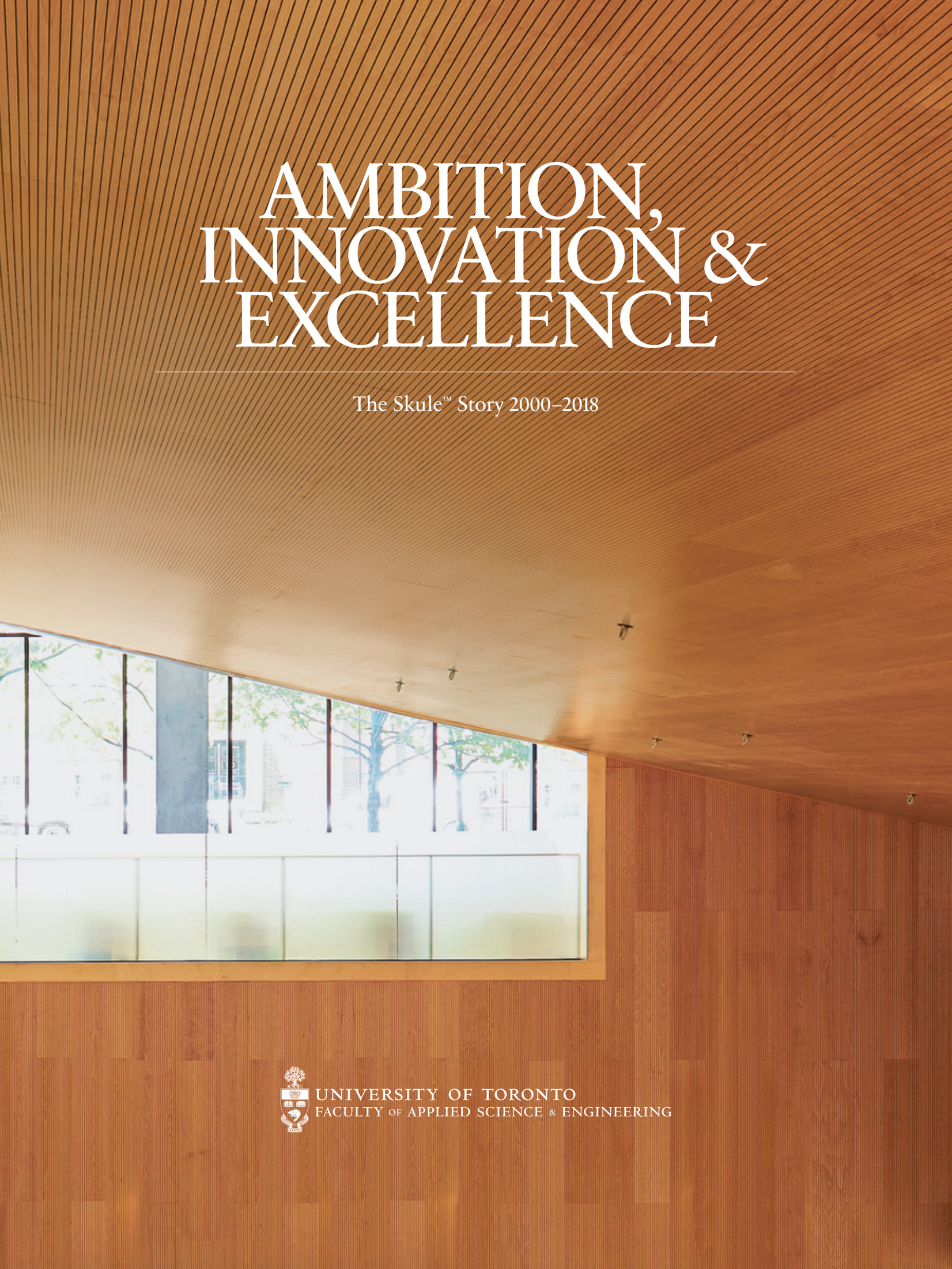
AMBITION, INNOVATION & EXCELLENCE

The Skule™ Story 2000–2018



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

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Introduction by Dean Cristina Amon
Afterword by Professor Emeritus Ron Venter

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An interior view of the Myhal Centre for Engineering Innovation & Entrepreneurship from the revealed atrium on Level 5. (Photo: Daniel Ehrenworth)

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Introduction by Dean Cristina Amon

For more than 140 years, the University of Toronto's Faculty of Applied Science & Engineering has led transformative change in technology, in the engineering profession and in society. Our quest for excellence is enduring.

The innovation and experimentation in our laboratories and studios is remarkable; notable highlights include autonomous flying robots, rapid genetic sequencing, light-emitting polymers, stem-cell-based implants to reverse damage from heart disease and strokes, microbial cultures that clean up contaminated sites and smart city technologies that reshape urban landscapes. These are research undertakings that would astound our Faculty's founders, and we can only imagine what will transpire in the future. U of T Engineering is creating entirely new products, processes and technologies, and the possibilities are boundless.

Our world-leading engineering endeavours in both research and engineering education are enhanced by our open environment, where collaboration across disciplines is seamless, diverse perspectives are embraced and unconventional ideas are encouraged. Our community—faculty, staff, students, alumni and industry partners—has never been more diverse, and we will continue our efforts to attract talent that reflects the full richness of the world we serve.

Our shared values, ambitions, ideals and goals are reflected in the Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre), our newest building, designed to be the vibrant hub of U of T Engineering. Its technology-enhanced active learning spaces reflect our commitment to providing an unparalleled learning experience, based on leading pedagogical research. Through its fabrication and prototyping facilities, we will continue to foster experiential learning activities for both curricular and co-curricular programming—including myriad collaborations with our partners in industry, university, government and our surrounding urban community. The Myhal Centre also provides a new home for our institutes and centres that maximize our students' contributions to the worlds of research, technology, leadership and entrepreneurship. It is where they become the next generation of global engineering leaders.

These pages reflect our Faculty's remarkable progress over the last two decades, capturing our current momentum, and signalling our bright future. They highlight the impactful research, unparalleled student experience and strong global network of strategic partnerships that make us one of the finest engineering schools in the world. Most importantly, they capture the innovative, pioneering spirit that is a part of everyone who graduates from our programs, collaborates with us on research and education, and supports us with their time, talents and resources.

This informative book of accomplishments, with many illustrations of our students and facilities, is dedicated to all the members of our engineering community who, through devotion, creativity and visionary leadership, are building a better tomorrow for all.

Cristina Amon
Dean, Faculty of Applied Science & Engineering
Alumni Professor of Bioengineering, Department of Mechanical & Industrial Engineering
University of Toronto

The School of Practical Science

In the fall of 1878, the Little Red Schoolhouse opened its doors as a fully operational engineering school. Richard White's comprehensive history of our Faculty in *The Skule Story: The University of Toronto Faculty of Applied Science and Engineering, 1873–2000*, serves as a springboard for the pages herein, which celebrate many historic achievements from the years 2000 to 2018.[1]

In January 1871, the Ontario government, under the leadership of Premier John Sandfield Macdonald, tabled a proposal to build a provincial school of technology, the purpose of which was to provide advanced instruction in the scientific professions. The government worked quickly to bring the project to fruition, securing $50,000 to purchase the existing Mechanics Institute at the corner of Church and Adelaide streets in Toronto. In September 1871, the government renovated the existing structure for their purposes with the intention of opening the institution's doors as soon as possible.

Before the renovations of the space were complete, the Sandfield Macdonald administration fell, and Member of Provincial Parliament Edward Blake became the new leader of the province. Instead of creating a stand-alone institution, Premier Blake preferred the idea of the school operating within the University of Toronto.

In May 1872, the college opened as a night school, named the College of Technology, offering instruction in chemistry and drafting. When Blake stepped down from his position to seek the federal Liberal leadership, Oliver Mowat was inaugurated as Premier in October 1872, and the government took legislative steps to enable the school to begin course offerings affiliated with University College, at the University of Toronto. This new iteration of the institute, called the School of Practical Science (SPS), officially opened in 1873.

Shortly after the SPS opened, a new champion of the institute, James Loudon, would see through the successful implementation of the school. Loudon, a graduate of University College and an instructor of physics at the College of Technology, would also create the initial vision of the SPS and encourage provincial leaders to support the growth of the school. Loudon favoured a less formal lecturing style and practical applications of science in his instruction, which informed the modus operandi of the SPS.

As Richard White writes in *The Skule Story*, Loudon was recognized as an innovative scholar and a strong leader and was consulted by the Minister of Education, Adam Crooks, on how to best move forward with the SPS. In his correspondence with Minister Crooks, Loudon contemplated where to build the institution, and how University College could evolve its practical science teaching in tandem with the SPS. Loudon proposed a school on the University grounds, so University of Toronto faculty could share their academic expertise as instructors at the school. Sharing faculty and staff would save money, Loudon argued; the only new hire required would be a professor of engineering, and University College students would be allowed access to laboratory space in the new building to enhance their studies.

In late 1876, Minister Crooks announced a plan in line with Loudon's thoughts. A new structure would be built, with laboratory space for chemistry, mineralogy and geology, and biology, and existing professors would be joint-appointed to the SPS. Construction of the Little Red Schoolhouse began in 1877.

To ensure an engineering instructor was in place prior to classes beginning in October 1878, the SPS accepted nine applications for the position. John Galbraith was appointed

Above

The School of Practical Science opened in 1878 and was demolished in 1966. It was located at the current site of U of T's Medical Science Building on King's College Circle. (Courtesy: U of T Archives & Records Management Services)

the first Professor of Engineering at the SPS in September 1878, weeks before the school's official opening. He was also the first dean of the school, holding the position until his passing in 1914. Galbraith held a bachelor's degree and a master's degree from University College, but he was not formally trained as an engineer. He had, however, been elected as a member of the Institution of Civil Engineers in England, and had successfully practised as an engineer for ten years prior to joining the original faculty members of the SPS.

The SPS first offered three diploma courses of study: Engineering (Civil, Mechanical and Mining), Assaying and Mining Geology and Analytical and Applied Chemistry. In addition to diploma students, University College scholars were also educated in the sciences at the SPS: in the school's first year, 76 University College students, including 23 medical students, received their science education at the school, while only eight students were registered in the three-year diploma. The next year, 137 University College students, along with 62 veterinary and medical students, completed their science requirements at the institute; only 12 students belonged to the SPS, all in engineering. Our Faculty continues to foster cross-disciplinary collaboration and has since developed a formal partnership with the Faculty of Medicine and the Faculty of Dentistry through the Institute of Biomaterials & Biomedical Engineering among others.

The SPS eventually outgrew the Little Red Schoolhouse as enrolment numbers steadily increased throughout the next two decades. As a result, our engineering precinct expanded in the early 20th century with the addition of the Mining Building, the Sandford Fleming Building, the Thermodynamics Building and the Mechanical Engineering Building, to accommodate new course and program offerings that would lead the way in the next phase of engineering education in Canada.

1. Prior to 1878, several iterations of our Faculty existed independently of the University of Toronto. The year 1878 marks the year the School of Practical Science (SPS), the precursor to our Faculty, was established within the precinct of the University. At this time, the SPS was only loosely affiliated with University College. The SPS amalgamated with the University in 1906.

INNOVATION & EXCELLENCE IN ENGINEERING EDUCATION

CHAPTER

1

Members of the U of T Supermileage Team work on their hyper-fuel-efficient vehicle. Each year the multidisciplinary student team builds and races prototype vehicles designed to consume as little fuel as possible. (Photo: Roberta Baker)

The Faculty of Applied Science & Engineering is a thriving hub of innovation and excellence, consistently ranked the #1 Canadian engineering school and top 20 across international rankings. Since 1878, we have led the way as the first engineering school in Ontario. Through innovations in engineering education, research and outstanding administration, our students and faculty continue to be influential in their academic pursuits and, later, in their careers.

Celebrating enrolment achievements

When the School of Practical Science first opened its doors, only a handful of students were enrolled in applied science and engineering courses. Our Faculty has since grown considerably in numbers and diversity, which is reflected in the students and faculty who walk through the halls of the engineering buildings each year.

- In the 2016–17 academic year, students earned 1,123 undergraduate degrees, the highest number awarded at our Faculty by that date.
- From 2007–08 to 2016–17, the annual number of undergraduate applications increased from 6,829 to 12,293 prospective students with international applications growing from 21 per cent to 35 per cent over that time. Total undergraduate enrolment in 2016–17 was 5,441.
- Our domestic graduate student population increased from 1,165 students in 2007–08 to 1,569 students in 2016–17. International graduate student enrolment also increased from 246 students in 2007–08 to 796 students in 2016–17.
- We increased the number of women first-year students from 20.2 per cent in 2006–07 to 40.2 per cent in 2017–18.
- In 2016–17, 618 women, a new record-high number, were enrolled in graduate studies at our Faculty.
- By 2016–17, Professional Experience Year Co-op Program (PEY Co-op) participation had increased from four interns in 1980 to more than 700 students annually. As of 2016–17, 70 per cent of all undergraduates participated in the PEY Co-op program.

Previous spread

Named after John Bahen (CivE 5T4) and his wife Margaret, the Bahen Centre for Information Technology has become a hub of student activity and multidisciplinary research. It is home to our Division of Engineering Science, The Edward S. Rogers Sr. Department of Electrical & Computer Engineering and Department of Mechanical & Industrial Engineering. (Photo: Daniel Ehrenworth)

Evolving and transforming multidisciplinary education

Our Faculty has a history of excellence in engineering education. Diverse course offerings and experiential learning opportunities prepare our students to address global challenges.

Transforming multidisciplinary engineering education

Under the leadership of Dean Cristina Amon, we transformed our multidisciplinary course offerings by creating world-leading research centres and institutes, developing new undergraduate minors and certificates, expanding our graduate technical specializations, creating new courses and co-curricular activities and increasing opportunities for experiential learning. These initiatives enable transdisciplinary collaboration between students and faculty members, creating a more holistic approach to engineering education.

Broadening multidisciplinary education

Multidisciplinary courses, minors and certificates provide students with the opportunity to enhance their professionalism, global awareness, leadership and communication competencies, which complement the strong technical foundations of our undergraduate and graduate offerings.

Undergraduate education

Through program-specific specializations, multidisciplinary minors and certificates and rich co-curricular and experiential learning opportunities, students can customize their undergraduate engineering experience. This flexibility enables our students to graduate with the technical and professional competencies and confidence to pursue any number of career directions—whether taking on leadership roles in industry, starting their own businesses or pursuing further post-graduate education.

Undergraduate minors and certificates

Between 2006–07 and 2017–18, our Faculty introduced eight minors and 10 certificates for undergraduate students:

Minors

Advanced Manufacturing
Bioengineering
Biomedical Engineering
Engineering Business
Environmental Engineering
Nanoengineering
Robotics & Mechatronics
Sustainable Energy

Certificates

Communication
Engineering Business
Engineering Leadership
Entrepreneurship, Innovation & Small Business
Forensic Engineering
Global Engineering
Mineral Resources
Nuclear Engineering
Renewable Resources Engineering

Timeline

Women in engineering

2017

Professor Cristina Amon is reappointed as Dean of our Faculty for a special third term to June 30, 2019.

2014

Professor Deepa Kundur becomes the first woman Associate Chair for our Division of Engineering Science. Kundur is appointed Chair of the Division in 2017.

Top

Professor Chirag Variawa, Director, First-year Curriculum, right, teaches a course in a pilot Technology Enhanced Active Learning (TEAL) room housed in the Sandford Fleming Building. The project, launched in 2014, was implemented to develop TEAL pedagogies and further enrich engineering education by supporting a blended modality of teaching. Small group seating and screens create an immersive learning experience. (Photo: Roberta Baker)

Bottom

Xiaoxiao (Maddy) Zhang (EngSci Year 1), pictured left, was the youngest student to join U of T Engineering at age 14 in fall 2017. Zhang and her classmates Lorna Lan and Brytni Richards, all studying Engineering Science, were part of the second consecutive undergraduate entering class to include more than 40 per cent women. (Photo: Roberta Baker)

2013

Professor Heather MacLean is the first woman to hold the title of Associate Chair of Graduate Studies for our Department of Civil Engineering (now the Department of Civil & Mineral Engineering).

2009

Professor Jean Zu becomes the first woman Chair of our Department of Mechanical & Industrial Engineering.

2006

Cristina Amon is appointed the first woman Dean of our Faculty as well as Alumni Professor of Bioengineering in the Department of Mechanical & Industrial Engineering. Professor Brenda McCabe is named the first woman Vice-Dean of the Faculty the same year. Two years later, McCabe is the first woman to be appointed Chair in our Department of Civil Engineering.

2000

Department of Chemical Engineering & Applied Chemistry professor Yu-Ling Cheng becomes the first woman Chair of our Division of Engineering Science; in 2007, Cheng is named the first woman Faculty Council speaker and is appointed the Director of the Centre for Global Engineering in 2009.

Women in engineering

When she became dean in 2007, Cristina Amon made it a priority to raise the visibility of the engineering profession and inspire young women to address the most pressing global challenges of the 21st century through STEM. In 2014, Engineers Canada pledged to increase the number of newly licensed women engineers to 30 per cent by the year 2030, an initiative referred to as "30 by 30." We are taking a leadership role in increasing gender diversity both within our Faculty and the profession. In 2016–17, 12 of our Faculty's 31 Canada Research Chairs were held by women. Over the same two academic years, 18 women professors joined our Faculty, which brought the total number of women professors to 55, increasing their representation to 21 per cent. We continue to actively recruit and empower positive role models and mentors, driving Engineers Canada toward its "30 by 30" objective.

