

2019-20 ANNUAL REPORT
BIG PICTURE



VISION AND MISSION

IMPROVE LIFE

Our world today requires thoughtful solutions to unprecedented global challenges, and advanced skills to develop and use disruptive technologies. The College of Engineering and Physical Sciences (CEPS) boasts internationally-renowned faculty and staff who are driving research discoveries and innovations that support a changing world. Our students graduate equipped for a shifting job market; prepared for dynamic careers in science, technology, engineering and mathematics

(STEM); and poised to advance society in meaningful ways that improve life.

Our College is one of the largest faculties at the University of Guelph (U of G), with nearly 4,000 students, 150+ faculty and 90+ staff. In partnership with our stakeholders and supporters, our exceptional community is relentless in its pursuit to solve some of the world's most complex challenges through chemistry, computer science, engineering, mathematics and statistics, and physics.

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A MESSAGE FROM THE DEANS

It is with pleasure that we present the inaugural CEPS annual report. While the 2019 novel coronavirus pandemic has shifted our expectations for teaching, learning and research, it has underscored that community and connection are core to who we are at the University.

In considering the big picture—the theme that weaves its way through much of this report, seen in the stories shared throughout—it is important to reflect on the ways that our collective efforts have supported Canadians during COVID-19, as well as how our continued efforts in other research and teaching areas continue to improve life.

We have experienced a remarkable year within CEPS and have made great strides in achieving the goals outlined in the CEPS Strategic Plan, Inspiring Excellence.

We strengthened our interdisciplinary collaborations through launching the Centre for Advancing Responsible and Ethical Artificial Intelligence (CARE-AI) and two new graduate programs. We reached new milestones within alumni affairs and development, experiencing a record-breaking year for giving and donations that exceeded our expectations.

Many of our people have won prestigious national and international awards, published in world-renowned journals and made new discoveries. And, we did this all in the midst of an unprecedented global pandemic. This report provides an opportunity to take a step back, look at the big picture and celebrate our achievements from the 2019–20 academic year.

Wishing you good health,

Gerarda Darlington

Gerarda Darlington, PhD, PStat
Interim dean

Mary Wells

Mary A. Wells, PhD, FEC, FCAE, PEng
Outgoing dean

OUR COLLEGE IN 2019 BY THE NUMBERS

13,000 alumni
making impact around the world



13% international students



Above national average for female-identified student enrollment

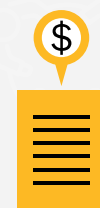
584
graduate students



3,352
undergraduate students

RESEARCH ACHIEVEMENTS

\$17.2 MILLION in competitive research funding



34 research contracts held

210 grants held

5

centres, facilities institutes

155
faculty



90
full-time staff

591
publications



1,892
Web of Science citations

7 research chairs



4 spinoff companies



7 inventions disclosed



11 patents

18,000 video views



1,079,538
unique website pageviews



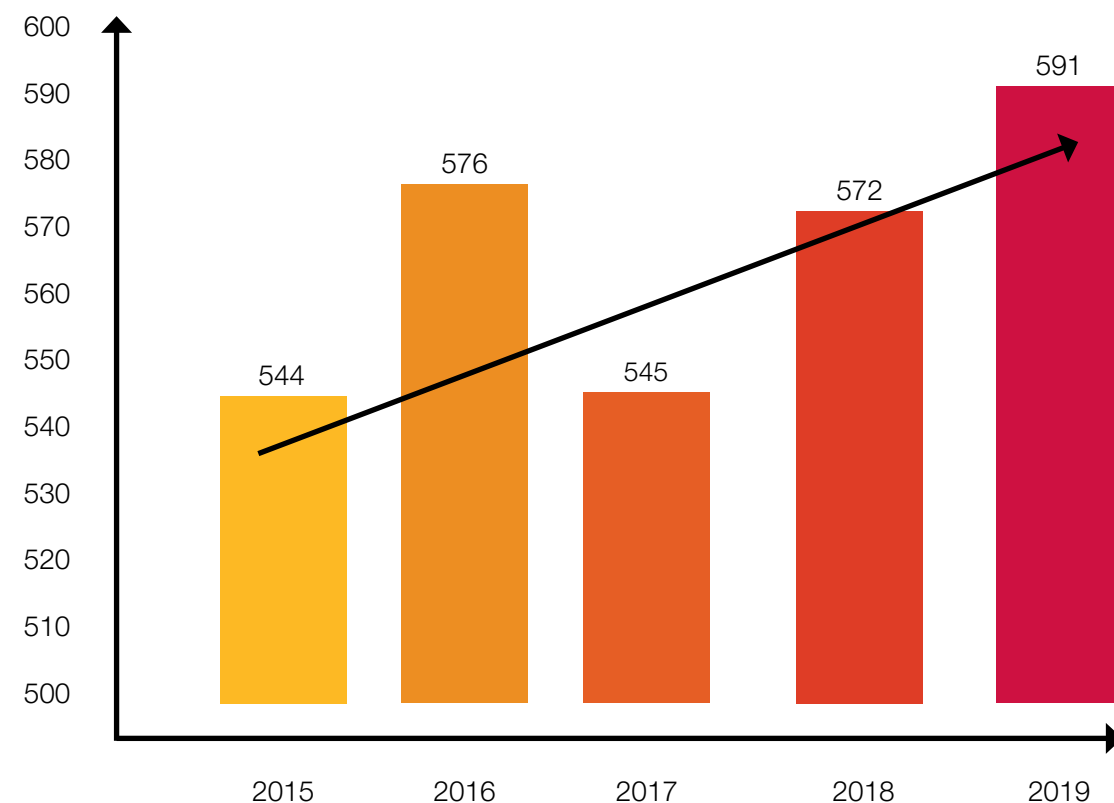
275,000
social media impressions

RESEARCH ADVANCEMENTS

SHARING RESEARCH TO IMPROVE LIFE

We are proud of the discoveries and innovations that result from CEPS researchers' efforts. By publishing the results of their studies, our researchers are active participants in the academic community. Each article, conference proceeding, letter and review published by our researchers is an indicator of the College's contributions to the global scientific literature and represents our faculty's contributions to enhancing our shared knowledge. It also promotes scholarly dialogue. That dialogue is what sparks new ideas. The number of articles published by our researchers has been on a growth trajectory over the past five years.

Publications by CEPS Faculty
2015–19



Disclaimer: These data represent the total number of publications that all current tenure-track or tenured CEPS faculty members produced between the 2015 and 2019 calendar years. Publications include articles, proceedings, letters, meeting abstracts and reviews. Data were pulled from Web of Science; they are current as of August 30, 2020.

RESEARCH AREAS

PRIORITY AREAS AND SUBJECT CATEGORIES

Web of Science, a scientific publication database, assigns articles to one or more subject categories based on the journal in which they are published. Examining the subject category data enabled us to find the top 25 research focus areas for our faculty in the last five years. The College's research focus areas are strongly aligned with the [University of Guelph's Strategic Research Plan](#). They include: Materials, Biochemistry and the Environment, among others.

