. Also, in collaboration with Anishanaabe Elder Peter Schuler from Mississaugas of the New Credit First Nation, Professor Dan McCarthy developed and launched a course on Indigenous knowledge. Co-taught with Elder Peter, the course integrates traditional Anishanaabe teachings with conventional scientific themes. Enrolment has grown from 15 students in 2015 to 40 students in 2018.

4 University Research Chairs since 2013

- > As part of its commitment to environmental education to the campus, the Faculty offers open lectures each term, featuring speakers discussing topics from different perspectives. The Department of Knowledge Integration, the Waterloo Institute for Complexity and Innovation, and other Environment organizations also offer regular lectures.
- > Waterloo's Aviation programs are gaining increased recognition globally. Commander Chris Hadfield made his University of Waterloo debut as a professor in 2014, teaching geography and aviation students in a third-year geography class on advanced remote sensing techniques. The Faculty of Environment's Suzanne Kearns facilitated a partnership between the University of Waterloo and the United Nations' International Civil Aviation Organization to offer an introductory course on aviation that anyone in the world can take for free.

- > Environment continually renews its commitment to teaching and student research and has hired five full-time dedicated lecturers since the beginning of the Strategic Plan. In 2018, Derek Armitage won the Award of Excellence for Graduate Supervision, and in 2016 Katie Plaisance was awarded the Distinguished Teacher Award.
- > The University of Waterloo launched the Sustainable Development Solutions Network (SDSN) Canada in 2018. The organization brings together Canadian post-secondary institutions, civil society members and others to mobilize around the United Nations 17 Sustainable Development Goals (SDGs) and the Paris Climate Agreement.
- > Environment has grown its roster of graduate programs significantly, adding a graduate diploma in Climate Risk Management, a Master and PhD in Sustainability Management, a Master of Development Practice, a Masters in Planning, and a Master of Climate Change.
- > Geography and Environmental Studies both rank in the top 100 programs in the world according to the independent international university ranking organization Quacquarelli Symonds.

STRATEGIC INITIATIVES:

STUDENT EXPERIENCE

- > The Museum Course is a core element of the Knowledge Integration program, where students practise interdisciplinary collaboration and design by creating original, interactive museum exhibits. They start by studying museums in history-rich European cities, and they finish with an exhibition of their own work at the end of the year.
- > Fourteen per cent of Faculty of Environment courses (37 out of 258) have a field experience component with great benefits for students. Some of these field experiences are facilitated by the Ecology Lab, which supports a range of hands-on lab and field activities that foster experiential learning in our courses. Since 2013, courses supported by the Ecology Lab grew from 17 to 25, and the lab tripled its high school outreach programs to 18.
- > A number of international field courses/placements are offered each year. In 2018, a group of Geography and Environmental Management and Environment Resource and Sustainability students embarked for Nepal as part of a 22-day course field trip to the Kathmandu and Everest regions. Other field courses over the past five years have taken students to Tobago, Nanjing, and Oxford.

14%

**of courses
have a field
experience
component**

ENTREPRENEURSHIP IN ENVIRONMENT

Environment has a long history of entrepreneurship, with more than 400 alumni identified as entrepreneurs. To better support Environment students' entrepreneurial goals, the Faculty of Environment launched Entrepreneurship at Environment in 2017. Brock Dickenson was hired as the Entrepreneur-in-Residence for this initiative. With experience as a United Nations Environment Programme Regional Youth Ambassador to North America, Dickenson offers students guidance and advice on their sustainable business ideas. The Faculty launched Velocity Start @ Environment — a partnership between Environment and Velocity to provide resources and support for Environment students developing startups. Velocity Start @ Environment joins the Jack Rosen startup competition, programs at St. Paul's Greenhouse, and selection of courses in the School of Environment, Enterprise and Development in Environment's suite of entrepreneurial offerings.

- > Environment continues to facilitate graduate-level internships for its students. The Master of Climate Change (MCC) program, which grew from 13 students in 2013 to 32 students in 2018, grew its internships for those students from 11 internships to 26 in the same time period.
- > Every year the Faculty of Environment supports Envigorate, a student-led one-day festival bringing together a multitude of environmental activities, causes and projects in a hands-on interactive showcase of the many ways Environment students are working on the world's toughest problems.
- > The Faculty of Environment works closely with its alumni interested in giving back to the Faculty through work placements, mentorship, and funding. Environment graduates have established five opportunities for students with local, not-for-profit organizations. Consultations are underway with the Office of Advancement to discuss further opportunities to support students with accessibility needs.