Opposite

Professor Angela Schoellig (UTIAS), left, is at the forefront of drone research. The impact of her work extends across industries, from mining to environmental analysis. In 2017, she was named to MIT Technology Review's list of Innovators Under 35. (Photo: Neil Ta)

Graduate education

Our Faculty enhances student experience, promotes research excellence and addresses global challenges through collaborative scholarship. Between 2006 and 2017, we nearly doubled our international and domestic graduate student population. Over the same period, we expanded our program offerings and Master in Engineering (MEng) emphases to enable students to customize their degrees—either specializing in one area or choosing to work across disciplines. We also created the Office of the Vice-Dean, Graduate Studies to address enrolment growth and to provide strategic leadership in policy development, recruitment of graduate students and the development of graduate programs. The Vice-Dean, Graduate Studies also takes a leadership role in establishing graduate student exchange agreements with international academic partners.

In 2015, we introduced our Faculty's first graduate-level collaborative specialization with the Ontario Institute for Studies in Education (OISE) in engineering education (EngEd). In 2017, we launched a second specialization with the University of Toronto Department of Psychology in psychology and engineering (PsychEng). Through these programs, our students enrich their educational experience by working with faculty from different disciplines within and beyond engineering around a common area of interest. We also developed a Prospective Professors in Training (PPIT) program to prepare PhD graduates for academic positions, and the Opportunities for PhDs: Transitions, Industry Options, Networking and Skills (OPTIONS) Program to help our PhD students and post-doctoral fellows prepare for careers outside academia.

Professional and transdisciplinary competencies

In 2004, the U.S. National Academy of Engineering (NAE) published *The Engineer of 2020, Visions of Engineering in the New Century*. The book describes "The Engineer of 2020 Project," which predicted the roles that engineers will play in addressing future challenges and determined the attributes that 21st-century engineers should possess. In line with the goals set out by NAE, we prepare our students with rigorous technical foundations, integrated with professional and global competencies, which enable them to address complex technical, social and ethical engineering challenges, focusing on global fluency, entrepreneurship, communication, leadership, design and teamwork.

Global fluency

Our Centre for Global Engineering (CGEN) strengthens our Faculty's education and research activities to respond to global challenges. It offers undergraduate students the opportunity to complete an interdisciplinary certificate in Engineering & Globalization with electives in global health, public policy, international studies, geography and international development. Students enrolled in the certificate program are required to participate in an international experience to integrate their academic knowledge with experiential learning. With the popularity of the Global Engineering certificate, we created a similar offering for our graduate students pursuing a MEng.

Entrepreneurship

The future of the global innovation economy relies upon the success of entrepreneurial ventures and a thriving startup culture. We have launched over 110 spinoff companies since 1970, and more than 30 collaborative undergraduate, graduate and faculty teams have founded businesses through our in-house startup accelerators, The Entrepreneurship Hatchery and Start@UTIAS. More than one-third of our undergraduate students graduate with a certificate or minor in engineering business, further enhancing their professional, entrepreneurial and leadership competencies.

Communication

We formalized our support of undergraduate student competencies in written and oral communication by creating the Language Across Curricular Program (LAC), renamed the Engineering Communication Program (ECP). Our award-winning interdisciplinary program ensures students have strong communication skills to help them excel in professional and post-graduate environments. ECP offers courses in writing and communication skills and also integrates content into existing core courses, reinforcing our Faculty's belief that communication competency is an essential component of a world-class engineering program.

Graduate programs and certificates

Research stream

Our research-stream graduate programs, Master of Applied Science (MASc) and Doctor of Philosophy (PhD), are offered in nine disciplines:

- Aerospace Studies
- Biomedical Engineering
- Chemical Engineering & Applied Chemistry
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Materials Science & Engineering

Professional stream

Between 2006–07 and 2017–18, we added new professional-stream graduate programs to include multi-disciplinary and single-disciplinary offerings that enhance technical expertise with four degree options:

- Master of Engineering (MEng)
- Master of Engineering in Biomedical Engineering (MEng)
- Master of Engineering in Cities Engineering and Management (MEng CEM)
- Master of Health Science in Clinical Engineering (MHSc)

MEng emphases

During the same period, we created 13 technical specializations that enable MEng students to specialize and customize their degrees:

- Advanced Manufacturing
- Advanced Water Technologies & Process Design
- Engineering & Globalization
- Entrepreneurship, Leadership, Innovation & Technology in Engineering
- Forensic Engineering
- Identity, Privacy and Security
- Robotics & Mechatronics
- Sustainable Aviation
- Sustainable Energy
- Energy Studies
- Financial Engineering
- Healthcare Engineering
- Information Engineering

Leadership

According to the NAE, engineers must understand and apply leadership principles to advance their careers and improve quality of life for people around the world. In 2010, we launched the Troost Institute for Leadership Education in Engineering (Troost ILead), anticipating the growing importance of leadership competencies in our students. An award-winning initiative and the first of its kind in Canada, Troost ILead offers courses and co-curricular activities to enable graduate and undergraduate students to excel as emerging leaders. Our students also gain invaluable leadership experience by becoming involved in one or more of the 100 clubs and teams offered through the Faculty, the Engineering Society and external volunteer organizations.

Design

Engineering design is integral to our undergraduate experience. Beginning in first year with the multidisciplinary Engineering Strategies & Practice (ESP) course for students in our core programs, and Praxis I and II for Engineering Science students, we enrich our curriculum with opportunities for collaboration and experiential learning. In these courses, students work in teams to address a challenge faced by an industry client or community partner in the Greater Toronto Area (GTA). The design challenges are often multifaceted, with social, environmental and economic implications, fostering students' ability to think critically and consider diverse perspectives while developing creative solutions. The courses provide a practical framework for theoretical courses and prepare students to excel in their required fourth-year capstone projects.

Opposite

Oreoluwa Kolade (MechE Year 3), at left, and Linda Low (MSE Year 3) work with 3D printers in The Entrepreneurship Hatchery's fabrication facility. From design to prototype, students apply their technical competencies to launch startups and develop solutions to some of the world's most pressing challenges. (Photo: Roberta Baker)

Left

Participants of the Troost ILead annual luncheon with business leaders at Massey College in April 2017. Front row from left: Doug Reeve, Professor and Director, Troost ILead; Ave Lethbridge, Executive Vice President, Toronto Hydro; Cristina Amon, Dean; Peter Wallace, City Manager, City of Toronto; Anne Sado, President and CEO, George Brown College; Dennis Fotinos, Executive Chairman, Enwave Energy; Tom Woods, (former) Vice Chairman, CIBC. (Courtesy: Troost ILead)

“Throughout our Faculty’s history, our community has pushed the boundaries of what is possible, paving the way for engineering innovation. Continuing to attract and empower faculty, students and staff depends on our ability to provide an environment that fosters creativity and inspires the very best in 21st-century learning and innovation.”

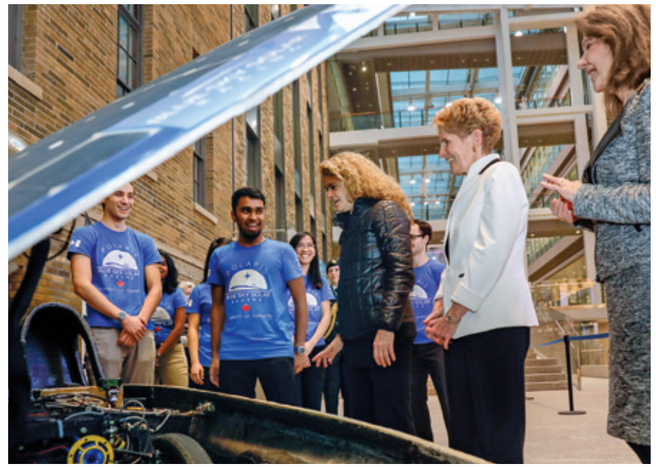
Cristina Amon
Dean

The unique Innovation, Hammers & Nails initiative also enables students to gain design competencies and a rich experiential learning opportunity. A partnership between our Institute of Biomaterials & Biomedical Engineering (IBBME) and the Hospital for Sick Children (SickKids), the program facilitates collaborations between undergraduate and graduate students and clinicians, nurses, staff and fellows to design engineering solutions to challenges identified by SickKids experts. The initiative has already generated several innovative solutions: its 2016–17 cohort developed wireless electrodes enabling intraoperative neuromonitoring and designed an expandable trocar device to enable instruments to be more easily inserted during keyhole surgeries.

Students develop advanced design competencies through several of our clubs and teams, including Blue Sky Solar Racing, Concrete Toboggan and Concrete Canoe teams, the University of Toronto Supermileage Team and the Human Powered Vehicles Design Team. Opened in 2018, the Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre) features design studios and fabrication and prototyping facilities that foster collaboration and spark innovation between students and faculty.

Teamwork

Fourth-year capstone design courses test and refine teamwork competencies in our undergraduates. In some courses, students must work in groups of five or six to address a design challenge, often presented by an external industry client. They can choose to work with students studying the same engineering discipline or they can complete a multidisciplinary or cross-cultural capstone project through the University of Toronto Institute for Multidisciplinary Design & Innovation (UT-IMDI). Students complete an online assessment of themselves and others through the Team Effectiveness Learning Systems (TELS) in their first year to reinforce their strengths and develop areas of weakness, further enabling them to excel in team dynamics throughout their studies and careers.



Right

Governor General Julie Payette (ECE MASc 9T0), centre, Ontario Premier Kathleen Wynne, second from right, and Dean Cristina Amon, right, study the Blue Sky Solar Racing team’s vehicle, Polaris, as part of the Governor General’s first official visit to Ontario in February 2018. (Photo: Jenna Muirhead)

Enriching our undergraduate student experience

Experiential learning opportunities enrich our curricular and co-curricular programs and enable our students to remain competitive in an era of fast-paced globalization.

First-year options and courses

TrackOne

In the 2007–08 academic year, we introduced the TrackOne, Undeclared Engineering program for incoming first-year undergraduate students, to attract strong applicants who have not yet decided on a core program. The flexible nature of this option enables students to declare their major at the end of first year, with guaranteed entry to their program of choice. Our TrackOne students gain a greater understanding of how engineers work across traditional disciplinary boundaries to address global challenges. We also offer the TrackOne Mentorship Program, which helps incoming students transition into a core program.

Engineering Strategies & Practice (ESP)

Launched in 2002, ESP is an award-winning foundational design and communications course that is required for all undergraduate students in our TrackOne and core programs. It implements engineering design processes as context to develop students' competencies in problem definition, team dynamics, critical thinking and cross-cultural relationships. In this two-term course, students are first introduced to the design process and work through a common team-based conceptual design project to identify social, human, regulatory and environmental factors that affect their success. In the second semester, students complete a multidisciplinary team-based, client-proposed project in groups of five or six. Clients include local community organizations, governmental organizations and partners across the University and its affiliated hospitals.

Through the ESP course, our students generate many practical solutions that exceed client expectations in Canada and around the world. In the 2016–17 academic year, a group of students were presented with a challenge from Pueblo Science, a Toronto-based charitable organization focused on advancing science education in low-resource communities around the world. Pueblo Science asked students to design a water purifier using locally available materials to help families in coastal areas of the Philippines have access to salt-free drinking water. Teachers in the Philippines taught the design and assembly to their high school students, who brought the purifier home to their families. In 2017, the organization successfully implemented the students' design in a school in Guyana—the innovation generated much excitement among community members.

Above

From left: Dunja Matic, Calista Biondic and Elisabeth Jong, all EngSci Year 1, present their project, "Improving Toy Hygiene in Pediatric Clinics," to Professor Jason Foster (EngSci) during the 2018 Praxis Showcase. (Photo: Laura Pedersen)

The Ajax division

To accommodate veterans returning from the Second World War, the University of Toronto's Faculty of Applied Science & Engineering created the country's first satellite campus in the town of Ajax, Ontario, in a converted shell-filling plant, approximately 42 kilometres east of the University's St. George campus. The role of engineering during the Second World War was deemed so vital that the government encouraged students to seek out training in this field, thus explaining the influx of students to engineering programs during this time. The first classes were held in January 1946, and the campus remained active until 1949. The "Rock of Ajax" stands outside the Galbraith building, and two floors of Innis Residence are named Ajax House to commemorate this time in our Faculty's history.
(Photo courtesy: U of T Archives & Records Management Services)

Praxis I and II

Personal and professional development are at the core of our undergraduate programs. With an experiential focus similar to our ESP course, Praxis I and II develops first-year Engineering Science students' engineering identity and builds competencies in design, communication and professional practice. The two-semester course is co-taught by an Engineering Science faculty member with expertise in engineering design and a faculty member from the Engineering Communication Program, to ensure students learn the holistic approach required to solve engineering challenges.

In the Praxis course, students engage with communities throughout the GTA to identify challenges that can be addressed through engineering innovation. Several of our students have successfully commercialized their Praxis designs, including the startup company PowerWring, which developed from a 2013–14 Praxis challenge requiring students to create a solution that would prevent injuries among caretakers and janitorial workers at the University. EngSci 1T7+PEY students, Jeremy Wang, Shuyi Wu, Ryan Williams and Noah Yang, designed a device that attaches to mop wringers and reduces the amount of force required. The team was accepted into The Entrepreneurship Hatchery as part of its 2014 cohort and now has patents under review in Canada and the United States. They also won second prize in the 2016 Minerva Canada's James Ham Safe Design Awards. This award is named in honour of former dean, James Milton Ham, whose Royal Commission Report on Health and Safety of Workers in Mines led to the creation of Ontario's Occupational Health and Safety Act in 1979, and to the adoption of the Internal Responsibility System in Ontario workplaces.

1992

Susan McCahan is the first woman to join our Department of Mechanical Engineering as a professor. McCahan is appointed the first woman Vice-Dean, Undergraduate, at our Faculty in 2011.

1975

This year welcomes the first woman President of the Engineering Society, Márta Escedi (CivE 7T6). Escedi is later the first woman to be appointed President of the Engineering Alumni Association.

1973

Professor Eva Kuhn is hired as the first woman faculty member in our Department of Civil Engineering, teaching mechanics and graphics. She contributes to the Department until her retirement in 2013.

1964

Professor Mary Jane Phillips is the first woman to join our Department of Chemical Engineering & Applied Chemistry as a lecturer in catalysis, receiving tenure in 1977. In the same year, Professor Ursula Franklin is appointed the first woman professor in our Department of Materials Science & Engineering. In 1984, Franklin becomes the first woman to receive the title University Professor at the University of Toronto, the University's highest honour.

1958

The first woman faculty member, Professor Marion Bassett, is hired to teach illumination as a permanent lecturer in electrical engineering.

Disciplinary, multidisciplinary and cross-cultural capstone design projects

Our students gain valuable experiential learning opportunities throughout all undergraduate programs. Fourth-year students complete mandatory team-based capstone projects within their core programs, or as members of a multidisciplinary team through the University of Toronto Institute for Multidisciplinary Design & Innovation (UT-IMDI).

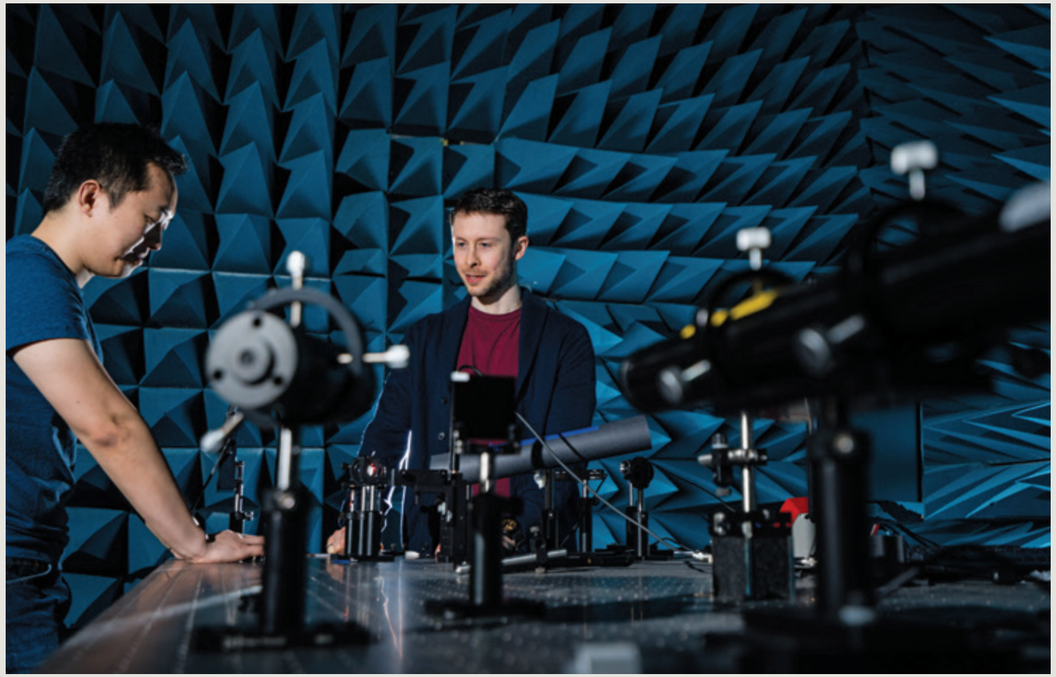
Industry partners or external organizations propose many of our capstone projects. Since the inception of the multidisciplinary capstone projects, more than 350 students from across our Faculty have collaborated on 78 projects for 38 industry clients such as Bombardier Aerospace, Defence Research & Development Canada, Drone Delivery Canada and NASA Ames Research Centre. Capstone projects also enable our students to pursue and develop their entrepreneurial competencies and expand their solutions in bold directions.

Community groups also seek out partnerships with our students. In the 2014–15 academic year, students participating in our multidisciplinary capstone design course developed a smartphone app called Xposure for the Hamilton Professional Firefighters Association (HPFA). The app enables firefighters to track and record their exposure to harmful chemicals to support Workplace Safety and Insurance Board claims if a firefighter experiences health effects from a fire. Xposure is enabling more effective data analysis, which will help to reduce health risks among firefighters. The success of the technology has resulted in its adoption by the HPFA and other firefighting agencies in the GTA.