Visualization of Top Research Areas in CEPS
2015–19

AUTOMATION **BIOCHEMISTRY**
ASTRONOMY **OPTICS** **HEALTH**
MECHANICS **ASTROPHYSICS**
COMPUTATIONAL **BIOLOGY**
WATER **ELECTROCHEMISTRY**
ENVIRONMENT **ATMOSPHERE**
MATHEMATICAL **BIOLOGY**
ENERGY **POLYMERS** **IMAGING**
FUEL **TELECOMMUNICATIONS**
SPECTROSCOPY **CONTROL**
BIOPHYSICS **FOOD** **MATERIALS**
AGRICULTURE **METEOROLOGY**



RESEARCH CHAIRS

Aicheng Chen

Tier 1 Canada Research Chair in Electrochemistry and Nanoscience

Carl Svensson

Tier 1 Canada Research Chair in Gamma-Ray Spectroscopy and Rare Isotope Physics

Graham Taylor

Tier 2 Canada Research Chair in Machine Learning

John Dutcher

CEPS Research Chair in Novel Sustainable Nanomaterials

Kevin Keener

Barrett Family Foundation Chair in Sustainable Food Engineering
The Barrett Family Foundation

Beth Parker

NSERC Industrial Research Chair in Fractured Rock Contaminant Hydrology

Peter Tremaine

NSERC/UNENE Senior Industrial Research Chair in High-Temperature Aqueous Chemistry

A GLOBAL REPUTATION FOR RESEARCH EXCELLENCE

Update from Leonid Brown, Associate Dean
(Research and Graduate Studies)

The success of the College's research programs depends on the hundreds of individuals—faculty members, students and staff—who are working relentlessly to make new discoveries and develop innovations that further our understanding of the world and improve life.

In 2018–19, our researchers secured more than \$17 million in competitive research funding, including the most Natural Sciences and Engineering Research Council of Canada (NSERC) funding on campus. Despite the added challenges associated with the emergence of COVID-19 last year, we were able to translate this funding into significant research advancements. For example, we shed light on new ways to harness the sun's energy and reduce our reliance on fossil fuels; built intelligent systems to identify cyberattacks and improve the security of our critical infrastructure; assessed novel soils that can pull carbon dioxide from the atmosphere to mitigate global climate change while improving crop yields; worked towards developing the quantum error correction theory to improve the reliability of quantum computers; and studied how gravity behaves around black holes, providing a window into the centers of our galaxy. This snapshot of the College's research advancements truly demonstrates the breadth of our research programs and the scope of our impact.

Thanks to all our faculty, students and staff who shifted their focus towards the development of COVID-19 tracking and screening technologies, and disease prevention and treatment strategies. Your efforts to keep us safe are truly appreciated.

I look forward to another inspiring year supporting the College's research enterprise.

A STUDENT WORKS IN A CHEMISTRY LAB AT U OF G
IN OCTOBER 2019.



AANI/BOZHO. WASAYAKWE NZDIZHNIKAAZ. MUKWA DODEM. HELLO! MY ANISHINAABEMOWIN NAME IS NORTHERN LIGHTS WOMAN. I AM BEAR CLAN.
PHOTO CREDIT: DARBY MAGILL PHOTOGRAPHY

FROM THE GROUND UP: ENGINEERING GRAD FOCUSED ON COMMUNITY BUILDING

Colleen O’Toole, Environmental Engineering (B.Eng)
Project Manager, Kerr Wood Leidal (KWL) Associates Limited

Colleen O’Toole (B.Eng, ’08) was born in Whitehorse, Yukon and grew up on a small farm in Southwestern Ontario. She has always had a passion for the outdoors and loved building things herself, using scrap wood and nails to create structures.

“I was raised in a family of strong women, teachers, advocates and social justice leaders,” says O’Toole. “This certainly framed the way that I see the world and reinforced the value placed on community and home.”

Her love for the outdoors, mixed with a natural affinity for creation, led O’Toole to the Environmental Engineering (Co-op) program at U of G. During her degree, O’Toole completed a co-op work term in British Columbia, ultimately resulting in a position with KWL Associates Limited—a leading employee-owned, multi-disciplinary engineering consulting firm—in Burnaby, British Columbia.

Originally working on small energy planning and run-of-river hydro development, Colleen’s role at KWL has shifted towards project management, contract administration and asset management.

“Through attending the University of Guelph, I became part of a curious, creative and engaged community,” says O’Toole. “I really enjoy projects that have many layers—culture, archaeology, environment, community engagement and civil infrastructure. I am deeply interested in building relationships, creating spaces for dialogue and removing barriers to support the development of Indigenous people.”

O’Toole’s desire to understand the impact of engineering around the world has taken her beyond Canada. At U of G, she connected with Engineers Without Borders, where she completed a fellowship, working in partnership with Ghanaian colleagues at the AfriLEAD Institute in Tamale. After returning to Canada, O’Toole volunteered with the Urban Native Youth

Association and spent three years as a mentor for Indigenous youth in her community. Her leadership, volunteer work and achievements earned her the 2013 University of Guelph School of Engineering Young Alumnus of Honour Award.

Recently, O’Toole has been using her engineering expertise and community focus to make an impact at home in BC. Inaccessible housing costs in the Metro Vancouver area are creating instability for new buyers, so O’Toole and nine friends developed a socially and economically sustainable approach. In 2018, all 10 purchased a single home on four acres in the Sunshine Coast Regional District with the ultimate goal of developing a small-scale community on the property along with 10 lots, which requires a change to current community plan and zoning bylaws. According to O’Toole, the proposal has generally been well-received by municipal government and residents.

“There is no question that attending the University of Guelph reinforced the importance of cultivating supportive spaces for learning and building community,” says O’Toole. “Learning about low impact development, and how to design water, sewer and drainage systems has certainly come in handy, too!”

Their vision is for a clustered-type of development, consisting of small homes with extensive green space and shared amenities, working alongside their neighbourhood, and acting as a role model for environmentally sustainable, affordable home development.



JENNA ROTONDI, FOURTH YEAR BIOMEDICAL ENGINEERING CO-OP STUDENT WORKING WITH COMPANY ENVISION SQ USES THE REACTOR IN BILL VAN HEYST'S LAB TO SYNTHESIZE AN ANTI-VIRAL COATING THAT CAN KILL COVID-19.

CEPS COMMUNITY UNIFIED IN THE FIGHT AGAINST COVID-19

The effects of the 2019 novel coronavirus swept across the globe in a matter of months. Its impacts demanded innovative solutions and strategies to slow its spread and mitigate its harm. Since the pandemic began, our researchers have been applying their expertise to develop improved strategies and new technologies to track, model, diagnose and treat the virus. Here are just a few COVID-19 initiatives led by our researchers:

CARE-AI collaborated with Arrell Food Institute and the Lang School of Business to determine how COVID-19 would influence food prices in an update to Canada's 2020 Food Price Report.

Matthew Saunders, senior laboratory coordinator with the School of Engineering, used a 3-D printer in the School to create face shields for healthcare facilities. Saunders also launched a Guelph Makers group on Facebook to coordinate the efforts of other community members.

Associate deans Karen Gordon and Bill Van Heyst worked with faculty and co-op students to launch The Quad, an online resource site that virtually introduces students to life at U of G.

Prof. Aicheng Chen, Department of Chemistry, is working with ZEN Graphene Solutions to develop unique anti-viral nanocomposites for ultra-thin coatings on face masks and other personal protective equipment.

Profs. Ed McBean and Andrew Gadsden, School of Engineering, are leveraging artificial intelligence modelling to predict the impacts of COVID-19 on Canada's healthcare system.

Profs. Petros Spachos and Stefano Gregori, School of Engineering, developed smartphone

technology that provides more secure and accurate contact tracing.

Prof. Daniel Ashlock, Department of Mathematics and Statistics, is building an artificial intelligence model funded by the Nova Scotia Research Coalition that can provide guidance on deploying vaccines and other disease mitigation strategies.

Prof. Bill Van Heyst, School of Engineering, worked with Guelph-based EnvisionSQ to repurpose technology they originally developed to reduce traffic pollution to kill the COVID-19 virus.

Prof. Rozita Dara, School of Computer Science, pivoted her research on understanding disease outbreaks using platforms such as Twitter to be applied to COVID-19 outbreaks. A full feature can be found on page 23.