LOOKING AHEAD:

- > With world-leading strengths in polar research, climate resilience, food security, urban sustainability transitions, ecological restoration, and green water research and health, Environment's passionate researchers and students are not just generating new ideas, but also mobilizing knowledge and spurring coordinated action across sectors to drive change at a critical moment in its planet's history. As the Faculty looks to the future, it aims to enhance its capabilities to pursue innovations and cutting-edge interdisciplinary research, train global environmental leaders, and drive collaborative action in the Faculty's mission to create a sustainable Canada and world.

FACULTY OF MATHEMATICS

Faculty Summative Report | Fall 2018

The Faculty of Mathematics has pursued an ambitious and successful drive to be a world leader in mathematics and computer science. Over the five years of Waterloo's Strategic Plan, the Faculty's continued investment in, and focus on, excellence in research and academic programming has resulted in impressive achievements. These achievements are evidenced across the disciplines of pure mathematics, applied mathematics, combinatorics and optimization, computer science, statistics, and actuarial science, as well as in interdisciplinary areas such as cybersecurity, data science, fintech, and artificial intelligence (AI). Innovation in technology-enabled teaching, responsiveness to student needs, and new approaches to engaging students has continued to advance the Faculty's outstanding academic programming. The Faculty's achievements are reflected in continued recognition from ranking institutions, record-breaking numbers of high-calibre student applications, and the continued recognition of faculty members' achievements.

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- > Waterloo is recognized as a world leader in mathematics and computer science. In 2017/18, the QS World University Rankings by Subject ranked Waterloo 31st for computer science and information systems and 39th for mathematics. The 2017 US News and World Report Best Global Universities listed computer science at Waterloo 15th globally, up from 18th in 2014 and 2016.
- > The Faculty of Mathematics holds nine Canada Research Chairs, five of which were renewed. In 2018, Anita Layton was named a Canada 150 Research Chair. The Faculty of Mathematics also holds four industry chairs.
- > Mathematics faculty members have earned six Ontario Early Researcher Awards since 2013.
- > Over the past five years, researchers in the Faculty of Mathematics have earned more than \$85.6M in research funding, including \$11M in funding from industry sources.
- > Faculty of Mathematics researchers received a record high \$6.9M in funding from the Natural Sciences and Engineering Research Council (NSERC) in 2017/18, including \$5.8M in Discovery Grant funding.
- > NSERC Discovery Grant funding to Mathematics reached its highest level ever in 2017/18, marking a 27 per cent increase over 2013/14.
- > Tamer Özsu was named a Fellow of the Royal Society of Canada, as well as a Fellow of the American Association for the Advancement of Science.

STUDENTS COLLABORATE IN
THE W.G. DAVIS COMPUTER
RESEARCH CENTRE.



- > In 2016, Kate Larson became the Canadian Association for Computer Science Outstanding Young Canadian Computer Science Researcher. Two other researchers received their Computer Science Lifetime Achievement Award.
- > In the past year, the Faculty of Mathematics has opened two new institutes: Waterloo.ai (Artificial Intelligence) with the Faculty of Engineering and the Cybersecurity and Privacy Institute.

\$86M+
**earned in research
funding and \$11M
from industry sources**

- > University of Waterloo mathematicians continue to solve difficult problems. Jim Geelen and co-authors made an announcement regarding the 40-year old proof of Rota's Conjecture in 2014, followed by Eric Katz and his colleagues proving Rota's 45-year old conjecture on the log concavity of the characteristic polynomial of matroids in 2016. Also in 2016, William Slofstra announced a solution for the strong Tsirelson problem.

Cutting Edge Research and Industry Partnerships: New Cybersecurity Lab

Known for its work in cryptography, the Faculty of Mathematics is building a cybersecurity lab in the Davis Centre with support from RBC. RBC is also funding research with three faculty members: Raouf Boutaba for data-driven software defined security; Ian Goldberg for privacy enhancing technologies; and David Jao for post-quantum cryptography. The \$1.8M funding will also cover the sponsorship of Michele Mosca's CryptoWorks21 Industry Day, a graduate student scholarship, thesis prize, and support for professional teaching. The collaboration will cement Waterloo's leadership in cybersecurity and privacy and help Mathematics researchers excel while RBC has the opportunity to develop Canadian talent to support the demands of the cybersecurity industry.