We partner with more than 30 institutions worldwide to provide our students with opportunities to enhance global fluency and develop key competencies in leadership and cross-cultural communication. Our Department of Mechanical & Industrial Engineering offers a number of International Collaborative Capstone courses, where students collaborate with an international team from a partner institution, including Beijing's Peking University and Tsinghua University. Students communicate with each other online throughout the year and meet in person in November, when the University of Toronto teams travel abroad to meet their collaborators. In April of the same academic year, students from the partner institutions visit Toronto to present their final designs. Projects have included a new steering system for a highly fuel-efficient experimental vehicle and reconfigurable assistive devices to help people with mobility challenges.

Above

Shatha Abuelaish (CompE 1T5) and Rob D'Amico of the Hamilton Professional Firefighters Association demonstrate Xposure, an app that helps firefighters track their exposure to hazardous chemicals. (Photo: Tyler Irving)



Electrical and computer engineering students conduct an experiment in one of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering anechoic chambers. (Photo: Neil Ta)

1952

Lois DeGroot and Madeline Hoare are the first women graduates of our Department of Mechanical Engineering.

1947

Marcia Lamont Scott is the first woman to graduate from our Department of Civil Engineering.

1927

Elsie MacGill graduates from our Faculty, becoming the first woman in Canada to receive a degree in electrical engineering. MacGill went on to become the world's first woman aircraft designer and professional aeronautical engineer, helping to shape Canada into a powerhouse of the aeronautical industry during the Second World War.

Leadership education

Launched in 2010, the Institute for Leadership Education in Engineering (ILead) program enables undergraduate and graduate students to develop key competencies in leadership and communication through courses, workshops and co-curricular activities. ILead offers six undergraduate courses and eight graduate courses that can be applied toward either a minor in Engineering Business or a certificate in Engineering Leadership. The Institute also offers Leadership Labs, a Faculty-wide leadership program created in 2016, and The Game, a six-month cohort program that challenges student teams to hone their leadership competencies by developing solutions to multifaceted social challenges.

In September 2016, ILead hosted the inaugural meeting of the National Initiative on Capacity Building and Knowledge Creation for Engineering Leadership (NICKEL). NICKEL hosted 40 professors, instructors and deans from Canada's major engineering schools, as well as representatives from industry and Engineers Canada. Together, attendees identified innovative methods of integrating leadership, creativity, innovation and entrepreneurship across engineering programs. In 2018, ILead was renamed Troost ILead in recognition of William Troost (ChemE 6T7) and his wife Kathleen's longstanding support of the Faculty.

Collaboration and influence

We continue to strengthen our engagement with institutional partners around the world. Our Faculty has formalized agreements on research collaboration, student exchanges and dual programs that enable students from peer institutions to complete their final year of undergraduate study at our Faculty.

International partnerships

As a global destination for both research and educational collaborations, we continue to build upon longstanding relationships worldwide, and expand our opportunities for international exchanges, cross-cultural projects and research partnerships. These strong reciprocal relationships provide our students with the opportunity to develop cross-cultural fluency almost anywhere in the world through an international student exchange or a summer research exchange. Our international partnerships are also enhanced by our global alumni network, which extends to more than 110 countries and continues to grow each year.

Since 2007, we have developed partnerships and research collaborations with institutions around the world, including Peking University, Tsinghua University, Addis Ababa University, Hong Kong University of Science and Technology (HKUST), ETH Zurich and Shanghai Jiao Tong University. One result of these flourishing partnerships is the 3+1+1 program with South China University of Technology, Shanghai University and Tianjin University. 3+1+1 enables students to complete their fourth year of undergraduate studies at our Faculty, with conditional acceptance to our MEng program.

1920

Esther Marjorie Hill receives a Bachelor of Applied Science degree in architecture (a discipline at the time linked to engineering) from the Faculty of Applied Science & Engineering and becomes the first woman architect in Canada.

1912

Chemical engineering student Hildegarde E. Scott is the first woman to graduate from our Faculty, earning a Bachelor of Applied Science and Engineering in analytical and applied chemistry.

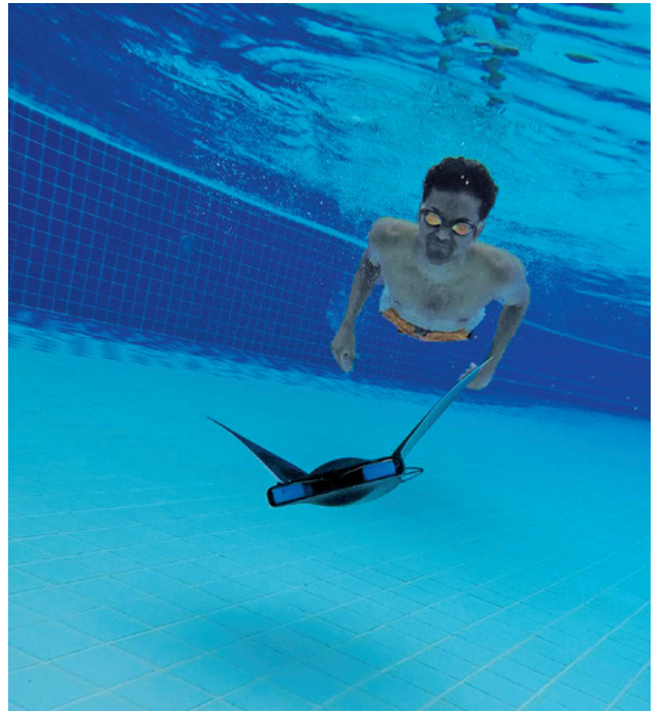
> "The IDCs are but one of the many new ideas we are exploring to help bridge institutions, and indeed countries, and help build innovative international partnerships."
>
> – Professor Chris Yip (ChemE, IBBME), Associate Vice-President, International Partnerships, U of T

International Doctoral Cluster

In 2018, the University launched its first International Doctoral Cluster initiative (IDC). The IDC provides resources to support the direct costs of research activities, which deepens collaboration and knowledge exchange with our global partners. Engineering researchers in The Edward S. Rogers Sr. Department of Electrical & Computer Engineering are at the forefront of global collaborations with the National University of Singapore (NUS) and HKUST, two of the three universities participating in the program. Together, researchers are innovating solutions in cyber security and next generation energy storage. The IDC formalizes our long-standing collaborations with NUS and HKUST and enables our students to gain global research experience and exposure.

Right

Mechanical engineering student Anston Emmanuel (MechE 1T7+PEY) tests the robustness of the attitude stability controls of a robotic manta ray at the National University of Singapore. (Courtesy: Anston Emmanuel)



Supporting our students

To ensure our students thrive in both their academic and co-curricular activities, we create specialized services and programs that anticipate the needs of our undergraduate and graduate students and support their success throughout their journey at our Faculty.

Alumni Mentorship Program

Launched in 2005, this program fosters valuable relationships between engineering alumni and undergraduate and graduate students in their third and fourth years. Students meet with experienced professionals from all engineering disciplines to seek advice and navigate the first steps of their careers. Under the strategic direction of our global Engineering Alumni Network (EAN), our Alumni Mentorship Program has grown significantly since 2011. The EAN has partnered with key student groups to enhance participation in the program. Guidance from our successful alumni empowers our students as they explore the boundless career opportunities offered by their engineering degrees.

Cross-Disciplinary Programs Office

The Cross-Disciplinary Programs Office was created in 2009 to provide academic and administrative leadership to enhance cross-disciplinary educational initiatives, including the coordination of our minors and certificates. With the support of the Associate Dean, Cross-Disciplinary Programs and the Manager and Student Counsellor of the Cross-Disciplinary Programs Office, our students are provided with the guidance they need to successfully select and complete their minors.

Dean's Student Town Hall

In 2007, we hosted the first Dean's Student Town Hall, which was created as a forum for Faculty leadership and the Engineering Society to foster student engagement. The town hall format further expands our capacity for direct in-person engagement and demonstrates our commitment to hearing student voices. Topics have included undergraduate research opportunities, resources to support mental health and improving assessment feedback for students.

Above

Dean Cristina Amon, right, celebrates the end of the 2017–18 academic year with incoming Engineering Society President Shivani Nathoo (EngSci Year 3), left, and outgoing Engineering Society President, Jonathan Swyers (ECE Year 4), centre, at the annual Engineering Society Awards. (Photo: Laura Pedersen)

Opposite

PEY Co-op intern Sebastian Gajewski (EngSci Year 4), left, works on the Next-Generation Small Canadarm prototype at MDA with Lauren Haensel (MechE 1T4+PEY), right. The Next-Generation Small Canadarm builds on the capabilities of Dextre, the Canadian-built robotic arm aboard the International Space Station. (Photo: Laura Pedersen)

Timeline

PEY Co-op

2017–18

Under the leadership of Dean Cristina Amon, the Professional Experience Year Internship Program (PEY) becomes a registered co-op program. This ensures participants retain their student status and have access to University support services while working. The program was renamed the Professional Experience Year Co-op Program (PEY Co-op) to reflect this change.

2016–17

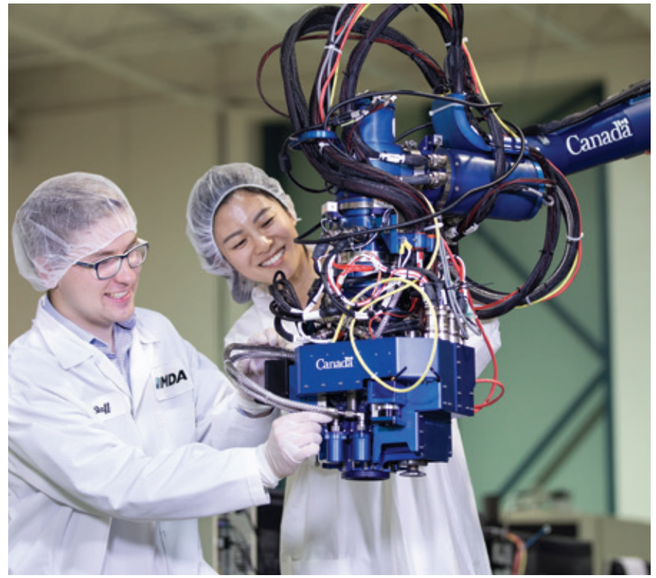
A record number of employers, 337, partner with the Engineering Career Centre (ECC) resulting in over 1,800 PEY internship opportunities.

Engineering Career Centre

The Engineering Career Centre (ECC) has been supporting and advancing our students' employability and career development since 1979 by providing advisory services and access to job postings, employer recruitment events and career fairs. It also administers the Engineering Summer Internship Program (ESIP) and the Professional Experience Year Co-op Program (PEY Co-op), Canada's premier undergraduate paid internship program. The ECC forms partnerships with diverse organizations in Canada and around the world to prepare our students to become the next generation of engineering leaders.

First Year Office

The First Year Office (FYO) provides support for students' transition into their new learning environment. The FYO provides critical guidance as students navigate both the academic and lifestyle elements of university life, and its expert team of advisors helps them make informed decisions during their first year of studies.



2015–16

The ECC places its 10,000th student; both IBM and AMD each surpass their 1,000th appointment. In the same year, the ECC places 790 undergraduate students – 70 per cent of the undergraduate class and a record number for the program.

2006–07

The ECC places its 5,000th student in an internship position.

2000–01

316 students are placed, well exceeding the target of 200 positions by 2000.

The Professional Experience Year Co-op Program

Our Faculty's long-standing Professional Experience Year Co-op Program (PEY Co-op), is the largest paid internship program of its kind in Canada. It offers our students the option to participate in a 12- to 16-month work experience opportunity that enhances their technical and professional competencies and gives new engineering graduates an advantage in the workplace.

In the late 1970s, faculty members in the Department of Mechanical Engineering developed an undergraduate teaching model that enabled students to gain invaluable practical engineering experience in real-world environments across many different industries. The proposed model went beyond traditional co-op positions by allowing students to earn a competitive salary for a 12- or 16-month work term. Long-term positions would enable students to become a valuable part of a workplace, contribute meaningfully to projects and train their successors in the four-month overlap in each 16-month employment term.

Our Faculty tested this model and invited a handful of companies to participate. In 1979, three companies joined the first PEY trial: General Motors Canada, de Havilland Aircraft of Canada Limited and Ontario Hydro. The trial, with its four positions, was a success, and throughout the 1980s, the program gradually expanded in popularity with both students and employers.

Now four decades since the first trial, more than 300 employers register positions each year, with more than 700 students electing to take advantage of the program. World-class organizations such as IBM and AMD have hired more than 1,000 of our students since the early years of the program. PEY Co-op has also led to full-time, post-graduation employment for hundreds of students. In these positions and in their careers, students have applied their technical and professional competencies to industry challenges and collaborated with world-leading industry employers to develop novel technologies and address global challenges.

Recognizing PEY Co-op industry leaders

Our Faculty thanks and recognizes the following employers who have hired 60 or more of our PEY Co-op students (as of June 2017):

- Advanced Micro Devices Inc.
- Altera Corporation
- Autoliv Electronics Canada Inc.
- Bell Canada
- Blackberry Ltd. (formerly RIM)
- Celestica Inc.
- CIBC
- Environment Canada
- GE Canada
- General Motors of Canada Ltd.
- Honeywell Ltd.
- Husky Injection Molding Systems Ltd.
- Hydro One
- IBM
- Intel (formerly Altera)
- Magna International
- MDA Corporation
- Messier-Dowty Inc.
- Microsemi Corporation (formerly Actel Corporation) – USA
- Mold-Masters Ltd.
- Ontario Power Generation
- Qualcomm – Canada/USA
- Red Hat Canada Ltd.
- The Regional Municipality of York
- Safran Landing Systems
- Sanofi Pasteur
- Scotiabank/Scotia Capital
- Suncor Energy
- Toronto Hydro
- Unilever Canada
- Xerox Canada Ltd.

1989–90

In the first 10 years, 342 PEY internship students are placed with an average annual participation of 34, which represents nearly five per cent of the graduating class.

1981–82

PEY is implemented as a Faculty-wide program.

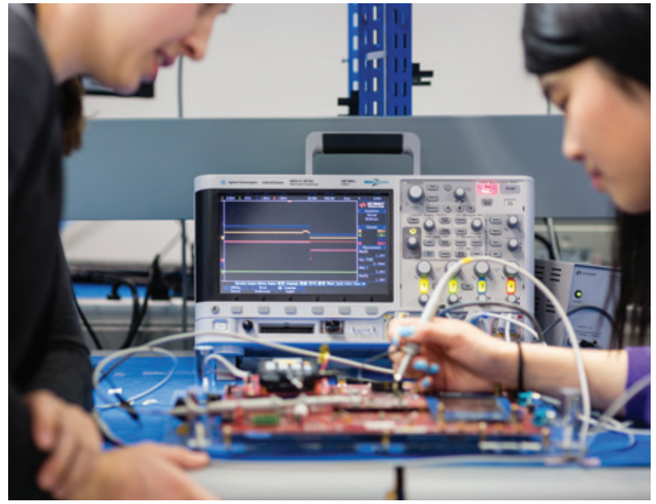
1979–80

The PEY internship program is offered to students in the Mechanical Engineering program in partnership with de Havilland Aircraft of Canada Limited, General Motors Canada and Ontario Hydro. Four students participate in the first PEY pilot.

Right

PEY Co-op students develop next-generation concepts of consumer electronics as part of Zebra Technology's product innovation team in 2016. The Professional Experience Year Co-op Program (PEY Co-op) is one optional experiential learning component of our engineering curriculum. Students develop key competencies in interview readiness and teamwork to prepare them to be successful in their final year of study and in their careers. (Photo: Neil Ta)

In the 2016–17 academic year, the combined salaries of PEY Co-op students exceeded $40 million, generating significant economic benefit to students and the country. Our PEY Co-op internship program positions are also reflective of our global alumni community, as many of our alumni, now flourishing as engineering leaders across Canada and around the world, hire PEY Co-op students. The Engineering Career Centre continues to work closely with students and employers to refine the PEY Co-op program and ensure our students excel in their positions and careers.



1979–80

Under the leadership of the Department of Mechanical Engineering and with the support of Dean Gordon Slemon, the PEY concept is nurtured and formulated by professors Derek McCammond, David Scott and Ron Venter. Program costs are minimal as each student is working in industry for a full 12- to 16-month period and returning thereafter to continue into their fourth year of study having gained invaluable engineering experience.

1978–79

Discussion of a paid internship program is initiated within our Department of Mechanical Engineering.

BLAZING A TRAIL IN ENGINEERING RESEARCH & ENTREPRENEURSHIP

CHAPTER

2

Research conducted by Professor Levente Diosady (ChemE), right, and Elisa McGee (ChemE 1T0, MASc 1T2, PhD 1T7), left, led to the development of techniques in fortifying salt with iron and iodine to prevent micronutrient deficiency diseases, which affect over two billion people worldwide. Diosady was honoured with the Engineers Canada Gold Medal Award in 2018. (Photo: Roberta Baker)

Innovation thrives at our Faculty. With support from industry partners and alumni, we foster a community that enables researchers and entrepreneurs to lead in a complex global engineering environment.

Global impact through research excellence

The world's most pressing challenges transcend the boundaries of traditional engineering disciplines. U of T Engineering researchers collaborate with experts from multiple fields and work closely with our more than 300 external partners to develop new solutions and translate them from the laboratory to the marketplace.

Solving sustainability challenges

On August 2, 2010, in "Snowbird," a human-powered ornithopter (HPO) designed by two alumni from our Division of Engineering Science and our University of Toronto Institute for Aerospace Studies (UTIAS), Todd Reichert (EngSci 0T5, UTIAS PhD 1T1) and Cameron Robertson (EngSci 0T8, UTIAS MASc 0T9) made headlines around the world as the first to achieve human-powered flight with flapping wings. With that challenge complete, the team set its sights on the Igor I. Sikorsky Challenge, issued by the American Helicopter Society (AHS) in 1980, long thought to be an impossible feat, even by the AHS. On June 13, 2013, in "Atlas," the human powered helicopter designed by Reichert and Robertson, considered to be the most efficient helicopter ever constructed, Todd Reichert hovered at an altitude of 3.3 metres, long enough for the team to win the competition, set a record and again generate news headlines around the world. In 2015, Reichert and Robertson were awarded the Belt of Orion Award for Excellence from Canada's Aviation Hall of Fame and received international acclaim for their strides in human-powered vehicle innovation.