The Office of Research and our College awarded \$126,000 to researchers for nine projects spanning chemistry, computer science and engineering, designed to support the battle against COVID-19 and mitigate its impacts. One project, led by professors Khashayar Ghandi (Chemistry) and Jeff Caswell (Ontario Veterinary College), will create a microwave therapy system that inactivates the virus in the lungs of infected patients.

CELEBRATING EXCELLENCE

FACULTY AND STAFF AWARDS

People are at the heart of the University of Guelph—their ingenuity, enthusiasm and collaboration create a robust research, teaching and learning community. We are pleased to recognize and thank all of our faculty and staff for their contributions, and particularly the six who received this year's College Awards. Congratulations on this achievement!

Assistant Professor Research Excellence Award Ali Dehghantanha, School of Computer Science

Assistant Professor Research Excellence Award Huan Yang, Department of Physics

Graduate Supervision Award John Dutcher, Department of Physics

Undergraduate Supervision Award Manjusri Misra, School of Engineering

Excellence in Undergraduate Teaching Award Ryan Clemmer, School of Engineering

Staff Excellence Award Jay Leitch, Department of Physics

When Jay Leitch began his career at U of G as a Nanoscience Technician in 2009, the nanoscience program was in its infancy. Now having been offered for more than a decade at the University, this B.Sc major provides undergraduate students with the opportunity to study the chemical and physical behaviour of materials at the nanoscale. Courses are taught using a multidisciplinary approach that integrates the fields of chemistry and physics.

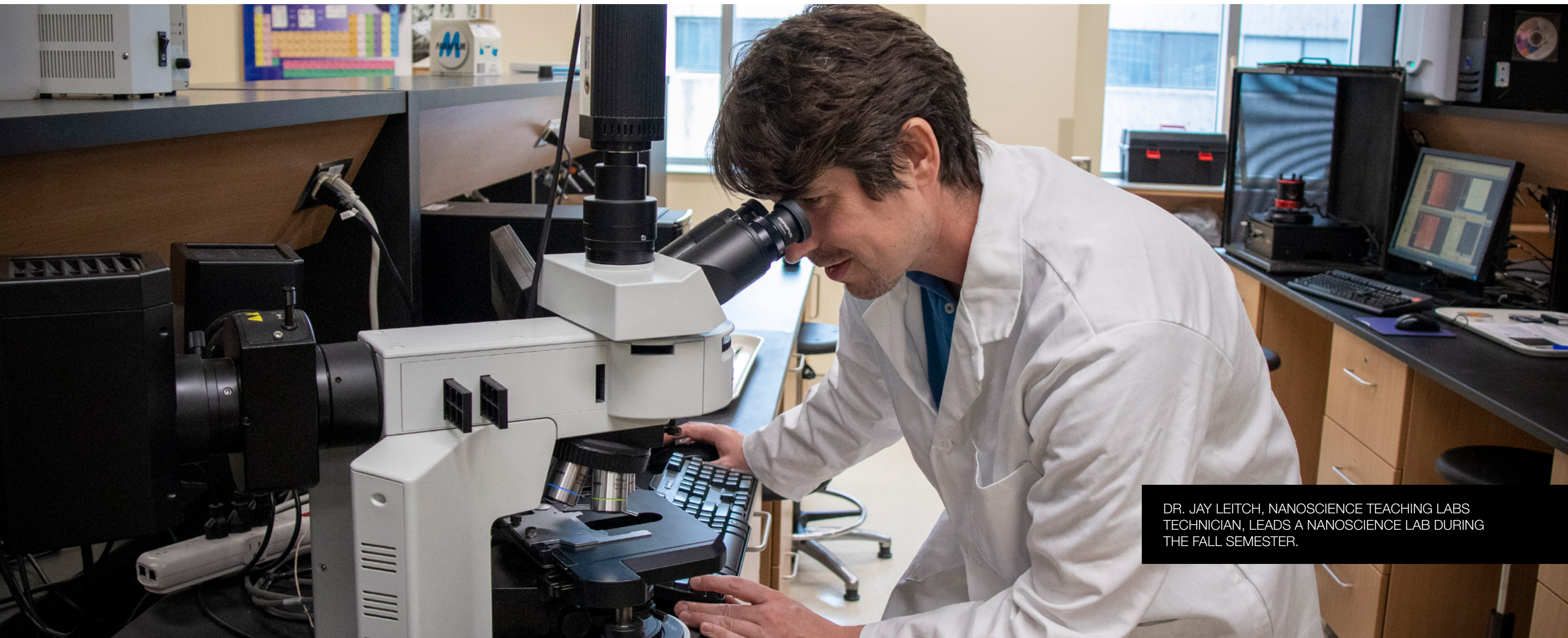
“When the nanoscience program was in development while I was still a PhD student, we spent a lot of time discussing its potential,” says Leitch. “I had ideas for the type of equipment, lab components and lab content that would benefit the students and give them a unique, hands-on education.”

Leitch built the Nanoscience laboratory as a full-time staffer while completing his PhD work. He developed the infrastructure for the laboratory; designed and

constructed the experiments and lab manuals; and taught all lab components. He also teaches lecture courses and supports course redesign.

“Jay has made outstanding contributions to the development and delivery of the Nanoscience program curriculum,” says John Dutcher, physics professor and nanoscience program director. “He has defined his role with enthusiasm, creativity, and technical competence, inspiring the next generation of nanoscientists.”

Leitch continues to maintain research activity, having published more than a dozen peer-reviewed research papers in electrochemistry and physical chemistry in a little over two years. He frequently participates in outreach and recruitment activities, such as Let's Talk Science and academic events, to create connections with students and prospective students.



DR. JAY LEITCH, NANOSCIENCE TEACHING LABS TECHNICIAN, LEADS A NANOSCIENCE LAB DURING THE FALL SEMESTER.



REMEMBERING PAUL ROWNTREE

The University of Guelph celebrates the life of professor Paul Rowntree, Chair of the Department of Chemistry, who passed away on July 27, 2020, following a brief cancer illness.

Paul grew up in London, Ontario and attended the University of Waterloo for his B.Sc, M.Sc and PhD studies in Chemistry, ultimately completing his PhD at Princeton University. Paul joined the University's Department of Chemistry in 2006 as a faculty member and accepted the role of department chair in 2013. The University has greatly benefitted from having him in this leadership role, skillfully navigating challenges and creating opportunities. Paul was always there to help, support and lead the department to a successful outcome.

Paul greatly enjoyed teaching; his interaction with students was one of his great joys. He was creative and innovative, developing unique learning opportunities for students. He was also considered an internationally recognized expert on how electrons interlaced with self-assembled monolayers. Paul's research began with the investigation of molecular spectroscopy in noble gas clusters. Throughout his career he forged significant industry partnerships and led research that would improve the industrial processes to refine metal ores and to develop a new approach for fuel cell engines to improve fuel efficiency and decrease the impact of transportation on climate change, among other impressive scientific feats.



CATALYSTS FOR CHANGE

From melting polar ice caps to devastating natural disasters, we are feeling the impacts of global warming. Unfortunately, rising carbon dioxide (CO₂) in our atmosphere is a by-product of items that we depend on. Most crude oil and gas are burned as fuel and just under 10% is used in the chemical industry. Producing petrochemicals such as plastics from a renewable carbon source would help alleviate global warming.

Chemistry professor, Marcel Schlaf, PhD student Maryanne Stones and their team are turning to biomass material. Plants, woods and waste could be viable alternatives to fossil hydrocarbons. However, nearly every carbon atom found in biomass-based molecules is connected to an oxygen atom, and a chemical reaction that separates the two is required. Enter catalysts: substances that increase the rate of chemical reaction without undergoing permanent chemical change themselves. In biomass conversion, scientists and engineers typically rely on heterogeneous catalysts, which are solids, as opposed to the reactants, which are liquids or gases. The problem is that the reactions required in biomass conversion rapidly deactivate solid catalysts by irreversibly modifying their surface. That challenge is what led the team to test homogeneous catalysts. They conducted experiments using soluble metal complex salts as a catalyst and found that using a homogenous catalyst resulted in a higher yield of renewable chemicals.