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMMING

- > A new mathematics undergraduate program in data science was approved by Senate in 2017. A new Master of AI and Data Science is awaiting approval.
- > To improve the faculty-to-student ratio and help students succeed in the core first-year algebra course (MATH 135), class sizes were reduced by a third.
- > Enrolments in wholly online courses offered by the Faculty of Mathematics have increased by 68 per cent since 2013/14. In 2017/18, more than 3,500 students were enrolled in 57 wholly online sections of 36 Faculty of Mathematics courses. Thousands more students have used the digital assets developed for online sections, as they have replaced textbooks in the corresponding on-campus sections of some courses.
- > In the past two years, the Faculty of Mathematics offered digital assets at no cost in place of a textbook that cost \$165, generating \$640K in total potential cost savings for students.
- > To further student learning, the Faculty expanded its use of technology to include Crowdmark, a marking software first piloted in 2014 and later integrated into Waterloo's learning management system LEARN. Piazza, a science, technology, engineering, and mathematics (STEM)-aware, online collaborative question and answer platform, was also incorporated to increase interactive learning technology.
- > Through a partnership with Maplesoft, the Faculty developed the world's first complete STEM disciplines authoring environment for online courses. In 2017, the Faculty built on this partnership to include Möbius support to teach mathematics at all levels.

68%

**increase in
enrolments in
wholly online Math
courses since
2013/14**



STEPHEN M. WATT, THE DEAN OF THE FACULTY OF MATHEMATICS, SPEAKS AT THE 31ST ANNUAL MATHEMATICS AWARDS CEREMONY AND DINNER WHERE WE CELEBRATED OVER \$1.8M IN MATH UNDERGRADUATE SCHOLARSHIPS.

> The Faculty of Mathematics has also significantly assisted or directly sponsored digital assets at readi.uwaterloo.ca, open.engineering.uwaterloo.ca, open.science.uwaterloo.ca, and a financial literacy site for the School of Accounting and Finance.

> At the Faculty and University levels, Mathematics instructors are recognized every year for their teaching excellence. Externally, Ian VanderBurgh was honoured with the 2016 Canadian Mathematical Society Excellence in Teaching Award, and Teaching Fellow Brian Forrest was honoured with the Mathematical Association of America's Clarence Stephens Distinguished Teaching Award and the Fields Institute Margaret Sinclair Memorial Award in 2017.

> The exceptional quality of Mathematics' academic programs is reflected in ever-increasing demand by outstanding prospective students. The Faculty of Mathematics received 16,300 applications for fall 2017 admission to its undergraduate programs, an increase of 58 per cent since 2013.

28%
increase in incoming students with 90%+ average

> The Faculty's graduate students are among the top teachers. In three of the last five years, a Mathematics student has been awarded the Amit and Meena Chakma Award for Exceptional Teaching by a Student. In 2016, two of the four awarded students were Mathematics students.

36%
of undergraduate students enrolled in 2017/18 Mathematics programs were women

- › More than 93 per cent of the fall 2017 undergraduate entering class had admissions averages of 90 per cent or higher, a 28 per cent increase since 2013.
- › 2017/18 marked record enrolment levels in Faculty of Mathematics undergraduate and graduate programs, which have increased by 16 per cent since 2013/14.
- › The number of women enrolled in Faculty of Mathematics programs reached new highs. Women comprised of 36 per cent of undergraduates enrolled in Mathematics programs in 2017/18, a four percentage point increase since 2013/14. The number of female graduate students increased by three percentage points, from 29 per cent in 2013/14 to 32 per cent in 2017/18.
- › Since 1968, a Waterloo team has come in the top five of the Putnam competition 19 times. In 2015, Daniel Spivak was one of the top six Putnam competitors and hailed a Putnam Fellow.
- › Students also participate in Faculty-hosted or sponsored hackathons and datathons. In 2018, the Faculty hosted the American Statistical Association Datafest and the Citadel and Citadel Securities Open Data datathons. The Faculty also sponsored StarterHacks, a hackathon that promotes gender equity and is geared towards those who have never coded before. It was co-founded by a Mathematics student.
- › The undergraduate Math Society in partnership with Women in Computer Science, and industrial and academic partners, started a student-run hackathon called Equithon in 2017 to create technical projects that promote equity — the first to do so.