Previous spread

Graduate students from our University of Toronto Institute for Aerospace Studies in Professor Alis Ekmekci's (UTIAS) Experimental Fluid Mechanics Laboratory. (Photo: Neil Ta)

While the Canadian mining industry operates under some of the most rigid environmental standards worldwide, stakeholders continue to look for innovative ways to improve the sustainability of operations. Professor Lesley Warren, Director of the Lassonde Institute of Mining at our Faculty is leading the next generation of biological approaches in treating waste water. By using metagenomics—the genetic characterization of microbial communities—to study and understand the

bacteria present in mining water systems, Warren is developing sustainable and economical solutions to treat waste water responsibly, which in time will reduce or eliminate the use of chemical solutions to filter leftover water.

Organic light-emitting diode (OLED) technology consumes considerably less power than traditional sources of light, like incandescent, fluorescent or halogen, which means less drain on renewable energy sources. In 2015, OTI Lumionics, founded in 2011 by Michael Helander (EngSci 0T7, MSE PhD 1T2), Zhibin Wang (MSE MASc 0T8, PhD 1T2) and Professor Zheng-Hong Lu from our Department of Materials Science & Engineering, was awarded $5.7 million from Sustainable Development Technology Canada. This funding enabled the team to implement a pilot production line capable of producing high volumes of OLED lighting panels.

Hydrogen fuel-cell technology is a cleaner, renewable energy resource—and no one knows this better than our Department of Mechanical & Industrial Engineering alumnus Pierre Rivard (MEng MechE 9T4). Rivard, who led two companies in the alternative-energy industry, is one of Canada's foremost experts on fuel-cell products and services. In the mid-2000s, he helped to launch Toronto's pilot Hydrogen Village initiative, which gave people with fuel-cell-powered cars easier access to hydrogen stations. Due in part to Rivard's exceptional contributions, the project prompted the creation of more hydrogen stations across Canada and around the world.

Above

Professor Jan Andrysek (IBBME), right, developed the AT-Knee, short for All-Terrain knee, a prosthetic joint that uses novel control mechanisms to adjust to the user's walking patterns. It provides safer and more natural movements. (Photo: Neil Ta)

Left

The Aerovelo team testing their human-powered ornithopter, "Snowbird." Aerovelo, an aerospace design company, was founded by two U of T Engineering alumni, Todd Reichert (EngSci 0T5, UTIAS PhD 1T1) and Cameron Robertson (EngSci 0T8, UTIAS MASc 0T9). (Photo: Sean Robertson)

Breaking new ground

Our Faculty has been a purveyor of countless "firsts" since its inception in 1873. These achievements are a testament to our Faculty's commitment to an unwavering pursuit of excellence and innovation.

Professor Erin Bobicki from our Department of Materials Science & Engineering and Department of Chemical Engineering & Applied Chemistry is investigating a new method to reduce the environmental impacts of mining and mineral processing. Bobicki and her team are using the electromagnetic radiation produced by microwaves to alter the surface chemistry and composition of mineral grains. This process can improve the separation of valuable minerals in downstream processing and reduce the energy input required to process low-value minerals.

Industrial sites around the world—from oil refineries to dry-cleaning facilities—are contaminated with legacy pollutants that affect both soil and groundwater. Professor Elizabeth Edwards, from our Department of Chemical Engineering & Applied Chemistry, is internationally recognized for using biotechnology to speed up the natural degradation of these toxic compounds. To do so, she makes use of anaerobic microbes, bacteria that live without oxygen that are found naturally in contaminated sites and are capable of breaking down pollutants. Edwards and her team use DNA sequencing to learn more about these organisms and how they collaborate to break down solvents in stages. They then cultivate the organisms in the lab, feeding them with increasing concentrations of contaminants and selecting those compounds that show the best degradation activity. In collaboration with environmental lab SiREM, which was founded by Edwards, these cultures are injected back into the sites to speed up the removal of contaminants. The work has been used to restore more than 500 industrial sites around the world and earned Edwards a number of accolades, including the 2016 Killam Prize in Engineering, an award presented to groundbreaking scholars and scientists engaged in research.

Developing a sustainable alternative for fossil fuels is an ongoing global research priority. Chemical engineering Professor Emeritus David Boocock recognized the need for alternative forms of power generation and began looking for ways to unlock the energy potential in organic waste. Through his research, he discovered a method for transforming waste animal fat into a richer, cleaner-burning fuel than traditional biodiesel fuels.

After several years of research in our Department of Chemical Engineering & Applied Chemistry, Boocock's company, BIOX Corporation, was launched in 2000. The company manufactures and supplies biodiesel made from animal fats, used cooking oils and pure seed oils.

Timeline

Breaking new ground

2017

Julie Payette (ECE MASc 9T0) becomes the first U of T Engineering alumna to be appointed Governor General of Canada and Professor Molley Shoichet is named Ontario's first Chief Scientist.

2016

For the first time in our Faculty's history, women constitute more than 40 per cent of the first-year class. In the same year, our Faculty also hosts Canada's largest STEM event for elementary school students, GO NORTH (formerly InnovateU) and Canada's first conference on engineering leadership education. Aerovelo sets a new record for the fastest human-powered vehicle on earth.

Engineering health care innovations

Biomusic is a technology that reads a patient's physiological signals and turns them into music, enabling unresponsive patients to communicate with loved ones. Creator of biomusic, Stefanie Blain-Moraes (EngSci 0T5, Rehabilitation Sciences/IBBME PhD 1T0), is dedicated to developing technologies that will improve quality of life for individuals who cannot move or speak. In 2015, Blain-Moraes won the 7T6 Early Career Award, which recognizes alumni who have made significant contributions to our profession and community within 10 years of graduation.

Medications used to treat cancer kill more than just the cancer cells; they kill healthy cells as well. Professor Warren Chan of the Institute of Biomaterials & Biomedical Engineering (IBBME) is finding a way to direct chemotherapy drugs to tumours to enhance their efficacy and lower patient side effects. Chan and the Chan Research Group are engineering nanotechnologies to improve the drug delivery process for better patient outcomes.

Professor Naomi Matsuura's Medical Imaging Materials Laboratory in our Department of Materials Science & Engineering is researching the development of materials that can aid in both the imaging and treatment of cancers. These engineered materials can be injected into the body and remotely tracked by medical imaging technologies, such as ultrasound imaging, computer tomography and positron emission tomography (PET) scans, so as to illuminate cancerous tissues. In addition to making it easier to characterize tumours in medical scans, these materials can also be used to deliver therapies to targeted sites within the body, including tumours in organs that are difficult to access, such as the brain.

Professor Tom Chau at our Institute of Biomaterials & Biomedical Engineering and Holland Bloorview Kids Rehabilitation Hospital applies engineering innovations to clinical situations to help children with disabilities communicate. He teaches computers to read blood flow on the surface of the brain to map and translate a patient's thoughts. His work uses technology to improve methods of communication for children with limited mobility and motor control and loss of speech.

Above

Professor Naomi Matsuura (MSE, IBBME), right, and graduate student Jessica Miller, left, (MSE 1T8, MASc candidate) conduct research in the Matsuura Lab in the Ted Rogers Centre for Heart Research. Matsuura's research spans the fields of materials engineering and medicine. Her goal is to use new, targeted compounds developed in her lab to enable more precise diagnosis and improved local treatment of disease.
(Photo: Laura Pedersen)

2014

In collaboration with the Ontario Institute for Studies in Education, our Faculty launches Canada's first masters and PhD cross-disciplinary Engineering Education (EngEd) program. In the same year, Michael Helander (EngSci 0T7, MSE PhD 1T2), Zhibin Wang (MSE PhD 1T2) and Professor Zheng-Hong Lu of our Department of Materials Science & Engineering develop the first consumer-ready organic LED lamp.

Maryam Shanechi (EngSci 0T4) was named to *MIT Technology Review*'s 2015 list of the world's top "35 Innovators Under 35" for her work on brain-machine interfaces. Shanechi's interfaces can potentially restore movement in people who are paralyzed, stimulate the brain during certain treatments and better control anesthesia, which are significant breakthroughs for neuroscience and treatments in neuropsychology.

For people who have experienced mobility loss due to stroke, spinal cord injuries or traumatic brain injuries, MyndMove may offer solutions. MyndMove is a functional electrical stimulation (FES) device that restores voluntary hand and arm function in patients suffering from upper-limb paralysis. It was invented by Professor Milos Popovic from our Institute of Biomaterials & Biomedical Engineering and the Toronto Rehabilitation Institute. The technology is available in 16 clinics across Canada and has been used to treat more than 120 patients as of 2017. For this work, Popovic earned the University Health Network Inventor of the Year award in 2014. Additionally, in 2017, Popovic won the Ontario Accessibility Tech Pitch Competition alongside his team from MyndTec Inc.

In many parts of the world, diagnosing, monitoring and screening for infectious diseases is a complicated task. Fully equipped medical laboratories are few and far between, and it can take weeks for patients to receive their diagnoses, during which time their symptoms often worsen. James Dou (ECE MASc 0T7) and his faculty advisor, Professor Stewart Aitchison from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, have developed an optical testing method that enables a number of diagnostic tests to be conducted at the point of care. Their portable, low-cost, easy-to-use platform provides lab-quality results in as little as 15 minutes. The rugged design does not require refrigeration, enabling it to be deployed in remote locations without access to electricity. Dou, Aitchison and flow cytometry expert Rakesh Nayyar created the startup company ChipCare Corporation to continue to refine the technology and deploy devices to organizations around the world. ChipCare has raised more than $10 million in financing, which enabled them to begin beta testing its first product in 2016.

2013

Aerovelo, a Faculty startup, wins the legendary Sikorsky Prize on the international stage, for its successful flight of Atlas, a human-powered helicopter. In the same year, Professor George Eleftheriades and PhD candidate Michael Selvanayagam of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering publish a paper demonstrating the world's first "active" electromagnetic invisibility cloak.

Additionally, Professor Milica Radisic and graduate student Boyang Zhang (ChemE PhD 1T4) and their collaborators at our Institute of Biomaterials & Biomedical Engineering (IBBME) are part of a team that develops the first-ever method for creating living three-dimensional human heart tissue that behaves like mature heart tissue.

Leg prosthetics tend to fall into two categories: high-end products that are priced out of reach for many, or low-cost products with limited functionality. Professor Jan Andrysek, at our Institute of Biomaterials & Biomedical Engineering, has created a product that combines the best of both worlds. He and his team have developed a technology known as the AT-Knee (short for All-Terrain knee) that uses novel control mechanisms to adjust to the user's walking patterns and provide safer and more natural movements, all while keeping costs low. Andrysek and three co-founders have launched LegWorks, Inc. to commercialize the All-Terrain knee technology and offer it at affordable prices through NGOs, improving the lives of those missing a lower limb in developing countries. In 2015, LegWorks began distributing the knees in 20 countries, serving the needs of low-income markets such as Cambodia and Tanzania, as well as highly-active users in places such as Canada, the U.S., Europe and Australia. Prior to the All-Terrain knee, Andrysek had developed and licensed other knee joint technologies, including the MiniMac and GeriMac, which are sold globally.

When treating serious burns, skin grafts are often a required course of treatment. This involves removing a section of healthy skin from a patient and grafting it onto the burned area, which can be a painful and invasive process. A team led by Professor Axel Guenther in the Department of Mechanical & Industrial Engineering is eliminating the first step of the graft process. They are using a 3D printer to create layers of skin, complete with hair follicles and sweat glands. The team includes alumni Arianna McAllister (IBBME MASc 1T4), Lian Leng (MIE MASc 1T0, PhD 1T5) and Boyang Zhang (ChemE PhD 1T4) as well as Dr. Marc Jeschke, head of the Ross Tilley Burn Centre at Sunnybrook Health Sciences Centre. The PrintAlive Bioprinter uses the patient's own cells, potentially eliminating immunological rejection. In 2014, the team won The James Dyson Award among Canadian competitors, presented annually for design that solves a pressing global challenge.

2012

The University allocates Site 10 to our Faculty for the construction of the Centre for Engineering Innovation & Entrepreneurship. In the same year, our Faculty introduces Canada's first Mobile App Lab in The Edward S. Rogers Sr. Department of Electrical & Computer Engineering (ECE).

2010

The Engineering Positive Space Committee is formed to celebrate and recognize the diversity of our student body. In the 2015–16 academic year, the Engineering Society introduced the first non-binary student to take on the role of Godiva's Crown, which has historically been held by a woman student.

Above

This Cast ConneX structure has become iconic to Torontonians working in or commuting through the Queen Richmond Centre West in the heart of downtown Toronto. Cast ConneX is a U of T Engineering startup. (Photo: Neil Ta)

Improving manufacturing processes

Through innovative steel casting designs, Cast ConneX has engineered an earthquake-proof solution to protect buildings against seismic activity. Founded by Carlos de Oliveira (CivE MASc 0T6) and Michael Gray (CivE PhD 1T2), the Toronto-based company produces cast steel connectors that enhance the safety of structures. In 2010 the company donated its connectors to post-earthquake Haiti to assist in building a seismic-resistant school, contributing to an affected community's revitalization.

Ali Rizvi (MIE PhD 1T4) designed a cost-effective commercial sponge that can be used in industrial oil-spill cleanups. Using light foam, it absorbs 24 times its weight per gram in oil and doesn't absorb water. In 2014, Rizvi's outstanding research and entrepreneurial spirit named him "30 under 30 Future Leaders in Manufacturing" by the Society of Manufacturing Engineers.

Professor Emma Master from our Department of Chemical Engineering & Applied Chemistry is leading a research project to engineer a new generation of sustainable, wood-derived materials for a wide range of everyday applications, from food packaging to bio-based adhesives for building construction. The team is looking in some unlikely places, from decomposing logs to the stomachs of moose and beavers. Master and her collaborators believe they can make better use of all biomass fractions in wood, creating new value stress from trees to potentially replace some plastic products.

Professors Vaughn Betz (ECE PhD 9T8) and Jonathan Rose (EngSci 8T0, ECE MASc 8T2, PhD 8T6) of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering are world leaders in field-programmable gate array (FPGA) technology. Betz and Rose founded Right Track CAD Corporation, which created and delivered innovative architecture software for FPGA and FPGA device vendors. In 2000, their company was acquired by Altera, where Rose served as Senior Director of the Toronto office from 2000 to 2003. At Altera, Rose's group assisted in the development of the first generations of the Stratix and Cyclone families, which continue to be applied across several industries, from automotive to data processing.

Our Department of Materials Science & Engineering maintains a long-standing tradition of expertise in steel production. Leading the way is Professor Kinnor Chattopadhyay, who works with international partners to improve the quality of metals production. Together, they are developing sustainable methods to manufacture and produce metals that reduce environmental impact yet enhance existing processes.

2008

Microelectronic Circuits, a textbook co-authored by former Chairs of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, alumnus Adel Sedra and Professor Emeritus K.C. Smith, reaches one million copies in sales. In 2017, the textbook is in its seventh edition with the eighth edition anticipated for publication in 2020. The textbook has been translated into 11 languages. Oxford Press, the textbook's publisher, has frequently stated that it is its bestselling publication after the Bible and the Oxford English Dictionary.

Addressing global challenges

Double fortified salt (DFS) is being distributed to 4.6 million families, representing more than 24 million people, in the state of Uttar Pradesh, India. The product, developed by Professor Levente Diosady (ChemE BASc 6T8, MASc 7T2, PhD 7T2) and his research team from our Department of Chemical Engineering & Applied Chemistry, provides a simple, effective way to add iron to the diets of those who do not currently get enough. It is modelled on the success of iodized salt, distributed by governments around the world as a way to ensure their populations obtain enough of the micronutrient iodine. Diosady and his team developed a method for adding iron to the mix. They packaged ferrous fumarate, an iron-rich compound, into tiny edible particles that look and feel nearly identical to salt grains and dissolve when consumed. Early trials of the DFS showed a significant reduction in rates of anemia among children who received it as part of their school meals. Through a grant agreement from Canada's International Development Research Centre, our Faculty supported the scale up and roll out of the product in Uttar Pradesh in 2017.

Access to clean drinking water and sustainable energy sources are obstacles for many remote communities around the world. Our Institute for Water Innovation (IWI) is addressing these challenges through research with industrial, commercial and domestic water applications. As an interdisciplinary group of researchers developing innovations in water management, chemistry, treatment and remediation, it is leading the way in water management by establishing a knowledge base, developing innovative technologies and educating future leaders. As a researcher with IWI, Professor Amy Bilton and her team from our Department of Mechanical & Industrial Engineering specialize in the implementation of low-cost water and energy systems. Keeping location and community resources in mind, the group works to provide a solution that can be easily implemented within existing infrastructure.

Kepler Communications, an award-winning team of alumni from our University of Toronto Institute for Aerospace Studies, Division of Engineering, Science and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, is building satellites so small that they fit into a gym bag. The startup, which has its roots in The Entrepreneurship Hatchery and Start@UTIAS, will place 140 low-cost "cubesats" into space between 2017 and 2022. Kepler's unique constellation of cubesats offers real-time data connection anywhere on Earth. Their orbiting system will make air travel safer, instantly detect leaks in remote oil pipelines, monitor the heart rates of remote emergency rescue teams and improve internet access in remote northern communities, where ground-based infrastructure is expensive.