"Homogenous catalyst systems have been relatively unexplored for this purpose," explains Schlaf. "Although there are still substantial challenges associated with homogeneous systems, our study shows that high-value compounds have the potential to be produced at a large scale through renewable chemical processes employing homogeneous catalysts."

Stones MK, et al. 2020 Jan;10(4):2667-83. Supported by NSERC, and the Ontario Ministry of Agriculture, Food and Rural Affairs.

GROWING UP GUELPH

STUDENT ON CAMPUS LIFE AND GIVING BACK

Vinuli De Silva, Mathematical Science (B.Sc)

Many students report a special connection to the University once they step onto its picturesque campus or connect with its inviting community of faculty, staff and fellow students. For mathematical science student Vinuli De Silva, that feeling was even more tangible.

“I spent a large portion of my childhood in Guelph and on campus,” says De Silva. “My aunt and uncle were both students here and lived in West Residence. As a kid, I would spend my weekends riding my bike around Branion Plaza and learning how to do cartwheels on Johnston Green.”

A visit to campus when considering options for her postsecondary education renewed De Silva’s affinity to the University.

“I always loved the community here at the University of Guelph. Seeing the diverse and welcoming atmosphere when I visited campus during my grade 12 year only reaffirmed that Guelph was the school for me.”

De Silva has always had a natural curiosity and love for learning. Growing up, she was drawn to both the sciences—because there were always ample opportunities for discovery—and the arts, because she could express herself and be creative. While she focused on arts in high school, her interest in the sciences ultimately pulled her in a different direction for university.

“There are so many different topics that interest me,” says De Silva. “I specifically like mathematics and statistics because the patterns and concepts are so interesting to me. I can also use my statistics knowledge and apply it to all my favourite subjects and fields!”

De Silva enjoyed the flexibility of having an area of emphasis, for which she chose Computer Science. Her favourite course so far has been CIS*2430: Object Oriented Programming, where she learned the programming language “Java”—her new favourite language—and was able to blend her interest in coding and design for a final project.

De Silva has also taken an active role in student life and leadership. Currently Vice-President, Communications of the CEPS Student Council (CEPSSC), she helps foster connections and bring the student community together. She is also a general member of several CEPS-connected clubs, including Women in Science and Engineering (WiSE), Guelph Women in Computer Science (GWICS) and the Math & Stats Club.

“As a member of CEPSSC, I am so grateful to be able to contribute to the University of Guelph community,” says De Silva. “I hope that the events, activities and resources we provide will ensure that students receive a university experience that is as close to normal as possible during COVID-19.”

Although she is not set on her path after graduation, De Silva is interested in pursuing topics in data science and analytics, computational biology, and software development.



VINULI DE SILVA, THIRD-YEAR MATHEMATICAL SCIENCES STUDENT, HAS A LONG HISTORY AT THE UNIVERSITY AND IS CURRENTLY VICE-PRESIDENT, COMMUNICATION, FOR THE CEPS STUDENT COUNCIL.



FIRED UP FIGHTING WILDFIRES

A devastating consequence of climate change, wildfires make global news every year. In 2020 along the West Coast of North America, we heard reports of “fire tornadoes;” a sequence of 11,000 lightning strikes in the span of 72 hours; and over 40,000 hectares of forest burned in California by mid-August. It is critical to plan for, predict and respond to these fires, which if left uncontrolled can destroy nearby neighbourhoods and create harmful smoke.

Statistics professor Khurram Nadeem and a team of researchers recently examined mathematical models to aid in fire management efforts. Their challenge: wildfire datasets are large and include a vast array of variables, such as vegetation, geography and atmospheric stability. To inform fire management programs, it is crucial to understand how wildfires respond to these diverse variables and how the variables themselves interact.

The team examined a series of variables that could cause wildfires in British Columbia and developed three mathematical models with different wildfire management applications. To improve the accuracy of the models, the team implemented a novel algorithm, which ranks the variables that drive daily human- and lightning-caused fires by order of importance. One factor,

known as baseline risk, proved especially important and was consistently high ranked by their algorithm. Baseline risk is measured as the average number of fires in a location since 1981.

“All three models were accurate and understanding baseline risk helped us interpret the other variables,” explains Nadeem. “Predictive models like ours can be used as a tool for fire agencies to make decisions around public advisories, prepositioning fire crews and aircraft routing—limiting the risks to humans that result from wildfires.”

Nadeem K, et al. 2020 Feb;29:11-27. Supported by the Department of National Defence (Canada), NSERC, and the Canadian Statistical Sciences Institute.

WORLD-CLASS TEACHING AND LEARNING

Update from Karen Gordon, Associate Dean (Academic)

Our College is recognized for its world-class educational opportunities, experiential learning, vibrant community and support services for students. In recent years, we have seen strong student interest in the programs we offer, leading to growth in our student body and relatively stable enrollment, even considering circumstances surrounding COVID-19.

Beginning in March, the University shifted to remote course delivery in response to the 2019 novel coronavirus pandemic. Faculty and staff in CEPS were tasked with learning new software and adjusting their assessment methods for alternative delivery. Throughout the summer, in anticipation of continued remote delivery, our faculty and staff organized and participated in workshops and webinars, and shared ideas and experiences to ensure optimized course delivery. I am proud of the number of instructors who demonstrated leadership by spearheading initiatives to strengthen teaching and learning at the University and nationally.

The summer also brought “the Quad,” an online platform for our incoming first year class to engage with upper year students, staff and faculty before September. Engagement levels were high, which indicates that this initiative should be continued in future years.

We continue to work through the challenges

and seize the opportunities that come with blended delivery. There is no doubt that the pandemic has brought changes to higher education delivery methods that will remain with us long after we are back in the classroom.

The College’s teaching faculty have received notable recognitions this year. Engineering professors Petros Spachos and Andrea Bradford won two of the 2020 University of Guelph Faculty Association Distinguished Professor Awards. Andrea also received the YMCA-YWCA Woman of Distinction Award. Engineering professor Ryan Clemmer received the 2020 CEPS Award for Excellence in Teaching in June. Finally, Prof. Dan Gillis, School of Computer Science, received the Ontario Confederation of University Faculty Associations teaching award, one of the province’s top teaching awards late last year. Congratulations to all and thank you for your outstanding contributions to the University.



ALUMNI AFFAIRS & DEVELOPMENT SOARS TO NEW HEIGHTS

Connections between individuals, groups and organizations create a sense of community. They provide a platform for new discoveries, stories and pathways to new opportunities. We know the importance of creating, cultivating and sustaining connections. The External Affairs team and Alumni Affairs & Development team broke records in 2019–20 for growth and funds raised—they welcomed new team members, attracted new partnerships and support, and elevated our College’s reputation.



MELISSA WOO, ALUMNI ADVANCEMENT MANAGER, WITH TERRY ROTHWELL (M.SC'96, ENG'75, OAC'72) AND ENGINEERING ALUMNI ASSOCIATION MEMBER AT THE 2019 SCHOOL OF ENGINEERING HONOURS AND AWARDS GALA. PHOTO BY ALUMNI AFFAIRS & DEVELOPMENT.

LIFESAVING HASHTAGS TWITTER TO THE RESCUE

As we navigate the COVID-19 global crisis, our government officials are challenged to quickly identify outbreaks and warn communities. Traditionally, governments rely on records provided by health departments to issue warnings. However, there can be lag between the time infected patients are logged to when a warning is issued for the public.