STRATEGIC INITIATIVES:

STUDENT EXPERIENCE

- › Waterloo students regularly compete and excel in the Association for Computing Machinery contests, including the East Central North America Regional and International Collegiate Programming Contests. Waterloo students typically finish in one, or all, of the top three spots.
- › To enrich the undergraduate student experience, the Faculty of Mathematics established contests including the Small c, Big E, and Special K contests. In each of the last four years, three students received a perfect mark in the Small c contest, which continues to have record-high participation in each of the last three years.

Building Effective Communication Skills

The Faculty of Mathematics believes that strong communication skills are essential for students' academic, professional, and personal success. This is especially important for international students. When employers who hire Faculty of Mathematics students on their co-op work terms reported that they were looking for stronger communication skills in mathematicians and computer scientists, the Faculty paid attention. A review of more than 3,000 employer appraisals of math students found they had the lowest score and the highest standard deviation across written, oral, and interpersonal communications. Since the fall of 2015, the Faculty requires that students successfully complete two communications courses, the first one prior to enrolling in a 2A term. With small class sizes of about 25, the courses include initiatives to address presentation skills. Students who have completed the courses have evaluated the courses and instructors highly, and some have even enrolled in additional courses beyond the requirements. The change has helped students to develop communication skills needed to succeed academically and professionally.

LOOKING FORWARD:

- › In 2017, Dean of Mathematics Stephen M. Watt launched a broadly consultative exercise to develop the Faculty of Mathematics Strategic Plan 2018. Centered on five key priority areas (People; Undergraduate Studies; Graduate Studies; Research, Creativity, and Innovation; and Outreach), the plan will articulate the Faculty's priorities, provide a context for decision-making, and provide a high-level description of the path forward for the Faculty to achieve its vision of being a world leader. This planning exercise also set out to enable informed contributions to the University of Waterloo Strategic Plan. Through the University's Bridge to 2020 exercise, the Faculty considered insights from the University and shared findings from its planning process with the University. Moving forward through the Bridge to 2020 period, the Faculty of Mathematics will seek to identify synergies and areas of alignment between the two plans, to best support the University's strategic ambitions while moving the Faculty forward meaningfully within its disciplinary contexts.

FACULTY OF SCIENCE

Faculty Summative Report | Fall 2018

The Faculty of Science's Strategic Plan for the period 2013–2018, consistent with Waterloo's institutional Strategic Plan, has continued to reinforce Waterloo's international leadership in Science education, research and scholarship. This Faculty Update provides a high level review of some of the Faculty's accomplishments in the areas of academic programming, teaching, research, experiential education and entrepreneurship which have been instrumental to contributing to institutional achievements. Faculty of Science faculty have published prodigiously and secured consistently higher research funding to support both fundamental and interdisciplinary research across its two schools and four departments. Significant research breakthroughs continue to be made by Science faculty in areas as diverse as quantum computing and renewable energy. New teaching space and programs to develop and foster teaching skills have further enhanced the Faculty's excellence in academic programming. In particular, Science has developed new initiatives to foster entrepreneurship, develop employment-ready skills, and provide work-integrated learning. Two new specializations, a new undergraduate program, a new international undergraduate program and two new residencies, provide greater opportunities for Waterloo's Science students.

STRATEGIC INITIATIVES:

TRANSFORMATIONAL RESEARCH

- > Canada Excellence Research Chairs Philippe Van Cappellen and David Cory received more than \$90M in funding from the Canada First Research Excellence Fund (CFREF) for water and quantum research.
- > Waterloo scientists partnered with the Southern Ontario Water Consortium to participate in the \$12M Accelerating Water Technologies Initiative.
- > Optometrist and vision scientist Kristine Dalton established Waterloo's Sports Vision Clinic, which is uniquely housed in a university setting and among the first of its kind in Canada.
- > Chemist Linda Nazar developed a safe, high-capacity zinc-ion battery that costs half the price of current lithium-ion batteries, yet lasts twice as long.
- > Physicist Thomas Jennewein worked with a team of Waterloo researchers to be the first to transmit a quantum key securely from a source on the ground to a receiver on an aircraft.
- > Biologist Heidi Swanson partnered with the Kluane First Nation to measure mercury levels in fish.