2007

Faculty spinoff, Cast ConneX, introduces custom-ized cast steel structural components to earth-quake-proof skyscrapers around the world. In the same year, our Faculty hosts its first Celebrating Engineering Excellence event to recognize and celebrate faculty and staff members. The Agnes Kaneko Citizenship Award, Harpreet Dhariwal Emerging Leader Award, Influential Leader Award, Innovation Award, Quality of Student Experience Award and Research Leader Award, created by Dean Cristina Amon, are presented for the first time at the 2010 event. In 2018, the Research Leader Award is renamed the Safwat Zaky Research Leader Award after Professor Emeritus Safwat Zaky for his contributions as the Chair of the Department of Electrical & Computer Engineering from 1993 to 2003 and Vice-Provost, Planning and Budget from 2003 to 2009.

Right

KIPP, a satellite built by U of T Engineering startup and The Entrepreneurship Hatchery team Kepler Communications, was launched into orbit on January 19, 2018. Its launch brought the company, founded by alumni from the University of Toronto Institute for Aerospace Studies, one step closer to achieving its goal of establishing a space-based network of communications satellites. (Courtesy: Kepler Communications)

Presence detection—the technology that identifies when a message recipient is online and available for conversation—is commonplace in an age of texting and social media, but it did not always exist. In 2002–03, eight graduates from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering built VirtualThere, a multi-million-dollar instant-messaging software company that pioneered developments in presence detection and interactive SMS capabilities.

More than 2.5 billion people around the world do not have access to safe sanitation systems. As a result, preventable diseases and diarrhea kill hundreds of thousands of people each year. In 2011, The Bill & Melinda Gates Foundation issued the Re-invent the Toilet Challenge. Innovators were called on to create a toilet that would disinfect human waste without access to water, a sewer or septic system or electricity, and with a cost of less than five U.S. cents per person per day. Professor Yu-Ling Cheng, from our Department of Chemical Engineering & Applied Chemistry, accepted the challenge with a team of her colleagues, delivering a prototype that placed third at the Re-invent the Toilet Fair in Delhi, India, in 2013. Cheng's group has received additional support from the Gates Foundation, to refine the design and improve the disinfection process, working to commercialize the product for use in low-income urban settings.

2006

Cristina Amon is named the first woman dean of the Faculty of Applied Science & Engineering. She has been recognized nationally and internationally for her transformative leadership of our Faculty.

2001

Canadarm2 launches on the International Space Station. UTIAS professors Peter Hughes and Gabriele D'Eleuterio, and UTIAS alumnus Dr. Glen Sincarsin extended Hughes's Canadarm1 analysis to encompass the additional difficulties posed by the Special Purpose Dexterous Manipulator (Dextre), which paved the way for a successful design of Canadarm2.

Enabling progress through robotics

In 2015, Google, Apple, Ford and Uber collaborated to accelerate the development of self-driving cars, but in Professor Tim Barfoot's lab at our University of Toronto Institute for Aerospace Studies, mobile robots have been driving themselves for years. The robots use sophisticated systems, such as light detection and ranging (LIDAR), to move safely through a space. The information collected by the robots enables Barfoot and his team to build 3D models of the environment the robot is driving through, creating new opportunities to understand spaces too dangerous for humans, from new mining sites to the planet Mars.

To ensure greater success rates for women undergoing in vitro fertilization, Professor Yu Sun from our Department of Mechanical & Industrial Engineering, jointly appointed to our Institute of Biomaterials & Biomedical Engineering and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, is using robots to select the best individual sperm for fertilization, tapping it with a tiny needle to mobilize it, picking it up and injecting it into an egg cell to fertilize it. These robots can perform precise manoeuvres more consistently than humans, which can significantly improve the outcome of in vitro fertilization.

A demographic shift is underway in Canada, and one of our engineering professors is ensuring the elderly are taken care of through robotics. Professor Goldie Nejat from our Department of Mechanical & Industrial Engineering is leading the development of intelligent assistive social robots that can meet the challenges posed by an aging population. Her interactive robots, Brian, Casper and Tangy, can lead group recreational activities to improve quality of life and enable seniors to stay in their homes longer.

For companies that need to move high volumes of warehouse inventory, efficiency of time and cost is paramount. In 2003, Raffaello D'Andrea (EngSci 9T1) co-founded Kiva Systems, which builds large autonomous robotic systems. Kiva robots bring inventory from the far reaches of large warehouses to centralized order parking locations. The company was purchased by Amazon in 2012, for $775 million.

Above

Professor Goldie Nejat (MIE) and her graduate student Christopher Thompson (MIE MASc candidate) play bingo with Tangy, a socially assistive robot designed to improve the quality of life for aging populations. (Photo: Laura Pedersen)

1999

Julie Payette (ECE MASc 9T0) is the first U of T Engineering alumna to travel to space and is a crew member on the first mission to manually dock the shuttle to the International Space Station (ISS). She also becomes the first Canadian to participate in an ISS assembly mission and board the Space Station.

1996

For the first time, an alumnus or alumna of the Faculty takes home an Oscar: William C. Shaw (MIE 5T1) wins for Scientific and Technical Achievement, with his three co-inventors of the IMAX projector.

1993

Adel Sedra (ECE MASc 6T8, PhD 6T9) becomes the first professor from our Faculty to hold the position of University of Toronto Provost. He holds the position until 2002.

Breakthroughs in artificial intelligence

The next time you use the personal assistant function on your smartphone or other device, it may be able to give you an honest answer. The algorithm created by our researchers in The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, Parham Aarabi (Engsci 9T8, ECE MASc 9T9) and Wenzhi Guo (ECE MASc 1T5), learns directly from human trainers, providing direct instructions used to pre-classify training samples as opposed to fixed examples. Known as the heuristic training approach, it holds promise for addressing one of the biggest challenges for neural networks: making correct classifications of previously unknown or unlabelled data. This method of identification will impact how machines learn new situations, such as identifying cancerous tissues for medical diagnostics or the objects surrounding a self-driving car.

Professor Baher Abdulhai and post-doctoral researcher Samah El-Tantawy from our Department of Civil & Mineral Engineering are implementing MARLIN, a machine-learning-based control software system created for the self-optimization of traffic lights. Recognized as "Inventors of the Year" by the University of Toronto in 2014, Abdulhai and El-Tantawy based MARLIN on artificial intelligence and game theory to enhance the timing of traffic lights. Their innovative design improves the flow of traffic and reduces maintenance and infrastructure costs, saving motorists and municipalities time, money and space.

Wearable athletic technology developed by alumnus Khalil Zahar (MechE MASc 1T4) from our Department of Mechanical & Industrial Engineering had the upper hand at the Rio de Janeiro 2016 Summer Olympics. A longtime boxer, Zahar looked for ways to improve his technique but found existing technologies limiting, so he created his own device through his startup company Hykso. Zahar and his team developed a small sensor that uses accelerometers and gyroscopes to gather data about hand movements, taking samples 1,000 times per second. Combining motion-tracking and machine-learning technology, the device instantly calculates movement and gathers and interprets data directly on the user's smartphone, providing unmatched insight into athletic performance.

1987

Jeffrey Skoll (ECE 8T7) graduates and eventually becomes the first employee and first President of eBay, the world's first and largest online auction site. He goes on to found Participant Media, the successful production company behind such films as *Spotlight, The Help, The Best Exotic Marigold Hotel* and *Bridge of Spies*, among many others.

1984–85

Our Institute for Biomedical & Biomaterials Engineering introduces a Master of Health Science (MHSc) in Clinical Engineering. It is unique to our Faculty and is the first engineering program in Canada to partner with a Faculty of Medicine.

Supporting research excellence: Multidisciplinary research centres and institutes

As Richard White outlines in *The Skule Story: The University of Toronto Faculty of Applied Science and Engineering, 1873–2000*, the inception of multidisciplinary research centres and institutes at our Faculty began in the 1960s, as graduate enrolment steadily increased. The Institute of Aerophysics, now our University of Toronto Institute for Aerospace Studies (UTIAS), was the first institute, followed by our Institute of Biomedical Electronics, now our Institute for Biomaterials & Biomedical Engineering (IBBME). As of 2018, our Faculty is home to more than 25 world-leading research centres and institutes, creating innovative technologies and processes in diverse strategic areas, including sustainability, artificial intelligence and human health.

Between 2007 and 2017, our Faculty launched 19 centres and institutes to enable enhanced research collaboration:

2017: U of T Electric Vehicle Research Centre (UTEV)
2015: Institute for Water Innovation (IWI)
Centre for Power and Information (CPI)
Centre for Aerial Robotics Research and Education (CARRE)
2014: University of Toronto Transportation Research Institute (UTTRI)
Toronto Institute of Advanced Manufacturing (TIAM)
2013: Institute for Sustainable Energy (ISE)
Centre for Research in Sustainable Aviation (CRSA)
2012: University of Toronto Institute for Multidisciplinary Design & Innovation (UT-IMDI)
Ontario Centre for the Characterisation of Advanced Materials (OCCAM)
2011: Centre for Resilience of Critical Infrastructure (CRCI)
Centre for Microfluidic Systems for Chemistry and Biology (CMS)
2010: BioZone
Institute for Robotics & Mechatronics (IRM)
Troost Institute for Leadership Education in Engineering (Troost ILead)
2009: Centre for Global Engineering (CGEN)
2008: Centre for Healthcare Engineering (CHE)
2007: Identity, Privacy and Security Institute (IPSI)
Southern Ontario Centre for Atmospheric Aerosol Research (SOCAAR)

Above

Professors Marianne Hazopoulou (CivMin), left, and Greg Evans (ChemE), right, on the portion of King Street altered for a transit pilot project. In 2018, researchers at our University of Toronto Transportation Research Institute (UTTRI) collaborated with the City of Toronto to study the effects of traffic-pattern changes on air and noise pollution and commuter decision making.
(Photo: Laura Pedersen)

Enabling innovation through industry partnerships

We continue to form strong partnerships with hundreds of industry leaders around the world to enable collaborative and groundbreaking research. As of 2017, our Faculty had more than 300 industry partners. Examples include:

Fujitsu

In 2018, multinational information and communication technology company Fujitsu Laboratories Ltd. launched the Fujitsu Co-Creation Research Laboratory in partnership with the University. As part of the launch, Fujitsu signed four research partnership agreements with researchers from our Chemical Engineering & Applied Chemistry Department and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering. One result of the collaboration with Fujitsu is the Digital Annealer, developed by our Faculty and Fujitsu researchers. The Digital Annealer is an important step forward in quantum computing; it accelerates the practical use of computing technologies that can reach beyond the limitations of supercomputers to tackle multifaceted global challenges that involve massive amounts of data and complicated calculations.

Havelaar

In 2016, Havelaar EV signed a partnership agreement with our Faculty to establish the U of T Electric Vehicle Research Centre (UTEV). Research activities at the Centre focus on advancing power electronics systems for the next generation of electrical vehicles. The agreement includes collaborative research project funding, seed funding for lab space and equipment and administrative needs. UTEV represents one of the largest industry collaborations undertaken by our Faculty. It is led by professors in The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, collaborating with professors from our Department of Mechanical & Industrial Engineering and our University of Toronto Institute for Aerospace Studies.

1981

Canadarm1 launches. The design of Canadarm1 is made possible by Professor Peter Hughes's development of an innovative approach to the dynamics of robotic arms with elastic links.

1980s

Professor K.C. Smith develops the origins of touch-screen technology in his lab in the Department of Electrical Engineering. It would later become ubiquitous in consumer electronic products.

1979

The Professional Experience Year internship program is created within the Department of Mechanical Engineering, with four student placements; the program is extended to all our departments in the 1980s. By 2018, more than 10,000 students have been placed in internship positions.

Hatch

Hatch's leadership is evident in many aspects of our Faculty. Research projects supported by Hatch include investigations of new metallurgical processes, improved analysis of concrete applications, novel systems for sustainable energy and new strategies for the mining industry. A number of our professors from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering have made remarkable contributions to the field of electromagnetic processing through Hatch's funding of the Hatch Industrial Research Chair in Electromagnetic Processing of Materials. Advisors from Hatch contribute expertise to our undergraduate design courses and some of our leading institutes, including the Lassonde Institute of Mining, the Troost Institute for Leadership Education in Engineering (Troost ILead) and the Institute for Sustainable Energy (ISE). Hatch also created the Graduate Scholarship for Sustainable Energy Research, to fund research and training for world-class researchers and engineers in the fields of recovery and utilization of energy derived sustainably from the sun and other sources. Hatch was presented the Corporate Academic Citizen Award at our Faculty's inaugural Industry Partnership Awards ceremony in 2016–17 for its leadership excellence.

Huawei

Chinese communications multinational Huawei began collaborating with our Faculty in 2013, supporting a diverse range of innovative research projects. For example, in The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, Huawei and Professor Wei Yu have been working together to design the next generation of wireless networks. Additionally, in 2016, the company announced it would provide funding for Faculty research projects ranging from designing optimized cloud computing and engineering next-generation internet architectures to enabling innovation in fields such as biomedical engineering, materials science and theoretical physics. Huawei has also hosted our undergraduate students through its Seeds for the Future work experience program, which invites undergraduate students from across Canada to enhance their technical expertise and learn about Chinese language and culture via a two-week exchange in Beijing and Shenzhen.

1978

Professor James Ham becomes the first dean of our Faculty to be appointed President of the University of Toronto. In the same year, *The Cannon* is introduced as the official student newspaper of the Faculty of Applied Science & Engineering.

1975

Don Allen, Adjunct Professor, Department of Mechanical Engineering, through his company Vibron, designs the stabilizing rings of the CN Tower, then the world's tallest free-standing structure and the world's largest tower.

Right

Third-year student and Professional Experience Year Co-op (PEY Co-op) intern Houssam Abou El Hoda, right, uses a virtual reality headset to validate the performance of a new Advanced Micro Devices (AMD) graphics card with his manager Lejla Bajic, left. As an intern at AMD, Houssam is an integral part of a team that improves the memory devices of the latest tech, from game consoles to cloud servers. (Photo: Neil Ta)

IBM Canada

IBM Canada and our Faculty have had innovative, collaborative relationships. One of IBM's most notable contributions is its role as an anchor partner for the Southern Ontario Smart Computing Innovation Platform (SOSCIP), a multi-institutional consortium created in 2012 to support collaboration between academic researchers and industries using advanced computing and big data analytics. IBM Canada also partnered with our University of Toronto Transportation Research Institute (UTTRI), among other universities, to develop iCity, a diagnostic tool to help decision makers and residents understand how their planning and transportation investment choices will affect their cities. IBM Canada is one of our long-standing Professional Experience Year Co-op Program (PEY Co-op) employers, having hired over 1,000 of our students since the first years of the program. The company received the Corporate Research Partner Award at the inaugural Industry Partnership Awards ceremony in 2016–17.

1970

Faculty members and undergraduate students in our Department of Mechanical Engineering participate in the Intercollegiate Clean Air Car Race with their electric/propane hybrid vehicle, nicknamed Miss Purity. Remarkably, the team placed first in their class and sixth overall.

1964

The *Toike Oike* is the first newspaper in the world to announce President Lyndon B. Johnson as President of the United States upon his election. A copy of the paper was accepted into the Lyndon Baines Johnson Memorial Library and Museum in 2016.

Leading health care research centres

Above
Professor Molly Shoichet (ChemE, IBBME), right, and her team are international leaders in tissue engineering and regenerative medicine. Her group has pioneered the development of materials called hydrogels, which surround and protect stem cells when injected into the body. In November 2017, she was named Ontario's first Chief Scientist. (Photo: Roberta Baker)

Medicine by Design

Established in 2015, Medicine by Design (MbD) harnesses the exceptional expertise at the University and its affiliated hospitals, converging the physical and life sciences, engineering, mathematics and medicine, to undertake transformative research in regenerative medicine and cell therapy. It fosters multidisciplinary collaborations using engineering design principles and quantitative biological modelling to nurture innovative environments where breakthroughs emerge. MbD researchers from our Faculty include:

- Professor Michael Sefton—Recognized as a world-leading pioneer in tissue engineering and biomaterials, Sefton has developed an implantable material that stimulates the growth of blood vessels. His team is now leveraging this discovery to create a new material to accelerate the repair of skeletal muscle after injury. Sefton became the executive director of Medicine by Design in 2017, for a five-year term.
- Professor Molly Shoichet—Shoichet is a leading researcher in stem cell transplantation and regenerative medicine. Her lab group is known for its use of materials called hydrogels that surround and protect stem cells when they are injected into the body. These hydrogels help stem cells survive and integrate into tissues, and may enable them to repair nervous tissue damaged by stroke, macular degeneration or other diseases.
- Professor Penney Gilbert—Gilbert and her team decipher the cues that "wake up" muscle stem cells and direct them to repair damage to skeletal muscle. These studies provide insight into how the body generates muscle and inform the development of new clinical devices, therapies or treatments that prevent or repair the damage caused by muscle wasting.

Above
Professor Craig Simmons (MIE, IBBME), centre, studies a heart with graduate students. Simmons, an expert in the field of mechanobiology and director of the Ted Rogers Centre for Heart Research, is recognized internationally for his innovative work combining mechanical engineering, biomaterials science and cell and molecular biology. His group investigates new methods of treating cardiovascular disease. (Photo: Neil Ta)

Ted Rogers Centre for Heart Research

In November 2014, the Rogers Family donated an unprecedented $130 million to establish the Ted Rogers Centre for Heart Research (TRCHR). Located on the 14th floor of the MaRS building in Toronto's Discovery District, the Centre brings together researchers from the University of Toronto, the Hospital for Sick Children (SickKids) and the University Health Network. Several of our faculty members and graduate students are working with the TRCHR as part of the Ted Rogers Translational Biology and Engineering Program (TBEP).

Engineering and medical researchers are combining stem cell technology with tissue engineering to regenerate heart tissue, heart valves and cardiovascular vessels to reveal new possibilities for more effective heart therapies and to create new technologies for improving heart diagnosis and monitoring in clinics. Professor Craig Simmons, joint-appointed to our Department of Mechanical & Industrial Engineering and Institute for Biomaterials & Biomedical Engineering, was appointed Scientific Director of TRCHR in 2015.