Social media sites can be used as a surveillance tool to warn officials about outbreaks and in subsequent public health planning. Computer scientist Rozita Dara and her team have introduced an Internet-based surveillance system that monitors activities related to diseases on Twitter, sorts through that information and provides a supplementary source of data for our officials. Previously, the team’s work focused on avian influenza, but in response to an immediate need, the researchers extended their framework to COVID-19.

The team’s Twitter-based data analysis framework monitors disease outbreaks in real time. Data are collected by a web crawler, which systematically visits Twitter every minute to search for keywords. The framework then filters out irrelevant posts and analyzes the information to detect the onset of outbreaks.

The researchers evaluated Twitter’s reliability by assessing the overlap between information from Twitter’s daily posts and official reports. With avian influenza, they found that 75 per cent of real-world outbreaks were identifiable from Twitter, and that the notifications reported on Twitter came earlier than official reports. Now, Dara and her team are shifting focus to COVID-19.

“We have collected more than five million COVID-related tweets so far,” says Dara. “We aim to predict the number of COVID-19 cases on a daily or weekly basis in selected regions.”

Yousefinaghani S, et al. 2019 Dec:9:18147. Supported by the Egg Farmers of Canada, the Chicken Farmers of Saskatchewan, the Canadian Poultry Research Council, and the Canada First Research Excellence Fund (Food from Thought).

IMPROVING LIFE IS CORE TO WHO WE ARE

Our 13,000 College alumni are improving life around the world. They drive STEM disciplines forward and contribute to advancements locally and globally.

Nanoscience grad Carley Miki is making waves in the beauty industry as a research scientist and co-founder at Veriphy Skincare in Guelph.

Engineering grad Alex Barrie is supporting soil and farm sustainability as a Soil Management Engineer with the provincial government.

Physics grad Bryce Moreira is leading the fight against wildfires in southern British Columbia as an aviation specialist.

GROWING CAPACITY FOR RESEARCH & STUDENT SUPPORT

Our alumni and friends know the impact that our students can make on the planet and want to support their journey. Collectively in 2019–20, CEPS raised more than \$9.5 million to support student success, scholarships and award funds.

In 2019, we made a major gift announcement—among the largest in the University’s history. A \$5 million gift from the Barrett Family Foundation will build our capacity for research focused on sustainability. This gift enabled us to recruit the Barrett Chair for Sustainable Food Engineering, occupied by Kevin Keener, whose tenure began in September 2019.

INDUSTRY INVESTING IN TALENT AT U OF G

Our College is a powerhouse when it comes to developing applied skills that meet current and future market needs. In the Fall of 2019, the Master of Cyber Security and Threat Intelligence (MCTI) program launched in the School of Computer Science under the leadership of its director, Prof. Ali Dehghantanha. This first-of-its-kind program has drawn significant global support and attracted top-tier students.

“We’re approaching a cyber security talent shortage of two million people worldwide in the next three to five years. Every cyber-security provider can contribute, and when we’re joined by respected education institutions like the University of Guelph, our combined effort makes the world safer.”

– Christopher D. Young, CEO, McAfee

GRAPHENE

MATERIAL OF THE FUTURE

Early in 2020, ZEN Graphene Solutions Ltd. (“ZEN”) management and employees, U of G researchers and staff, and other key stakeholders gathered to celebrate the opening of ZEN’s new pilot plant production facility in Guelph, Ontario. The company has partnered with chemistry professor Aicheng Chen since 2015 with strong support from the NSERC Collaborative Research and Development program and the Ontario Centres of Excellence Voucher for Innovation and Productivity program. Chen and his team are refining methods to produce graphene-based nanomaterials from ZEN’s unique Albany Pure™ graphite and to develop novel graphene-based technologies.

We are all familiar with graphite, a soft material used in pencil lead. Graphene is a single, thin layer of graphite. Despite how thin it is, because of its honeycomb-like structure, graphene is one of the strongest materials in

the universe—even stronger than steel. Thanks to its unique properties, graphene could be used as an additive to improve fuel economy or to improve energy storage in supercapacitors and batteries.

Chen and his team have developed methods to convert ZEN graphite into graphene, graphene oxide and interconnected reduced graphene oxide. They have filed five patents, with two awarded recently. As well, the partners have reached a license agreement between ZEN and the University. The team has also published several articles providing a closer look at graphene’s potential application in energy storage technologies. Specifically, they highlight graphene’s potential for hydrogen storage. Hydrogen is the most abundant element on earth and harnessing it as an energy source could help reduce greenhouse gases and alleviate climate change.

The research partnership added a new direction in 2020, thanks to support from the NSERC Alliance program and Mitacs. Chen and the team at ZEN are contributing to the fight

against COVID-19; they are exploring the use of graphene-based nanocomposites as an ultra-thin coating on personal protective equipment. The graphene-based coating may bind and destroy the virus that causes COVID-19, enabling the safe reuse of personal protective equipment.

“I am very proud of the work that my research team has been doing alongside ZEN,” says Chen. “Graphene has tremendous potential, and ZEN’s efforts to rapidly scale up graphene production will enable our continued research efforts.”

Peter Wood, the President of ZEN Graphene Solutions Ltd. echoes Chen’s sentiment: “We are excited to be working with the Chen team at the University of Guelph and to continue working to uncover graphene’s incredible and beneficial applications.”



CHEMISTRY PROF. AICHENG CHEN AND PETER WOOD, ZEN GRAPHENE SOLUTIONS PRESIDENT, AT THE ZEN GRAPHENE SOLUTIONS PRODUCTION FACILITY OPEN HOUSE.



NANOSCIENCE TOOL IMPROVES SUSTAINABILITY

Chemistry professor Khashayar Ghandi and team developed a new way to investigate processes connected to a potential long-term storage solution for nuclear reactor waste. They studied radiation chemistry and electronic structure of materials at scales smaller than nanometres, developed samples in Ghandi's lab, then tested them at the TRIUMF particle accelerator in Vancouver by bombarding the samples with antimatter subatomic particles. Their findings provide a new way to study sub-nano-scale materials and chemical processes.



HONOURING THE WOMEN LOST 30 YEARS LATER

The vibrant lives of 14 young women were lost during the École Polytechnique massacre in Montréal. Twelve of the 14 who died were engineering students. For the 30th anniversary of the massacre in December 2019, former CEPS dean Mary Wells spearheaded a national initiative with other female engineering leaders to honour the victims. The campaign, 30 Years Later, highlighted the accomplishments of 30 women since they attended Canadian engineering schools around the time of the massacre.



CHEMISTRY GRAD CELEBRATED ALUMNI OF HONOUR AWARD

Mark Lautens graduated from U of G in 1981 with a B.Sc in Chemistry. Since then he has become a world leader in organic chemistry and catalysis, a winner of multiple prestigious awards, an outstanding mentor and a recipient of the Order of Canada. To recognize his significant contributions to the scientific community and as a leader in his field, U of G bestowed one of its top awards—the Alumni of Honour Award—to Lautens in 2020.



RESEARCH CHAIR NAMED IN SUSTAINABLE NANOMATERIALS

Physics professor John Dutcher, a world-renowned nanoscience researcher, has been appointed as the CEPS Research Chair in Novel Sustainable Nanomaterials, effective June 1, 2020. Many of his findings have informed the creation of sustainable solutions in a variety of application areas, including personal care, drug delivery and water processing. His research has also provided important insights into how we can mitigate the spread of bacterial infections.