EXTERIOR VIEW OF THE
SCIENCE TEACHING
COMPLEX.



- > Chemist Linda Nazar was named an Officer of the Order of Canada, a Thomson Reuters Highly Cited Researcher, and University Professor.
- > Chemist Janusz Pawliszyn was named the 14th most influential person in analytical science by Analytical Scientist's 2015 Power List.
- > The School of Optometry and Vision Science partnered with the Canadian Paralympic Committee to offer out-of-competition classification services for national parasport athletes from across Canada.

\$40M+
in industry-sponsored
funding since 2013

- > Earth scientist David Blowes was awarded \$7.2M through Natural Sciences and Engineering Research Council's (NSERC) Training toward Environmentally Responsible Resource Extraction (TERRE) Collaborative Research and Training Experience (CREATE) Program and TERRE Network (TERRE-NET) programs to lead training programs for highly qualified persons in sustainable mineral extraction.
- > Waterloo scientists won two NSERC Synergy Awards for partnering with industry to enhance biological and geochemical processes in waste rock piles and profitability and sustainability of aquaculture.
- > Waterloo scientists partnered with major international companies and organizations including DeBeers, Pfizer, World Anti-Doping Agency, BASF, Diavik Diamond Mines, SCIEX, International Paralympic Committee, and Yellow Island Aquaculture Ltd.
- > Since 2013, Science faculty members have received more than \$40M in industry-sponsored research.
- > The Faculty of Science announced Assistant Professor Andrew Doxey as the first recipient of the Science Excellence in Early Career Research Award (SEECRA). The annual award, adjudicated by the Science Research Fellows, recognizes a tenure-track researcher in their second probationary term who stands out as most exceptional in terms of scholarship.

- > Pharmacist Nancy Waite is co-lead of Ontario Pharmacy & Research Collaboration (OPEN).
- > The Faculty of Science has hosted research delegations and workshops in China, Hong Kong, France, and Korea.
- > Biologist Brian Dixon collaborated with Cedarlane labs to produce and market 45 different antibodies.

STRATEGIC INITIATIVES:

ACADEMIC PROGRAMING

- > Since January 2013, the Faculty of Science has hired 13 new faculty members, many coming with top international reputations. Science's new members include:
 - Will Percival, Physics & Astronomy's Distinguished Chair in Astrophysics;
 - Christine Muschik, Physics & Astronomy and IQC;
 - Dale Martin, Biology (as of July 2018);
 - Laura Hug, Biology;
 - Anna Klinkova, Chemistry;
 - Rodney Smith, Chemistry;
 - Chris Yakyumchuk, Earth and Environmental Sciences;
 - Nandita Basu, Earth and Environmental Sciences;
 - Emmanuel Ho, School of Pharmacy; and
 - Stan Woo, School of Optometry and Vision Science.
- > Overall the Faculty saw an increase in the proportion of female faculty from 38 per cent to 43 per cent.
- > Created five introductory online courses in biology, chemistry and physics for the Ontario Universities Online Consortium.
- > The Faculty of Science introduced two new undergraduate specializations — bioinformatics and water science.

2 new
undergraduate
specializations

- > Pharmacy's Doctor of Pharmacy (PharmD) program received full accreditation status. The School also implemented a bridging PharmD program, allowing students enrolled in Waterloo's BSc Pharm degree to take additional courses to earn a PharmD degree.



THE HONOURABLE MINISTER OF SCIENCE AND SPORT KIRSTIN DUNCAN ANNOUNCES THE CANADA FIRST RESEARCH EXCELLENCE FUND RECIPIENTS.

- > Waterloo signed a five-year agreement with Jazz Aviation, granting Waterloo students access to the Jazz Aviation Pathways Program, which offers additional training, scholarships, and jobs for top-performing students upon graduation.
- > Partnering with the French Universities of Bordeaux and Toulouse, Waterloo offers a new international bio-based chemistry program.
- > School of Optometry and Vision Science introduced two new residencies — Sports Vision and Vision Therapy and Ocular Disease.
- > Through a partnership with Conestoga College, Honours Biology and Biomedical Sciences students are now able to earn a one-year Biotechnology Technician Diploma during their third year of undergraduate study.