Rahul Udasi (MIE MEng 1T6), back left, takes notes as a child with cerebral palsy tests a robotic exoskeleton prototype. Udasi and Manmeet Maggu are the co-founders of Trexo Robotics, a company that builds exoskeletons to help children with disabilities walk. The company graduated from The Entrepreneurship Hatchery in 2016. (Photo: Laura Pedersen)

1962

The Institute for Biomedical Electronics opens—the first multidisciplinary research institute to join together the faculties of engineering and medicine in Canada. The Institute for Biomedical Electronics merges with the Centre for Biomaterials and the Tissue Engineering Group in the Department of Chemical Engineering & Applied Chemistry and is renamed the Institute of Biomaterials & Biomedical Engineering (IBBME) in 1999.

1957

Chemical engineer Lewis Urry (ChemE 5T0) develops the first commercially viable alkaline battery, the basis of many common household brands. It is considered to be one of the 100 greatest inventions of all time.

Above

In its new home in the Myhal Centre, The Entrepreneurship Hatchery provides a state-of-the-art space for the next generation of engineering entrepreneurs to collaborate, innovate and accelerate their ideas from design to prototype. (Photo: Laura Pedersen)

Fostering entrepreneurship

The University of Toronto is Canada's #1 engine for research-based startups.[1] Our Faculty is at the epicentre of the University's thriving entrepreneurship ecosystem, fostering entrepreneurial spirit and solutions. Through a variety of programs and the generous support of notable alumni, we facilitate the translation of innovative engineering research into products and services that improve lives and drive economic growth.

Centre for the Management of Technology and Entrepreneurship

Established in 1991 in the Department of Chemical Engineering & Applied Chemistry, our Centre for the Management of Technology and Entrepreneurship (CMTE) is a research leader in communications technology for the Canadian financial services industry. Founded and led by Professor Emeritus Joseph Paradi, CMTE collaborates with financial institutions such as BMO Financial Group, Canadian Imperial Bank of Commerce (CIBC), Royal Bank of Canada (RBC), Scotiabank and TD Canada Trust to conduct research into next-generation financial technology. Its innovations enable businesses to stand out among competitors and ensure ongoing productivity improvements as well as customer satisfaction and loyalty. CMTE also delivers several entrepreneurship courses for engineering students, including six undergraduate and five graduate courses at the Faculty level. These courses continue to inspire our students to discover their entrepreneurial spirit and to become the innovative thinkers needed to solve the world's most pressing challenges.

1. As ranked by the Association of University Technology Managers in 2013

1953

George Klein (MechE 2T8) invents the world's first electric wheelchair.

1946

The first satellite campus is established in the town of Ajax, Ontario.

1945

U of T mechanical engineers Paul Dilworth (MechE 3T9) and Winnett Boyd (MechE 3T9) develop Canada's first all-Canadian jet engine.

The Entrepreneurship Hatchery

The Entrepreneurship Hatchery (the Hatchery), launched in 2011, enables students to realize their entrepreneurial ambitions. Envisioned as a "startup that creates startups," the Hatchery provides support at all stages of the journey from lab to marketplace, including mentorship and advice on issues related to intellectual property, product development and marketing. Support is provided by industry mentors and engineering leaders, and fabrication facilities are available to assist with prototyping.

The Hatchery runs the Hatchery Nest, which is dedicated to cultivating formative entrepreneurial skills, and the Hatchery Launch Lab, which provides support for research-based graduate and faculty-led startup companies. In addition to these programs, the Hatchery offers several professional-development events and workshops, including:

- Accelerator Weekend, a business ideation competition;
- The Idea Market, a networking event that enables entrepreneurially-minded students to meet and form teams;
- A year-round speaker series, which serves as a forum for leaders to connect with students and faculty in the Hatchery.

An Advisory Board and executive team of experienced entrepreneurs and academics continue to be instrumental in the success of the Hatchery and creating a strong entrepreneurial community within the University more broadly.

Kepler Communications

Developed out of the Hatchery and Start@UTIAS, Kepler Communications, co-founded by alumnus Mina Mitry (EngSci 1T2, UTIAS MASc 1T4), is an award-winning team that is leading the way in near-Earth telecommunications. The startup's goal is to create a network of nanosatellites that can relay information from larger sensing satellites to ground stations. The information transmitted through this orbiting system could enable safer air travel, more accurate detection of leaks in remote oil pipelines and even improved crop yields. Kepler has raised more than U.S. $5 million in seed funding and launched its first satellite in November 2017.

PhD student wins national entrepreneurship award

In May 2018, Natalia Mykhaylova (ChemE PhD 1T8), founder of WeavAir, was named the Student Entrepreneur National Champion by Canada's largest student leadership development organization, Enactus Canada. WeavAir builds on her innovative research (supervised by Professor Greg Evans [ChemE]) on the development of low-cost, portable detectors that can quickly report the levels of common air pollutants. Her startup is developing technology that could be integrated into current HVAC systems to save energy, improve indoor air quality and reduce costs. It will create both advanced sensors and the software needed to analyze the data, predict outcomes and adjust operation modes appropriately. Mykhaylova is also an alumna of The Entrepreneurship Hatchery, where she founded her first company, Cleanopy. (Courtesy: Enactus Canada)

1943

Skule™ is used to refer to the Faculty of Applied Science & Engineering for the first time, in a Skule™ Nite program.

1934

Frank Henry Ralph Pounsett (ElecE 2T8) designs the first car radio for General Motors Canada.

1927

Elsie "Queen of the Hurricanes" MacGill graduates as the first woman electrical engineer in Canada. MacGill builds a career as the world's first woman aircraft designer. In 2016, MacGill was recognized for her achievements and contributions and chosen as a finalist in the Bank of Canada's search for a "bankNOTEable" Canadian woman to feature on Canadian money.

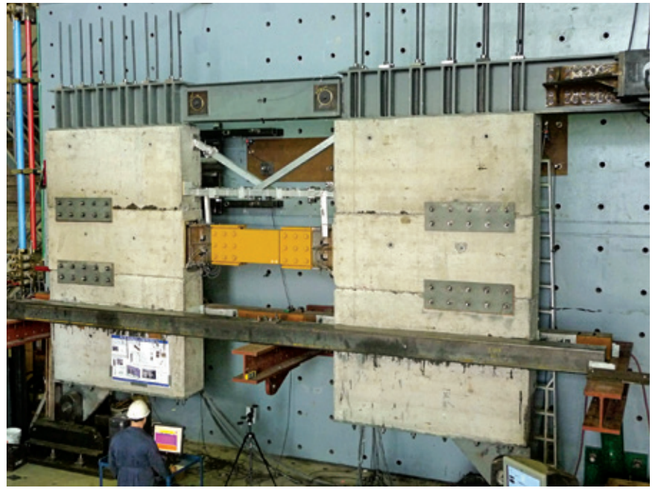
Wattpad

(Courtesy: Google)

As the world's largest community for readers and writers, Wattpad publishes stories that have become not only published books but also blockbuster movies and prime-time television shows. The Toronto-based storytelling app, co-founded by Allen Lau,[1] has evolved, from connecting its writers to publishers through its Wattpad Stars program to the recent launch of a Studios division that will support the creation of Wattpad-inspired entertainment. The app has 2 million monthly "storytellers" who are part of Wattpad's community.

This content originally appeared in Google's 2016 GO NORTH lookbook, a showcase of Canadian startups and entrepreneurship. Reproduced with the permissions of Vice Studio Canada Inc.

1. (ECE 9T1, ECE MASc 9T2)



Heffernan Commercialization Fellowships

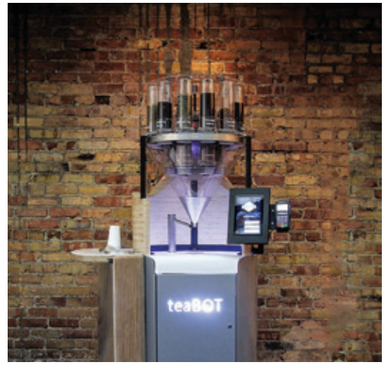
Founded by alumnus Gerald Heffernan (MMS 4T3), the Heffernan Commercialization Fellowships provide annual funding for up to three years to post-graduate fellows and new alumni to develop their research into working prototypes and to bring their ideas to market. From implanted seizure-detecting chips to seismic-resistant infrastructure, the Heffernan Commercialization Fellowships have been central to fostering entrepreneurial spirit within our Faculty and impacting the lives of thousands of people through the innovative ideas developed by our students. Since 1997, the Heffernan Commercialization Fellowships have directly contributed to the success of eight Faculty spinoff companies. Heffernan has contributed an additional $8 million toward fostering entrepreneurship at our Faculty since founding the Heffernan Commercialization Fellowships.

1925

The first "iron ring ceremony" for graduating engineers at U of T is conducted; prolific writer Rudyard Kipling pens the Ritual of the Calling of an Engineer in May 1922 for use during the ceremony, as commissioned by Professor Herbert Edward Terrick (H.E.T) Haultain.

1921

Edward S. Rogers Sr. enrols at our Faculty. Before his undergraduate degree is complete, he creates the first all-electric radio station and becomes the first Canadian amateur radio operator to transmit a signal across the Atlantic. In 2000, our Department of Electrical & Computer Engineering is renamed The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, in honour of the late Edward (Ted) Rogers Sr.



Above

teaBOT creates customized, robot-blended cups of loose-leaf tea, brewed in under 30 seconds. Its machines are deployed in Toronto and various cities in California. (Courtesy: teaBOT)

Opposite

Kinetica viscoelastic coupling dampers (yellow) are tested by applying forces to the two concrete slabs on either side of the damper. Kinetica is a U of T Engineering spinoff company founded by Michael Montgomery (CivE PhD 1T1) and Professor Constantin Christopoulos (CivE). (Courtesy: Kinetica)

Kinetica

Michael Montgomery (CivE PhD 1T1) and Professor Constantin Christopoulos transformed their research on viscoelastic damper technology to create seismic-resistant structures. Kinetica's innovative technology was incorporated into the YC Condos at the corner of Yonge Street and College Street in Toronto, which won High Rise Project of the Year Award at BILD GTA in 2015. Additionally, as part of the Ontario government's trade mission agreement with China in 2015, Kinetica signed a deal to distribute its products to the country.

Start@UTIAS

In 2014, University of Toronto Institute for Aerospace Studies alumnus and entrepreneur Francis Shen (UTIAS MASc 8T3) committed $1 million to establish an entrepreneurial incubation program at UTIAS. Start@UTIAS encourages graduate students to apply their knowledge and skills to create a startup company. Each team includes at least one founder who is a UTIAS student, alumnus or alumna. The program provides aspiring entrepreneurs with mentoring, network opportunities and seed funding.

teaBOT

Co-founded by UTIAS PhD candidate Rehman Merali, teaBOT sells robot-blended, customized cups of loose-leaf tea. The startup received support from a number of accelerators, including Start@UTIAS, where Merali worked directly with alumnus Francis Shen to refine the business plan. The company operates on two models: retail and office. The retail model involves installing a teaBOT in a public space, such as a library, shopping mall or hotel lobby. Companies can lease the machines for office use and pay for refills of the tea cartridges. As of 2017, teaBOT is operating in six locations across North America, including the University's Gerstein Library and the 365 by Whole Foods Market in the Silver Lake neighbourhood of Los Angeles.

Nanoleaf

How a trio of self-proclaimed "tree-huggers" created a funky-looking light bulb that's now illuminating the global LED residential lighting market.

Above

Aurora panels, cost $0.39 to power over an entire year. (Courtesy: Google)

- A Nanoleaf bulb will last 20 years.
- The Canadian government invested $2.9 million in Nanoleaf.
- There are 33 omnidirectional LED lights in a Nanoleaf Bloom bulb.

Ask a major company to design a better light bulb and they might come back with a method for producing cheaper filaments. Ask three Canadian guys in a garage for a better light bulb, and they could end up revolutionizing a multi-billion-dollar industry.

Gimmy Chu, Tom Rodinger and Christian Yan are the founders of Nanoleaf, a company specializing in distinctively designed smart lighting systems. Their flagship product, the Nanoleaf One, is a 3D-printed circuit board mounted with LEDs and folded, origami-style, into a dodecahedron bulb. While your typical incandescent bulb needs 100 watts to generate 1,600 lumens, Nanoleaf does it in 12. It turns on instantly, plugs into a standard fixture and lasts for 30,000 hours of usage. Widely reported as having the world's most energy-efficient light bulb, Nanoleaf's been responsible for diverting over 700 million pounds of carbon dioxide away from the atmosphere. Not bad for three self-proclaimed "tree-huggers" without lighting-design backgrounds.

Chu, Rodinger and Yan first met in 2005 as engineering students at the University of Toronto, where they were members of the school's solar car team. The trio went their separate ways after graduation, but kept in touch through regular conference calls in which they challenged one another to keep solving pressing societal problems using green technology. Eventually, the group set their sights on residential lighting, and realized that a unique configuration of LEDs could make for a far more energy-efficient light bulb. Voila, the Nanoleaf bulb was born.

When Nanoleaf's (then called NanoLight) first Kickstarter campaign launched in 2012, the team blew past their initial $20,000 goal, raising $273,278. Then, a second Kickstarter, for a dimmable version of the bulb, raised $192,973—over six times their goal. They promptly quit their jobs and moved to Shenzhen, China, to develop Nanoleaf full-time. Nanoleaf eventually received major investment from billionaire Li Ka-shing (Hong Kong's richest man), Kleiner Perkins and Christopher Burch (co-founder of lifestyle brand Tory Burch), and the company opened offices in Shenzhen and Hong Kong. Nanoleaf moved back to its hometown of Toronto in 2015, eventually snagging its own headquarters downtown to take advantage of the area's tech-industry concentration.

As a company, Nanoleaf prides itself on an inquisitive, human-centred mentality. Nanoleaf designers don't set out to build a product: they seek to solve a consumer problem, and constantly beta-test. Case in point: Nanoleaf's Toronto office is located above a Second Cup coffee-chain franchise, and designers will often run down to ask customers for opinions on their latest prototype. "A coffee costs us two dollars," says Chu, "and we get such amazing, invaluable feedback."

This grassroots design approach has helped the company sprout several exciting new product lines: Nanoleaf Aurora, launched in October 2016, will be the world's first connected, modular LED light panel system. Aurora panels can be snapped together in unique patterns, and the lights' colour and brightness can be controlled by smartphones—Chu jokingly suggests that users consider setting theirs to "Netflix and chill."

Nanoleaf continues to flourish, but its three founders see no need to relocate their Toronto office. Chu cites the Canadian government's Scientific Research and Experimental Development tax credit, which returns 40% of a company's total research and development spending as an incentive for inspiring home-grown tech innovation. There's also a wealth of talent: "In Toronto, we have 10,000 engineers graduating every year," notes Chu, "It's a huge pool of really brilliant minds, from some of the world's best universities. We also have an incredibly diverse and creative design community. Why would we want to go anywhere else?"

This article originally appeared in Google's 2016 GO NORTH lookbook, a showcase of Canadian startups and entrepreneurship. Reproduced with the permissions of Vice Studio Canada Inc.

Gimmy Chu (ElecE 0T6), Christian Yan (ElecE 0T6)

Faculty spinoff companies

A number of our alumni and faculty members have developed innovative spinoff companies through their research. Many of these have been successful on a national and international scale, addressing some of the world's most complex challenges. This is evident in the breadth and depth of the companies' expertise and successes.

Between 2000 and 2017, Faculty spinoff companies included:

Aerovelo

Aerovelo pushes the boundaries of human-powered vehicle design. It captured the Sikorsky prize for the longest sustained flight of a human-powered helicopter and has twice surpassed its own record for the world's fastest bicycle. Aerovelo was founded by alumni Todd Reichert (EngSci 0T5, UTIAS PhD 1T1) and Cameron Robertson (EngSci 0T8, UTIAS MASc 0T9).

Cast ConneX

Cast ConneX designs steel castings that strengthen new and old buildings for earthquake resistance. It was founded by faculty members Jeffrey Packer and Constantin Christopoulos from our Department of Civil & Mineral Engineering and alumni Michael Gray (CivE PhD 1T1) and Carlos de Oliveira (CivE MASc 0T6). The spinoff has designed steel cast nodes and brace end connectors for the Transbay Center in San Francisco, California, and a retractable roof for the Arthur Ashe Stadium in Flushing, New York.

ChipCare Corp.

ChipCare Corp. created a portable, user-friendly platform to conduct tests for diagnosing, monitoring and screening for infectious diseases such as HIV. It was launched by Professor Stewart Aitchison and James Dou (ECE MASc 0T7), from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering.

Deep Genomics

Deep Genomics is building a data and AI-driven platform that supports geneticists, molecular biologists and chemists in the development of gene therapies. Deep Genomics was founded by Professor Brendan Frey of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering. In 2017, the company raised $13 million from a Silicon Valley venture capital firm to fund the expansion of the company.

1919
A plot of land at Gull Lake in Ontario is purchased by the University of Toronto for our Faculty. It is the country's first off-campus teaching facility for the study of surveying, opening its doors in 1920. Known by students and alumni as Survey Camp, it continues to be used by our civil and mineral engineering students and faculty for the practical education of root surveying and topographic mapping.

1912
Analytical and applied chemistry student Hildegarde E. Scott becomes the first woman to graduate from the Faculty of Applied Science & Engineering.

1911
Toike Oike is first published as an election paper; it later evolves into a student humour paper still in existence more than 100 years later.

Above

The Nymi™ Band, pictured on the right hands of the researchers, is a wearable, multi-factor authenticator that can be used with any application, device or service. (Courtesy: Nymi™)

Interface Biologics Inc. (IBI)

IBI develops transformative biomedical polymer technologies that improve the safety and effectiveness of medical devices. The spinoff has 17 U.S. patents issued and licensing agreements with several medical device manufacturers. The company was founded by Professor Paul Santerre of our Institute of Biomaterials & Biomedical Engineering (IBBME).