ARTIFICIAL INTELLIGENCE PLAYING IT SMART

Math is a powerful tool that can be used to solve real-world problems. This ability is accomplished by breaking down the problem into its component parts, then using mathematical terms to explain each component—developing a mathematical model of the problem. Mathematics professor Herb Kunze and his students, Bryson Boreland and Gord Clement, established that mathematical models of the brain, called neural networks, can solve Sudoku and KenKen puzzles.



STUDENTS MANAGING DURING A GLOBAL PANDEMIC

Computer science student and 2019–20 Society of Computer and Information Science President Sooraj Modi shared how he coped with the changes to life and school during March and April 2020. He suggested connecting with friends virtually and prioritizing self-care through yoga and breaks. Modi's advice isn't just limited to COVID-19 circumstances: talk to a friend or family member about what you plan to do today and the challenges that might get in your way.



CEPS GRADS RECEIVE TOP CONVOCATION AWARDS

Fatima Haque, School of Engineering, received the D.F. Forster Medal (Doctoral) for outstanding academic achievements, research, and leadership in her advocacy for educational opportunities. Ryan Dunlop, Department of Physics, received the Governor General Gold Medal for a superb academic record and his significant impact on physics research through a collaboration at TRIUMF's GRIFFIN facility.



BUZZWORTHY MATH SAVING THE BEES

Beyond providing a sweet spread for our morning toast, honeybees are important pollinators that play a crucial role in maintaining the Earth's natural ecosystems. Mathematics professor Hermann Eberl along with Nasim Muhammad, former U of G PhD student, leveraged mathematical models to understand disease dynamics in honeybee colonies. Their work could shed light on effectiveness of strategies aimed at pollinator remediation.



INSPIRING COMMUNITY OUTREACH INITIATIVES

Community and educational outreach efforts in our College bring STEM to life for potential future scientists—school-age children from grade school through to high school. In 2019–20, our faculty and outreach staff successfully implemented numerous outreach programs.

Highlights

- Let's Talk Science hosted Witchcraft and Wizardry in November 2019 with support from WiSE, the Physics and Astronomy Club, and the CEPS dean's office.
- 2020 Women in STEM took place in February, supported by Creative Encounters with Science. WiSE and GWiCS presented workshops.
- The Department of Chemistry hosted

annual take-your-kid-to-work day in November, presenting a “Breaking Bad in the Chemistry Lab” tour for grade nine students.

- Orban Thomas, Department of Physics, moderated the sold-out Bill Nye the Science Guy Central Student Association event in February 2020.
- More than 200 high school students visited CEPS labs (in chemistry and computer science) and gained hands-on lab experiences, such as synthesizing caffeine and solving programming challenges.



FROM LEFT: TOXICOLOGY STUDENT ASSOCIATION MEMBERS KAITLYN CHANNAN, STEPHANIE DURFY, MIKALA BAKER, OLIVIA BAXTER, CAROLINE PETCU AND RYLEE KALPIN PREPARE TO HOST THE 34TH ANNUAL TOXICOLOGY SYMPOSIUM.

OUTREACH STORIES

In response to COVID-19, our STEM outreach program, Creative Encounters, pivoted their usual annual summer camps to a “camp-in-a-box” and virtual experiences in spring and summer 2020. Five undergraduate and four high school instructors, along with two camp directors, delivered more than 200 boxes filled with scientific experiments, coding challenges and games to campers and community partners, and broadcast a series of educational videos and virtual camps.

In 2019, the Department of Chemistry won the bid to host ChemEd 2021, the largest North American conference focused on high school and introductory chemistry education best-practice. The conference has been adapted for COVID-19 circumstances and typically has 400–800 educators and teachers in attendance.

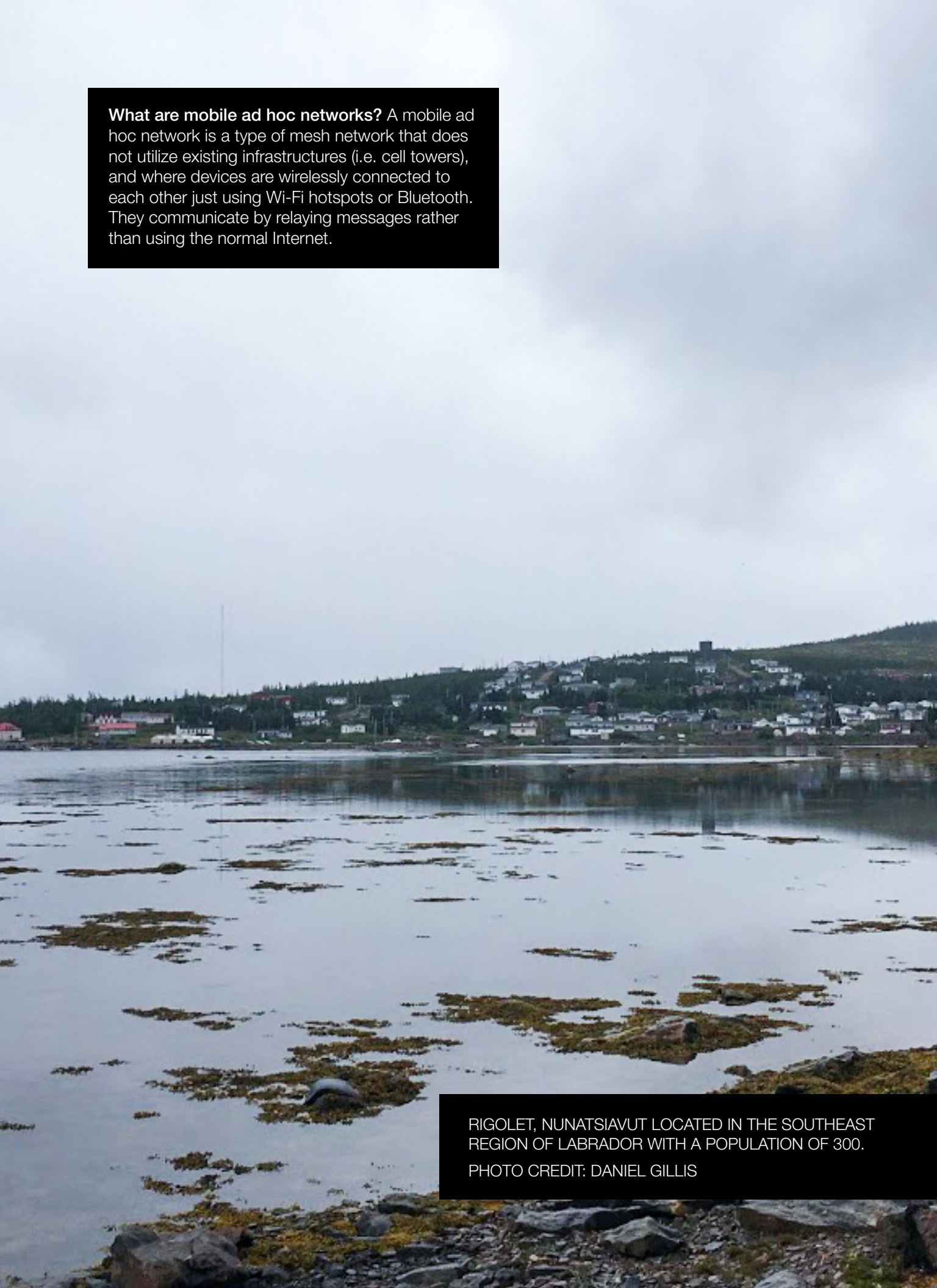
The School of Engineering hosted Go ENG Girl in October 2019 with dozens of students from grades seven to ten, featuring inspirational women speakers, including former CEPS dean, Mary Wells. During the morning event, the girls participated in two engineering design activities while parents toured the school and attended a panel discussion. Members of WiSE oversaw the activities and event organization.