STRATEGIC INITIATIVES:

ENTREPRENEURSHIP

- > Waterloo Science faculty have created four new companies — Metagenom Bio Inc., Mediphage Bioceuticals, Salient Energy, and WildType Biotech.
- > Waterloo researchers have published more than 20 patents in the last five years.

- > The Faculty of Science partnered with Velocity to create Velocity Science to promote commercially-orientated research and support the development of student-led startups in physical and life sciences.

Velocity Science: Turning Concepts into Reality

ExVivo Labs is developing a skin patch that allergy specialists can use to test patients instantly, right in the doctor's office. No needles, no blood, no lab testing required. Their first round of patches, which use nanotechnology to detect and quantify immune reactions, will test for the 23 allergens most recommended by allergists. What began as a two-person company through Velocity Science in 2014, now employs 10 people and ExVivo Labs plans to move into their own lab this spring. Co-founder and CEO of ExVivo Labs Moufeed Kaddoura, who was also named 2018 Forbes 30 under 30, Health Care, notes "As a Science-based company, the Velocity Science Lab was critical for ExVivo labs to develop its first prototype and turn concepts into reality."

STRATEGIC INITIATIVES:

EXPERIENTIAL LEARNING

- › The School of Pharmacy created a Community of Practice learning model to provide clinical experiences for students.
- › The Chemistry Department partnered with Maplesoft's Möbius to optimize web-based resources in order to enrich the online learning environment for chemistry students.
- › Science Computing developed two teaching tools — evaluate (online teaching evaluation tool) and MarkBox (a scantron alternative for marking multiple choice tests) — to allow for faster feedback from instructors and more accessible analytics.
- › The School of Pharmacy partnered with the McMaster University School of Medicine to develop TransEd, a free online educational module to assist healthcare students in learning how to deliver high-quality care to transgender patients.
- › The Science Teaching Complex added 120,000 sq. ft. dedicated to student-centred teaching, lab and student space for biology, chemistry, and physics students.
- › The School of Pharmacy offered the first primary care pharmacy residency outside of a hospital and increased experiential training for professional pharmacy students in northern Ontario.
- › The Faculty of Science launched the Dean's Undergraduate Teaching Initiative to support teaching and learning initiatives for undergraduate students.
- › The School of Pharmacy developed 22 educational courses and modules for professional pharmacists — TransEd, 5in5 and pharmacogenomics.

120,000 sq. ft.

of space dedicated to student-centred learning

LOOKING AHEAD:

- › The Science Centre for Innovation, a new building centred around world-class research and entrepreneurship, is currently in the planning stages. The 105,000 sq. ft. facility will house physical and life science labs as well as labs for Velocity Science and a unique infrared electron free laser (IR-FEL) facility. It has been named by the central administration as the University's top infrastructure priority.
- › Continue to refine the Faculty's undergraduate curriculum to best position the Faculty's graduates in the workplace and for success in society.

Award Winning Analysis

Third-year Science undergraduate student Emily Pass won the 2017 National Co-op of the Year Award for developing a data analysis program that rapidly detects objects in the Kuiper Belt, a region of space beyond Neptune. Awarded the Schulich Leader scholarship to attend Waterloo, Pass is the third Waterloo student to win the Co-operative Education and Work-integrated Learning (CEWIL) Canada award in the last four years. She also won the top prize in the province, the Education at Work Ontario (EWO) Co-op Student of the Year Award, as well as the Waterloo Faculty of Science Co-op Student of the Year Award. *"You have to think about how something could go wrong, how to test it and the possible outcomes,"* says Pass, *"You have to do a deep think of the problem before starting on the solution".*

- › As part of this commitment to research, the Faculty is also looking to expand international collaboration, particularly in biomedical and vision science research with high profile institutes such as the Hong Kong Polytechnic University.
- › Interdisciplinary research is a strength of the Faculty of Science and the Faculty will continue to build the interface between fundamental research and applied technology. Key interdisciplinary areas include biomedical and vision sciences, climate and environmental research, drug discovery and analytical chemistry, as well as quantum and material sciences.
- › The Faculty of Science is committed to graduate student recruitment, both domestically and internationally. Science actively seeks to attract the best international students, while at the same time, capitalize and foster top talent from within the province and country as a whole.

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