InVisage Technologies

InVisage produces QuantumFilm, an image sensor technology that improves the quality of digital photographs taken with a cell phone camera. The company was founded by Professor Ted Sargent of The Edward S. Rogers Sr. Department of Electrical & Computer Engineering. The company was acquired by Apple in 2017.

ModiFace Inc.

ModiFace Inc. creates augmented reality technology for beauty brands. Established by Professor Parham Aarabi from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, ModiFace technology has been adopted for at-home makeup testing by global-beauty brand Sephora, among others. The company was acquired by French cosmetics giant L'Oréal in 2018.

Nymi™

Nymi™ is the world's first biometric wearable authentication system, launched by Foteini Agrafioti (ECE MASc 0T9, ECE PhD 1T1) and Karl Martin (EngSci 0T1, ECE MASc 0T3, ECE PhD 1T0).

OTI Lumionics Inc.

OTI Lumionics Inc. develops organic light-emitting diode (OLED) technology for flexible lighting and displays. It was created by alumni and faculty in our Department of Materials Science & Engineering, including Michael Helander (EngSci 0T7, MSE PhD 1T2), Zhibin Wang (MSE MASc 0T8, PhD 1T2) and Professor Zheng-Hong Lu.

Xagenic Inc.

Xagenic Inc. has developed an easy-to-use, lab-free molecular diagnostic platform that delivers results in 20 minutes. The company was co-founded by Professor Ted Sargent from The Edward S. Rogers Sr. Department of Electrical & Computer Engineering.

1909
Civil engineering student Harry Tate graduates. He goes on to play a leading role in the development of the Toronto Transportation Commission and Canada's first subway line.

1906
The Faculty of Applied Science & Engineering is established within the University of Toronto. John Galbraith is appointed the first dean.

1885
The Engineering Society is formed. John Galbraith, then a faculty member, serves as the first President, through four terms.

1873
The Ontario School of Practical Science, the precursor to our Faculty, opens its doors as the first engineering school in Ontario.

THE SKULE™ EXPERIENCE

CHAPTER

3

The Myhal Centre's Level 0 is home to The Engineering Society Arena, which houses flexible facilities that directly serve the requirements of most of the 100-plus student clubs functioning within the mandate of the Engineering Society. This is a unique glimpse of Level 0 before it was first populated by student clubs in summer 2018. (Photo: Daniel Ehrenworth)

Previous spread

Kate Lonergan (MechE 1T6+PEY) is one of many engineering students who are also Varsity athletes. Outside of their academic pursuits, engineering students passionately pursue their interests through extracurricular sports, clubs and teams. (Photo: Roberta Baker)

Our Faculty's record of excellence, inclusive environment and strategic outreach and recruitment initiatives have enhanced diversity among our students and within the engineering profession. Through educational and experiential events for prospective students of all ages, we ensure engineering innovation continues to thrive in Canada and around the world.

Making a difference

Outreach is a longstanding priority for our Faculty. In 2009, the Faculty created the Engineering Outreach Office to administer and support the delivery of our core outreach programs. It is our central unit for outreach activities promoting science, technology, engineering and math (STEM) education to several key audiences, including pre-university students and members of communities currently underrepresented in our profession.

Community outreach and impact

The Engineering Outreach Office (EOO) designs and delivers a range of pre-university programs that engage students from grades three to 12 in STEM. EOO also increases awareness of the role of engineers in society and inspires students to consider a career in engineering as a way of making a positive impact in the world. Each year, programs delivered by EOO engage more than 10,000 pre-university students from the Greater Toronto Area (GTA) and across Canada.

Outreach programming

Our flagship Da Vinci Engineering Enrichment Program (DEEP) is a unique summer program designed to provide highly motivated high school students from across the world the opportunity to experience a variety of engineering, technology, business and science disciplines through a hands-on curriculum. It includes four programs: DEEP Summer Academy for high school students, Jr. DEEP and Girls' Jr. DEEP summer day programs, and Saturday programs for students in grades three to eight.

ENGage, a collaboration with the Faculty's chapter of the National Society of Black Engineers (NSBE), highlights Black role models, encourages STEM literacy and promotes academic and social growth. Running throughout the summer, the program enables students from grades three to eight to develop leadership skills, engage in design projects and engineering science experiments, gain an appreciation of a diverse array of academic career options and participate in sports in a supportive environment. Many of the engineering-oriented classes are taught by our NSBE students.

Girls' Leadership in Engineering Experience (GLEE) is a weekend-long program that empowers and inspires female engineering applicants by connecting them with the dean, program chairs, professors, alumnae and current students to learn about diverse experiences of studying and working in engineering. The applicants stay overnight in a University residence to gain a firsthand glimpse of life at Skule™.

In the 2016–17 and 2017–18 academic years, we welcomed a first-year undergraduate class that was more than 40 per cent women—a Faculty record. We have worked passionately to promote engineering as a career path for young women and increase gender diversity in our first-year classes each year.

Go ENG Girl is another example of this outreach. The annual event, presented in partnership with the Ontario Network of Women in Engineering, invites girls in grades seven through 10 who are interested in engineering to a day-long symposium with female leaders in industry. Students are given the opportunity to participate in fun, hands-on projects and to speak to industry leaders and representatives. Current engineering students also share their experiences with participants.

In May 2017, EOO hosted the second GO NORTH (formerly InnovateU) event, Canada's largest STEM event for children in grades three to eight. This one-day celebration of STEM was created in partnership with Google Canada and Actua, a national STEM charity. More than 1,200 students and their teachers were invited to engage in activities during which they engineered, built and created their own innovations and technology—on topics ranging from robotics and genetics to roller coasters and video games. Classes from across the GTA explored below the surface of today's tech, including smartphones, 3D printers and solar cars, to understand how they work—all while experiencing the University environment in a fun and accessible way.

The EOO also creates STEM programs to present to teachers and elementary and high school students. In February 2016, four full-day workshops attracted nearly 350 elementary school teachers from the Toronto District School Board to learn how computer coding can help them teach subjects from mathematics to literacy. EOO also shares teaching strategies with elementary and high school teachers for incorporating STEM topics into lesson plans. The ultimate goal of these workshops and activities is to encourage youth to consider a post-secondary education in one of the STEM disciplines. The programs also provide important opportunities to undergraduate students who create and deliver them, as they develop key competencies in project management, communication and engineering education.

Indigenous reconciliation

Alongside the University, our Faculty is committed to finding ways to engage Indigenous youth in STEM. In May 2016, a team of U of T volunteers—including engineering student Yonatan Lipsitz (IBBME PhD candidate)—partnered with Sandy Lake First Nation in Northern Ontario to deliver a series of STEM workshops. Both children and adults in the community took part in science and engineering activities, including learning about the night sky in an astronomy workshop. The project has been running since 2001 and is delivered through Let's Talk Science, a national organization that connects graduate students and youth in STEM.

Top

Prime Minister Justin Trudeau, centre, speaks with elementary school students who spent the day designing neighbourhoods of the future at a workshop organized by U of T Engineering Outreach. The project was part of an announcement by Waterfront Toronto and Sidewalk Labs to design a new model of a mixed-use, complete community on Toronto's Eastern Waterfront. (Photo: Roberta Baker)

Bottom

Dean Cristina Amon, centre, engages with elementary students participating in one of the Faculty's outreach programs. Under the leadership of Dean Amon, our Faculty has increased the number and diversity of programs offered to ensure that students of all backgrounds have the opportunity to ignite their love of science, technology, engineering and math. (Photo: Roberta Baker)

A commitment to Indigenous education

Following Canada's Truth and Reconciliation Commission (TRC) call to eliminate educational gaps between Indigenous and non-Indigenous peoples, the University of Toronto commissioned a report in 2017, entitled Answering the Call: Wecheehetowin, which called on the University community to take action in six key areas: Indigenous spaces, Indigenous faculty and staff, Indigenous curriculum, Indigenous research ethics and community relationships, Indigenous students and co-curricular education, and institutional leadership and implementation.

In response to Answering the Call, our Faculty created the Eagles' Longhouse: Engineering Indigenous Initiatives Steering Committee in March 2017. The steering committee was composed of members from across our Faculty and the Oneida Nation, which provided strategic guidance through a Blueprint for Action by engaging Indigenous representatives and engineering educators. The recommendations presented to the Faculty by the steering committee provided immediate and ongoing actions to enrich the relationship between the Faculty and Indigenous communities, including facilitating greater integration of existing outreach, recruitment and retention initiatives, both within the Faculty and across the University.

Additionally, in summer 2016, Rachel Mandel, from our Department of Mechanical & Industrial Engineering, was one of 12 students from across Canada who was selected to deliver STEM workshops through the National Indigenous Youth in STEM (InSTEM) program. Developed and run by Actua, InSTEM is a customized, community-based approach to engage First Nations, Métis and Inuit youth in locally and culturally relevant STEM education programs. Mandel and her teammates travelled more than 8,000 kilometres, visiting Indigenous communities in Nunavut as well as the Six Nations of the Grand River in Ontario. The workshops covered diverse topics, including Arctic ecology, computer programming and the use of unmanned aerial vehicles in the mining industry.

We continue to collaborate with the University's First Nations House and with Indigenous peoples and communities to ensure a welcoming, supportive and inclusive environment for students, faculty and staff.

Student-led initiatives

Many of our students participate in national and international organizations that seek to improve quality of life for people around the world. A number of these organizations have been successful and influential in increasing diversity and inclusivity in the engineering profession.

Co-curricular experiential learning

Our Faculty is known for its vibrant student life. With more than 100 student-run clubs, teams and organizations—from Women in Science and Engineering (WISE) to Blue Sky Solar Racing to the Engineering Society—we offer countless co-curricular opportunities for undergraduate students to gain experience in leadership, volunteerism, design, teamwork and much more. Students can document these activities in their U of T Co-Curricular Record (CCR), an official document that recognizes competencies gained through athletic teams, student government, cultural clubs, design teams, work/study opportunities and more.

Right

Elder Cat (Mark) Criger, left, and a Jr. DEEP camper, right, participate in a camp-wide smudging ceremony on U of T's St. George Campus. (Photo: Engineering Outreach Office)

Student clubs and teams

Our Faculty's student clubs and teams enable students to pursue their passions and interests, engage with and compete alongside peers across the Faculty, University and around the world, while developing competencies in leadership, communication and teamwork.

Engineers Without Borders

The University of Toronto chapter of Engineers Without Borders (EWB UofT) leverages engineering creativity and design toward creating systemic change in Canada and Sub-Saharan Africa. EWB UofT engages with communities around the world and at home, with a year-long curriculum on global development to educate students, the opportunity to apply findings to solutions-based projects and leadership-mentorship program opportunities. The chapter has four key project areas—evolving engineering, political advocacy, youth engagement and equitable food systems—as well as the Project Incubator, through which individuals can pitch for funding and project management support for an initiative that aligns with the larger organization's ideas.

Women in Science and Engineering

The University of Toronto's chapter of Women in Science and Engineering (WISE) supports and empowers women to recognize their potential as leaders in engineering. With major partners, donors and industry affiliates, WISE has become a network for students in engineering and strives to support them throughout their pre-university endeavours, undergraduate and graduate degrees and careers. To develop leadership skills, confidence and involvement in research and technology, WISE focuses on building a supportive community through five initiatives: professional development, mentorship, high-school outreach, community outreach and the WISE National Conference, which was revitalized by students in 2013. In January 2017, WISE celebrated its fifth annual conference with delegates from over 15 Canadian universities and colleges in attendance. Attendees gathered in Toronto to listen to speakers from Ladies Learning Code and Shopify, among others. WISE also runs mentorship programs, networking events and other community outreach initiatives throughout the year to ensure women continue to realize their full potential.

Blue Sky Solar Racing

Blue Sky Solar Racing is an engineering student-run team promoting the adoption of sustainable technologies by designing, constructing and racing world-class solar-powered vehicles. Since the team was founded in 1997, Blue Sky Solar Racing has engineered nine vehicles that have competed in more than 10 international competitions. The team's eighth-generation vehicle, Horizon, finished third overall at the American Solar Challenge in 2016. Its latest design, Polaris, finished 11th at the Bridgestone World Solar Challenge, a rigorous 3,000-kilometre race across the Australian outback that attracts the most competitive teams from around the globe. Our Blue Sky Solar Racing team exemplifies our students' capabilities in innovatively implementing sustainable technologies under strict design parameters.

Federal Minister of Science, Kirsty Duncan, left, watches a drone demonstration with elementary school students at the 2018 GO NORTH event. Organized by the U of T Engineering Outreach Office, Google and Actua, this massive one-day STEM event brings 1,400 elementary school students to U of T's St. George campus each year. (Photo: Laura Pedersen)

“ Through curricular, co-curricular and experiential learning opportunities, our students develop the ability to succeed and lead in a rapidly changing engineering world. When students pursue the learning experiences that resonate most strongly with them personally, it deepens their engagement and motivates them to maximize their contributions.”

– Cristina Amon, Dean

Members of the Blue Sky Solar Racing team with their vehicle Horizon. Every two years the multidisciplinary student team designs, builds and races a solar-powered car more than 3,000 kilometres across the Australian outback powered only by the sun. (Courtesy: Division of University Advancement)

The Ritual of the Calling of an Engineer

In 1922, seven former presidents of the Engineering Institute of Canada decided that engineering graduates should recite an obligation upon completion of their studies. This group became the original governing body of the Corporation of the Seven Wardens that governs the Camps.

Included in the group of former presidents was Herbert Edward Terrick (H.E.T) Haultain, an early graduate of civil engineering from the School of Practical Science (SPS), and a former professor of mining engineering in our Faculty. Haultain contacted English poet Rudyard Kipling, who agreed to pen The Ritual of the Calling of an Engineer, which is still recited in 21st-century Iron Ring ceremonies. The Iron Ring is conferred upon individuals who have graduated from an accredited Canadian engineering program and is worn on the pinky finger of the engineer's dominant hand. It is the symbol of having taken the pledge, and a reminder of the standards of integrity, responsibility and professional conduct expected of an engineer.

The faceted ring was originally forged from wrought iron but is now made of stainless steel, although graduates in Camp One, to which the University of Toronto belongs, can still opt for a ring made of wrought iron. Two enduring rumours suggest that the first iron rings were fabricated in Haultain's laboratory in the Mining Building, and that the iron used to create the rings came from remnants of the first Quebec Bridge, which collapsed during construction in 1907.

The Ritual of the Calling of an Engineer takes place in a private ceremony. While it is not considered a secret event, attendees are advised not to speak of ceremony details to the public. This privacy is meant to convey the seriousness and honour of the obligation. The inaugural Iron Ring Ceremony was held at the University Club of Montreal in 1925. Soon after, the University of Toronto administered the obligation to 14 members of the Engineering Alumni Association, thus creating the first chapter of the Corporation of the Seven Wardens.[1] Forty Canadian schools, organized into 26 Camps, now bestow Iron Rings on their graduates.

[1]The Corporation of the Seven Wardens is the governing body that holds the rights and the duty to carry out The Ritual of the Calling of an Engineer in Canada. It is organized into 26 regional Camps, which are numbered by the year they were established. The term "camp" is used to convey a close-knit community among engineering students and alumni.

The evolution of Skule™

Our longstanding undergraduate student traditions span generations. They inspire vibrant co-curricular activities and bring engineering students together to form memories, friendships and experiences that last a lifetime.

The story of Skule™

"Skule™," refers to our engineering-student community at the St. George campus, and is used in place of "School," which was a short form students used for the SPS. The name persisted after appearing in a 1943 School Night variety show program (known thereafter as Skule™ Nite). Many people refused to use the new spelling, believing it was degrading to the SPS, even after the name was changed to the Faculty of Applied Science & Engineering in the early 1900s. School was used for more formal occasions, until 1967 when the Little Red Schoolhouse (then called the "Little Red Skulehouse") was demolished, and ties to the Faculty's origins were less apparent.

The Engineering Society trademarked Skule™ in 1984, preserving the term and its history for the Faculty.

Ye Olde Skule™ Traditions

Fostering a rich student experience has been a cornerstone of our Faculty since its inception. Social engagement and mentorship are critical in educating and inspiring future engineering leaders. With this mission in mind, students at the School of Practical Science (SPS) founded the Engineering Society in 1885.

The Engineering Society began with four key objectives, as cited in its constitution: to encourage original research in the science of engineering; the preservation of the results of such research; the dissemination of these results among its members; and the cultivation of a spirit of mutual assistance among the members in the practice of the profession of engineering. More than a century later, the Engineering Society has become a fixture in the lives of many engineering students and in sustaining a culture of excellence within our Faculty.

In time, as Faculty enrolment numbers grew, the Engineering Society created department-specific clubs, eventually known as Discipline Clubs, designed to provide academic support and experiences tailored to each student. Many Skule™ traditions have roots in the Engineering Society, with each event and custom fostering distinct Skule™ spirit. Student-organized traditions have been passed on by generations of undergraduates, contributing to our tightly knit global alumni community.

The Skule™ Trinity

Comprised of Ye Olde Mighty Skule™ Cannon, the Lady Godiva Memorial Bnad and the Brute Force Committee, the Skule™ Trinity can be found at many Skule™ events.

Ye Olde Mighty Skule™ Cannon

The Cannon has been a symbol of Skule™ spirit for over 100 years. Prior to the commissioning of an official Skule™ Cannon in 1936, there were many variations of the coveted mascot in the Faculty's history: it was recorded that SPS students stole a cannon from the Military Institute between 1899 and 1900; one of the two Hart House cannons was fired as part of a prank in 1929; and in the late 1920s and 1930s, student-engineered cannons appeared at Skule™ events. It is noted that in 1936, W.H. Kubbinga, a machinist in our Department of Civil Engineering, was unofficially approached to build the first official Skule™ Cannon. This cannon was called "Mark I." Kubbinga also created the second rendition of the Cannon in 1949, referred to as "Mark II."

Skule leather jackets are personalized with patches (pictured) to reflect a student's year, discipline of study and involvement in curricular and co-curricular activities. (Photo: Roberta Baker)

Toike Oike, Toike Oike
Ollum Te Chollum Te Chay
School of Science, School of Science
Hurray, Hurray, Hurray!