We hosted Go CODE Girl in February 2020, with approximately 40 students from grades seven to ten. GWiCS and Creative Encounters hosted three workshops for the day, with support from Ontario Women in Engineering (ONWiE) and the School of Computer Science. The event featured keynote speaker Carter Cousineau, Managing Director of CARE-AI.

The Department of Mathematics and Statistics hosted a longstanding, celebrated event for the math community: SuperMath Day. Dating back to the early 1980s, the event has drawn hundreds of school-age children to campus. In 2019, teachers and more than 60 students attended math lectures and tours featuring Daniel Kraus and Nagham Mohammad, two faculty members from the Department of Mathematics and Statistics.

At the Guelph Civic Museum in November 2019, the Department of Physics hosted over 600 elementary students for STEM week with demonstrations on vibrations and waves, energy, the physics of space exploration and astronomy, the mechanics of flight, and electricity and electrical devices. Students from the Department's unique third year Science Communication course supported event activities and promotion.

What are mobile ad hoc networks? A mobile ad hoc network is a type of mesh network that does not utilize existing infrastructures (i.e. cell towers), and where devices are wirelessly connected to each other just using Wi-Fi hotspots or Bluetooth. They communicate by relaying messages rather than using the normal Internet.



RIGOLET, NUNATSIAVUT LOCATED IN THE SOUTHEAST REGION OF LABRADOR WITH A POPULATION OF 300.
PHOTO CREDIT: DANIEL GILLIS

STORING DATA NO INTERNET REQUIRED

Marshall Asch, Computer Science (M.Sc)

From checking email, to loading grocery flyer deals, reviewing the weather, or getting health test results, the Internet is intrinsic to our day-to-day activities. Somewhat ruefully, many of us would probably admit that we need the Internet for daily life. But, what if we didn't have reliable Internet? What if the nearest cellphone tower was 300 km away? That is the case for some remote Canadian communities, such as Rigolet, Nunatsiavut. This problem inspired Marshall Asch's graduate student journey to collect and store network data—without the Internet.

“The eNuk project in Rigolet sparked my interest in this type of research back in 2018,” says Asch. “My advisor, Prof. Dan Gillis, described the project—a community-led mobile app where members could report different environmental conditions, like ice safety or fishing quality, using mesh networks instead of relying on Internet access. I was struck by the issue of sharing and storing data without the need for Internet Service Providers.”

Without reliable Internet access, cloud servers were not an option for data storage in Rigolet, and other existing methods also would not work because they require computers rather than cell phones. Driven by these challenges, Asch's research focuses on impacts of social interactions on the optimization of data storage schemes in mobile ad hoc networks. After joining the eNuk project team, he co-led the development of the wireless mobile mesh-enabled Android version of the community-led eNuk health and environment monitoring tool.

“Marshall's work was a huge contribution to community-based environment and health monitoring programs in remote and rural areas and has implications for data sharing and storage across Canada,” says Prof. Dan Gillis, School of Computer Science. “In the time that I have known him, Marshall has demonstrated himself to be a hard-working and innovative individual who improves the lives of his peers and supports communities that are too often marginalized. To say that Marshall has had a profound impact on the student body in the School of Computer Science would be an understatement.”

Asch has held executive positions in the Society of Computing and Information Science and the Guelph Coding Community. He helped grow the clubs to have larger impact for students,

such as hosting Roboticon, hackathons, bringing speakers to campus and raising funds to send students to competitions.

Asch's research on data storage and mobile ad hoc networks has long-lasting implications for communities across Canada. It will enable them to store, manage and access valuable data amongst each other. His efforts have been noticed by institutional and national bodies. In 2019 and 2020 alone, Asch has been awarded a Canada Graduate Scholarship (Master's) from NSERC and an Ontario Graduate Scholarship. He has received support from Polar Knowledge Canada's Northern Scientific Training Program, the Mitacs Accelerate Program, along with several notable U of G recognitions: the CEPS Dean's Scholarship; Erin Angus Student Award; and CEPS Society of Excellence.

As he embarks on the latter half of his master's degree, Asch will begin simulations to evaluate the use of human mobility in mesh networks to assess their usability for more effective network strategies. After graduation, Asch plans to seek a role in industry to develop software that makes use of mesh networks.





UP AND ATOM INSIGHT FROM FERMIONS

Most of us are familiar with protons, neutrons and electrons—the subatomic particles that make up atoms. But, what many of us do not know is that these familiar particles are examples of fermions. Fermions make up solid objects and it is impossible for two fermions to be in the same place at the same time. Experiments on fermions has provided insight into atomic clocks, telecommunications and even the inner workings of high-density collapsed stars.

There is even more to learn from fermions, particularly when we turn down the temperature. Physics professor Alexandros Gezerlis and his research team study ultracold atomic systems. The way fermions behave within these frigid systems provides insight into the smallest known energy scale. Fermions within ultracold systems experience forces and even spin, a form of angular momentum. To date, researchers have focused on the “two-component” fermion-system structure. This structure considers two types of fermions, which differ based on the direction of their spin: spin-up and spin-down. This kind of system is akin to one that is made up of neutrons only. In any nuclear system there are two additional components to consider—the spin-up and spin-down of protons. The team has scaled-up the fermion system structure problem by examining a system that involves the strong interactions between four fermion components. They have implemented novel microscopic simulation methods that sheds light on how fermions interact in this more complex system.

“We have made a step toward understanding fermionic clustering from first principles,” explains Gezerlis. “These findings can be tested experimentally in the future by manipulating the four-component fermion system in a laboratory setting.”

Dawkins WG, et al. 2020 Apr;124, 143402. Supported by NSERC; the Canada Foundation for Innovation; the Ontario Ministry of Research, Innovation and Science; the U. S. Department of Energy; the European Commission; and SHARCNET.

AWARDS AND RECOGNITIONS SEPTEMBER 2019—AUGUST 2020

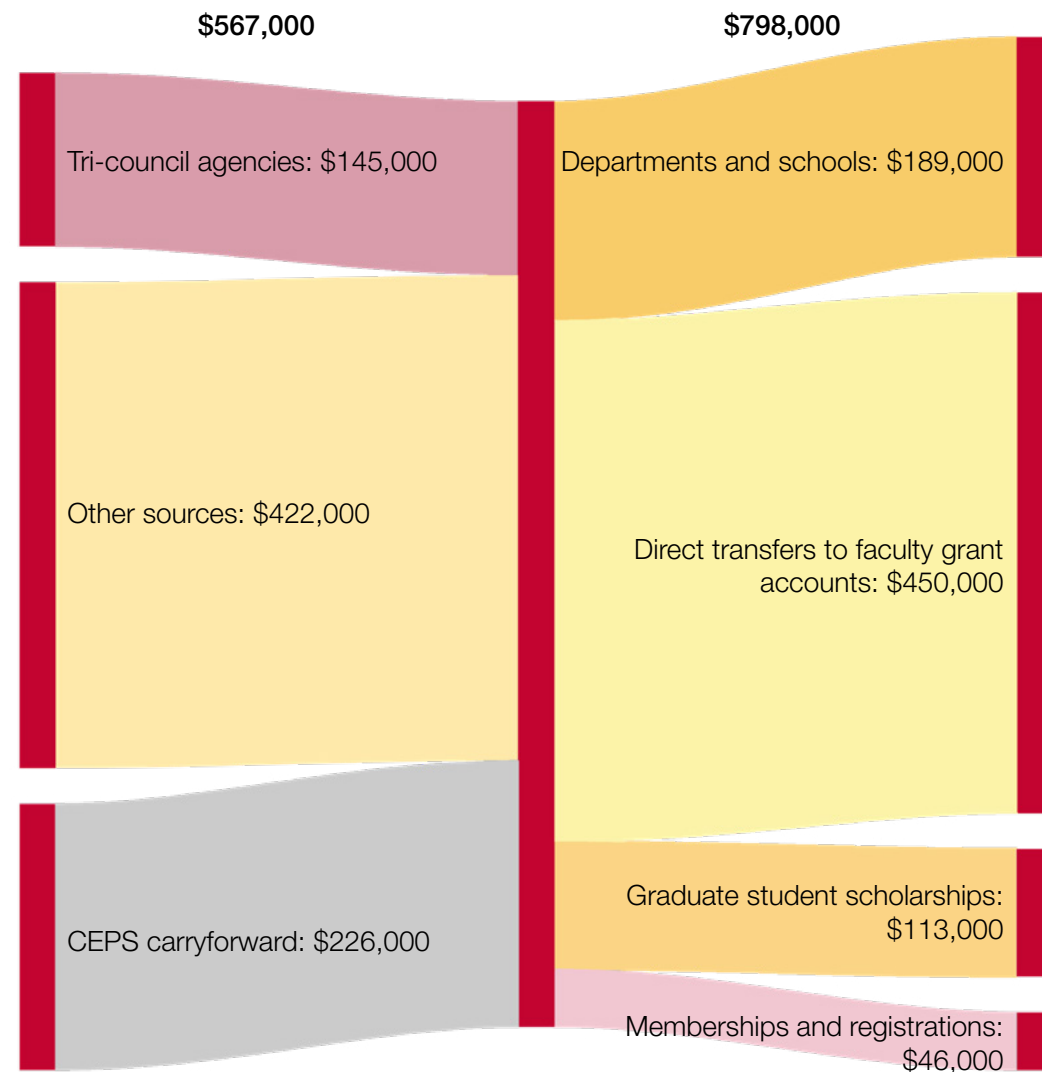
Daniel Gillis	Ontario Confederation of University Faculty Associations (OCUFA) Teaching Award
Shawki Areibi, Gary Grewal	International Conference on Field Programmable Logic and Applications Michal Servit Best Paper Award
Andrew Gadsden	University Research Excellence Award
Andrea Bradford	YMCA-YWCA of Guelph annual Women of Distinction
John Cherry	Stockholm Water Prize
Jana Levison	IAH-CNC Early Career Hydrogeologist Award
John Dutcher	CEPS Research Chair in Novel Sustainable Nanomaterials
Abdallah Elsayed	Bradley Soughton Materials Teaching Award
R. Ayesha Ali, Gerarda Darlington	The Canadian Journal of Statistics Award
John Donald	Canadian Engineering Education Association (CEEA) Fellowship
Ali Dehghantanha	CEPS Assistant Professor Research Excellence Award
Huan Yang	CEPS Assistant Professor Research Excellence Award
John Dutcher	CEPS Graduate Supervision Award
Manjusri Misra	CEPS Undergraduate Supervision Award
Ryan Clemmer	CEPS Excellence in Undergraduate Teaching Award
Jay Leitch	CEPS Staff Excellence Award
Mostafa Elsharqawy	University Research Excellence Award
Beth Parker	Swedish Research Council Tage Erlander Professorship
Aicheng Chen	International Association of Advanced Materials (FIAAM) Fellowship

Listed in order of receipt or announcement from September 1, 2019 to August 30, 2020

FINANCIALS

AT A GLANCE

Flow of indirect costs of research recovered by CEPS for the 2018–19 fiscal year.

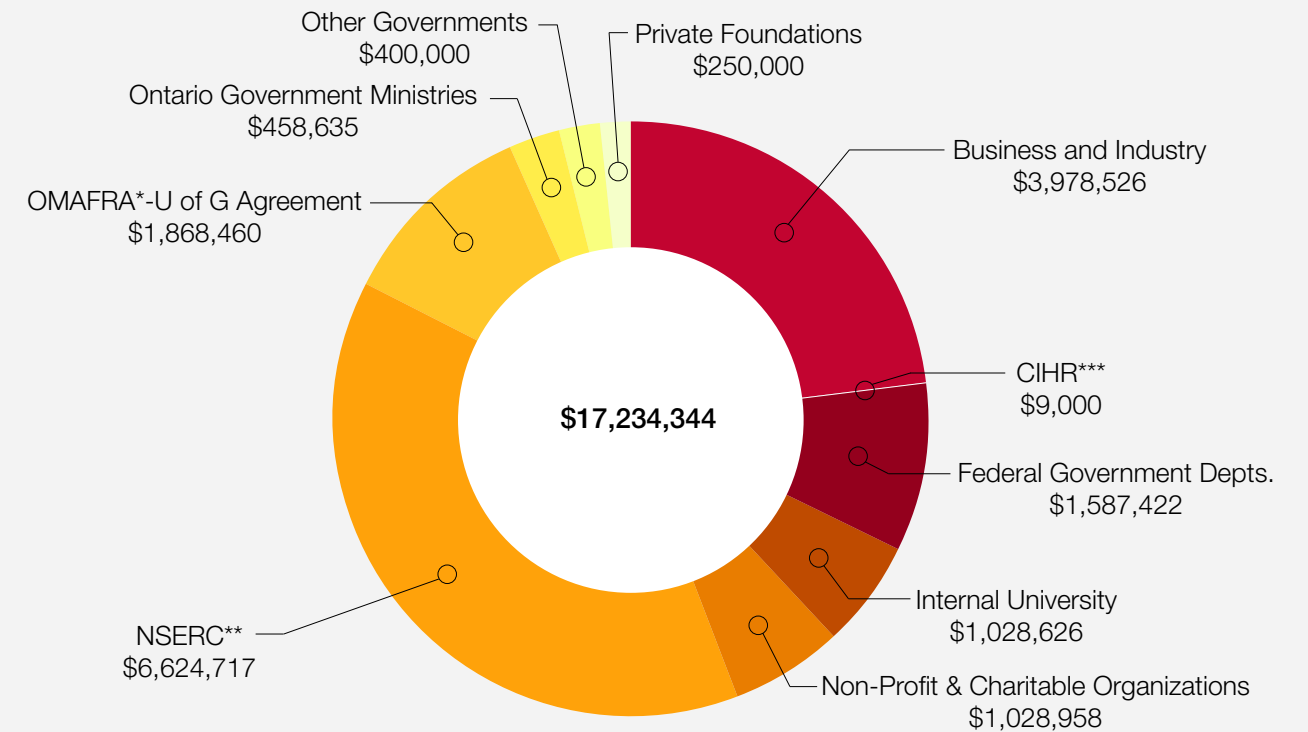


In the 2018–19 fiscal year, the indirect costs of research recovered by the University from CEPS faculty grants and research contracts totaled nearly \$6.4 million. Of this amount, the College received \$567,000. The College uses this funding to support various initiatives; however, the expense of these initiatives outweighs the revenue generated. Thus, the College uses its carryforward to cover the balance. *Disclaimer: Values are rounded to the nearest \$1,000. The indirect costs of research recovered are calculated based on a percentage of the direct research expenses incurred in the 2018–19 fiscal year. The values distributed by CEPS represent the costs incurred by the College in the 2019–20 fiscal year.*

RESEARCH FUNDS

AWARDED TO CEPS

Research funding awarded in the 2018–19 fiscal year.



The research funds secured by CEPS in the 2018–19 fiscal year includes all research projects with start dates falling in the University's fiscal year May 1, 2018 through April 30, 2019. For ongoing projects, the funds secured includes project installments with start dates in the same period. The figures represent award or installment values, without reference to when research revenues or funds were actually received. The data used in the 2018–19 report is up to date as of May 13, 2019.

*Ontario Ministry of Agriculture, Food and Rural Affairs

**Natural Sciences and Engineering Research Council of Canada

***Canadian Institutes of Health Research

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