– The Skule™ Yell

" The countless number of opportunities that Skule™ has to offer really allows students to feel like they are part of something bigger than themselves."

– Shivani Nathoo (EngSci Year 4), Engineering Society President, 2018-19

Over the years, many other cannons have been built, stolen by other faculties and colleges, lost, won and replaced. Most recently, the Cannon was rebuilt in 2013 and fired for the first time during "F!rosh Week" the same year. The Cannon is guarded by a group of trained students, the Cannon Guards, headed by the Chief Attiliator (or Cannoneer), who is also responsible for the maintenance of the Cannon.

The Lady Godiva Memorial Bnad

First organized in 1949 with 15 members, the Lady Godiva Memorial Bnad (LGMB) quickly grew to include more than 250 members. The ability to play an instrument is not a requirement for becoming a LGMB member, nor do members need to be able to read music—a willingness to learn and listen to the "Bnad Leedur" is the only prerequisite.

The LGMB has played at several notable events such as Expo 67 in Montreal, the opening of the Bloor-Danforth subway line in 1966, the opening of the CN Tower in 1976 alongside Prime Minister Pierre Trudeau and Margaret Trudeau and the inaugural operation of the Sheppard subway line in 2002. The LGMB has also been invited to march in the Toronto Santa Claus Parade every year since 2007, after years of "unofficially" playing the event.

The Brute Force Committee

If the Brute Force Committee (BFC) existed, it would be the secret society behind elaborate "installations" on U of T campuses, executing technical and challenging feats to entertain people. The BFC could be led by an entity named "Mario Baker," and might have members with designations such as, "Ryes Over Rums," "Smoke and Mirrors" or "Delayed Eruptions," but their true identities would never be revealed. It is likely that other universities are home to similar secret societies, and these organizations would compete against each other for the most difficult and complex pranks.

Other celebrated traditions

In addition to the Skule™ Trinity, other engineering traditions are celebrated—some with roots originating in the early years of the SPS.

The Skule™ Yell

Much like today, the student body at the SPS was spirited and proud of their education, and they wanted a way to convey that pride. A small group of students from the class of 1898 created what is known as The Skule™ Yell.

In addition to the yell, a school song emerged to mark the occasion of the Royal Convocation of the Duke of York in 1901 when the monarch, who was crowned King George V of England in 1910, was bestowed an honorary degree. Many musical groups formed within the community in the years that followed, including the LGMB, the Toike Oikestra, the Schoolhouse Four and the SPS Octet.

Skule™ Papers: *Toike Oike* and *The Cannon*

Since 1911, the Engineering Society has published a student paper. The original, the *Toike Oike*, began as a hard news source to communicate timely Skule™ issues, particularly around Engineering Society elections. By the mid-1950s, the *Toike Oike* took a turn toward the comic and the need for an official engineering student newspaper emerged. *The Cannon* was created in 1978, catering to Society news, and the education and technical activities of the Faculty and University.

Legend has it that the name of the paper originated from a caretaker in the Little Red Schoolhouse, Graham, who had a thick Irish accent. "Toike oike" is the phonetic spelling of how Graham pronounced "Take a hike," as he instructed students to leave the building for the day.

Left

Godiva's Crown, Lia Codrington (EngSci Year 2), walks behind the Blue and Gold Committee float at the 2017 Toronto Pride Parade. Each year, the Blue and Gold Committee designs and builds a float to celebrate the LGBTQ+ community. (Courtesy: University of Toronto Engineering Society)

Why Bnad?

According to Skulepedia.ca, "the use of the term bnad is a reference to the inability (or unwillingness) of engineers to spell correctly."

What does it mean to get "Toiked"?

As the last page of the *Toike Oike* is printed in black ink only, students sometimes find themselves with black fingertips from the newsprint. If a engineering student suddenly appears and rubs this page on a another engineering student's face, to transfer the ink to their skin, the engineering student has been "toiked."

Skule™ dances: Cannonball and Gradball

Cannonball, the annual Engineering Society's semi-formal dance, began as a tradition at the Ajax campus in 1945, where social events were the heart of the academic community. Originally named the Engineer's Ball, the event was renamed Cannonball in 1955. Cannonball takes place at the conclusion of Godiva Week in January of each year. Since the 1990s, the LGMB has made an appearance at the event, and the newly elected Godiva's Crown and Mr. Blue & Gold share the first dance.

Gradball, the annual Engineering Society formal founded in 1960, celebrates the graduating class of each year. It is typically held the weekend after the Iron Ring Ceremony. All students in the Faculty are invited to attend to build Skule™ spirit. At the formal, the Skule™ Cannon makes an appearance, as well as the LGMB. A custom of the latter, the "Joonyur Bnad Leedur" and "D(r)umb Miner" are inaugurated as Bnad Leedur and "D(r)umb Majur(k)" at Gradball; and the Chief Attiliator—the caretaker of the Skule™ Cannon for that year—is revealed.

Many alumni who attended these formal balls will fondly recall the fine efforts of Professor Emeritus and former Faculty Curator L.E. (Ted) Jones. In the 1970s and 1980s, Professor Jones worked with the Engineering Society and student organizers to gracefully educate students on the expected rules of etiquette with respect to formal dining and dress, which added to the tremendous success and enjoyment of these unique and treasured events.

F!rosh Week

The tradition of F!rosh Week was established early in the Faculty's history to initiate engineering first-year students. F!rosh initially began as a day of initiation during the first week of classes, followed by a banquet. It eventually evolved into a week of events that build camaraderie and a sense of community among engineering students. F!rosh Week continues to be about good-natured fun, including the annual Havenger Scunt and The Hardhat Oath. Historically, first-year students have had the option to be dyed purple and to take part in good deeds and fundraisers around the city, such as Shinerama and Charity Buskerfest.

Godiva Week

Lady Godiva, an 11th-century historical figure, is heralded as the patron saint of engineers. Engineers relate to Lady Godiva's story of self-sacrifice for the betterment of society, and students honour and celebrate her spirit in early January each year, with a week of festivities in her name. The Godiva Week traditions include hard hat decorating competitions, as well as the Mr. Blue & Gold and Godiva's Crown competitions, which elect two students who embody Lady Godiva's selflessness and creativity; Mr. Blue & Gold and Godiva's Crown are both required to welcome incoming students the following fall. The week culminates in the annual engineering semi-formal, Cannonball. Other events that take place during Godiva Week include the Charity Car Smash, the Charity Auction, Godiva's Quest and Godiva's Resurrection.

Members of the Lady Godiva Memorial Bnad (LGMB) play music on U of T's iconic front campus. The LGMB is a student-led marching band that has been part of Skule™ tradition since 1949. (Photo: Roberta Baker)

Godiva's Hymn

Godiva's Hymn, sometimes called the Engineer's Hymn, has its roots in the U.S. Army Corps of Engineering. Different versions of the hymn exist at engineering faculties across North America. U of T Engineering students typically sing Godiva's Hymn at the appearance of the Skule™ Cannon and first-year students have the option to learn the hymn during F!rosh Week. In 2015 and 2017, the Engineering Society in collaboration with our Faculty, organized a contest calling for three new verses to Godiva's Hymn that better reflect contemporary values such as the rich diversity of the Skule™ community. Three students were chosen as the winners of the 2017 competition. Their winning entries are as follows:

At F!rosh Week does it all begin, with cheers and purple dye,
And then before you know it we've returned from PEY.
We made it through the many years with blood and sweat and tears,
Though time may pass we shan't forget—I am an engineer!
—Calvin Huynh (Year 2 MSE) (winning verse)

Among the great traditions that our dearest Skule™ does hold,
There is one in particular that is quite small but bold.
The Cannon when it blows it does make such a mighty clatter,
Thus the moral of the story is that size doesn't always matter!
—Eden Gough (Year 3 MIE)

"Who are, who are, who are," you ask, "Those people over there?
In blue hardhats and sunglasses, I just can't help but stare."
We'll tell you, "They bring spirit up, through pranks and switcharoos"
But mention them again to us, and we'll respond with "who?"
—Mackenzie Seward (Year 1 EngSci)

Ye Grande Olde Chariot Race

The origins of the Skule™ chariot races date back over 110 years, when the Engineering Society election night was a much-anticipated social event. Students would balance themselves on chamber pots threaded with towropes and a team of their peers would pull them around the drafting room of the Little Red Schoolhouse. During the war years, these old-style chariot races changed and were revived in 1947, in a new, larger, outdoor format. The chariot race now takes place annually during Godiva Week, where discipline teams push or drag one-person chariots, creatively constructed from recycling bins, wheelbarrows and barrels, for one lap around front campus while trying to sabotage other teams and making their best attempt at capturing the grease pig, played by an engineering student. Since 1949, the winning team has been awarded the Jerry P. Potts Memorial Trophy to commemorate its accomplishment.

Why purple?

According to legend, from the mid-19th to the mid-20th century, members of the British Royal Navy's Engineering Corps were identified by purple armbands on their uniforms. At sea, the salty ocean water often caused the dye of the armbands to bleed, seeping into the skin and dying an engineer's arm purple. In the event of a vessel sinking, the engineers most often remained on board until the last possible second, attempting to help in any way they could, and in many cases, they went down with the ship. The tradition of dyeing first-year engineering students this rich shade is to honour the sacrifices made by the engineers of generations past and to demonstrate the students' dedication to the profession.

Above

Skule™ Nite 1T2 cast performs at Hart House Theatre. Skule™ Nite 1T2 was directed by Jonathan (Jonny) Sun (EngSci 1T1+PEY), who is a well-known internet personality and author. Skule™ Nite is an annual musical-comedy produced by the Engineering Society and is directed, written, produced and created by engineering students. (Photo: Billy Wong)

Suds

Suds operates every Friday during the school year in the Sandford Fleming Building basement. Once Suds managers pull out the bar for the evening, a popular common area for students, called "The Pit," turns into a lively social space. Some might remember Suds as the Sandford Fleming Pub or the Duke of Skule™, before its prevailing name was created in 1984.

The Skule™ leather jacket and coveralls

Students who complete their first year of engineering have earned the right to purchase leather jackets and coveralls to show their Skule™ spirit. At the time of purchase, students are encouraged to personalize their jackets, with badges, their discipline and graduation year as well as other insignia to represent their Skule™ experiences and extracurricular involvement.

Skule™ Nite

Skule™ Nite is a musical and comedy show organized by engineering students. The first Skule™ Nite (then spelled School Night), entitled Ngynyrs in SPaSms, took place in March 1921 at Massey Hall, with overwhelming success, and the event maintained popularity until the mid-1960s. As a tribute to the Faculty during its 100th-year celebration in 1973, Skule™ Nite resumed for one night with a sold-out show. Due to the success of the show, the tradition was revived. Performances take place in March each year, often with sold-out shows. Additionally, during F!rosh Week, Skule™ Nite actors and actresses perform a short sketch. In 2012, the performance "The Worst Test" was recorded and received upward of four million views on YouTube.

Engineering Athletics Association

Athletics were an important component of Skule™ as early as 1901 and continue to be a popular extracurricular activity for many students today. With the motto "Nerds by Day, Players by Night" imprinted on their T-shirts, our Engineering Athletics Association (EAA) organizes interdisciplinary and University-wide intramural sports for engineering students. EAA offers several women's, men's and co-ed sports, including rugby, volleyball, hockey, football, basketball, flag football, water polo and soccer.

For more information about Skule™ traditions, the following resources are available: *Skulepedia.ca, A Century of Skill and Vigour* by Barry G. Levine, *The Skule Story: The University of Toronto Faculty of Applied Science & Engineering, 1873–2000* by Richard White, and *Cold Iron and Lady Godiva* by Robin S. Harris and Ian Montagnes.

After Skule™

Alumni are ambassadors of our engineering community. They provide inspiration, mentorship and essential guidance that enable us to prepare the next generation of engineering leaders.

Engineering Alumni Network

For over 100 years, our Engineering Alumni Network (EAN), formerly the Engineering Alumni Association, has nurtured a strong bond between Skule™ alumni, students and the Faculty. It fosters the richness, strength, diversity and inclusiveness of our engineering community in its activities and outreach. In 2016, we expanded the reach of our global alumni community through the U of T Engineering CONNECT platform, a social media network powered by Graduway that enables interaction among our alumni and current students.

In 2016, the Executive Board made the decision to rename the organization the Engineering Alumni Network (EAN) to better reflect and reinforce the richness, strength, diversity and inclusiveness of the entire Skule™ community.

Above

U of T Engineering alumni from the Class of 5T3 celebrate their friendship at the 2018 Alumni Reunion. (Courtesy: U of T Engineering Advancement)

Opposite

Undergraduate students from the classes of 1T7+PEY and 1T8 smile for photos on front campus after their convocation ceremony in June. (Photo: Roberta Baker)

National and international alumni networks

Our Faculty is home to over 50,000 Skule™ alumni who are located in more than 100 countries. Our alumni have created three EAN chapters outside of Toronto, with more anticipated in the future, to keep Skule™ spirit alive in Canada and around the world.

Calgary

The EAN Calgary chapter was founded by Ross Pitman (GeoE 7T4), Mike Hantzsch (ChemE 7T8), Richard Gleasure (ChemE 8T4) and Peter Noble (ChemE 8T9). The chapter created the Calgary Skule™ Admissions Scholarship to encourage and support Calgary-based students who want to pursue an education in engineering at U of T. The fund currently offsets over 75 per cent of a student's first-year tuition, with a goal to offset 100 per cent of costs.

In 2010, founding member Ross Pitman was awarded a University of Toronto Arbor Award for his work in establishing the chapter and the Calgary Skule™ Admissions Scholarship.

Hong Kong

The Hong Kong EAN has been instrumental in maintaining ties between our Hong Kong-based alumni community and Skule™. It received status as an organization under inaugural President Emmy Choi (ElecE 9T5). Members organize events, seminars and outdoor activities. The chapter also gives back to the community by organizing charity events, such as the Hong Kong Terry Fox Run.

San Francisco Bay Area

Co-founded by Angela Tran Kingyens (EngSci 0T5, ChemE MASc 0T7, PhD 1T2), our San Francisco Bay Area chapter maintains strong ties between San Francisco Bay Area–based alumni and Skule™. The chapter often holds events for its members, including speaker series and receptions, to enhance professional development and provide networking opportunities.

Toronto

After graduation, many of our alumni begin and build their careers in Toronto. For those who live in or outside the city, we offer many opportunities and programs to stay connected with the Faculty and mentor the next generation of engineering leaders through events such as the BizSkule speaker series and Skule™ Lunch & Learn. Alumni are invited to join us at Spring Reunion each year, where they can relive their days at Skule™ and reconnect with former classmates and faculty members.

CHAPTER

4

PLACES & SPACES

The engineering precinct tells the story of our Faculty's long-standing history at the University and our ongoing commitment to engineering innovation, education and excellence.

Celebrating a new era in engineering education and research

On April 27, 2018, our Faculty launched a new era in engineering education and research with the official opening of the Myhal Centre for Engineering Innovation & Entrepreneurship. Named in honour of the Myhal family—including George Myhal (IndE 7T8) and his wife, Rayla, two of the Faculty's most ardent supporters—the building embodies key engineering qualities such as collaboration across disciplines, experiential learning and entrepreneurship.

Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre)
55 St. George St.
Opened 2018
The Faculty launched a new transformative era in collaborative engineering education and research innovation with the opening of the Myhal Centre. Located adjacent to two of the University's most iconic buildings, Knox College and Simcoe Hall, it was designed by University of Toronto alumnus Robert Davies of Montgomery Sisam Architects in Toronto, in association with Peter Clegg of Feilden Clegg Bradley Studios in England. The Myhal Centre features interactive classroom technologies, leading-edge laboratories and collaborative spaces for students, faculty, alumni and staff. It is home to leading multidisciplinary research centres and institutes as well as design, fabrication and prototyping facilities. The building enables innovation, entrepreneurship and experiential learning and brings students, faculty and industry professionals together to prepare the next generation of engineering leaders to excel in a complex global environment.

Previous spread

A view from Level 1 of the Myhal Centre for Engineering Innovation & Entrepreneurship overlooking the Engineering Society Arena on Level 0 and the west side of the main foyer. The Myhal Centre is home to Many of our Faculty's design clubs and teams, offering space for them to design, test and prototype their projects. The building's official opening was celebrated in April 2018.
(Photo: Daniel Ehrenworth)

A view of the stairs from the revealed atrium on Level 5 of the Myhal Centre. The stairs are constructed of simple materials, including bronze and Baltic birch, to ensure the longevity of the building.
(Photo: Daniel Ehrenworth)

The road to the Myhal Centre

The years leading up to the official opening of the Myhal Centre required extensive strategic planning and thorough consultation with members of our engineering community, including students, faculty and staff to inform how our Faculty will inspire the next generation of engineering innovators and entrepreneurs. Beginning in 2008, under the leadership of Dean Cristina Amon, our Faculty undertook an extensive review of all assigned Faculty space. It was clear that our Faculty required prototyping facilities with collaborative spaces and state-of the-art labs, studios and learning spaces to foster research excellence and cultivate the next generation of engineering leaders.

Following the extensive review of the Faculty's space inventory, five potential sites were considered for the construction of a new engineering facility: the Engineering Annex (Site 16), the footprint of the Thermodynamics Lab in the Mechanical Engineering Building (Site 17), 245 College Street, the south-west corner at the intersection of McCaul & College Streets, and the parking lot at 55 St. George Street (Site 10).

The next steps required further consideration: prioritizing the Faculty's emerging needs and aspirations, raising funds while managing costs, working with the limitations and constraints of each site and exploring the anticipated approvals from the City of Toronto. We established a Project Planning Committee, which included broad participation from Faculty representatives, the University of Toronto Engineering Society (EngSoc) and graduate-student representation. The committee assembled a detailed project-planning report in late 2012. The proposed plan was embraced across the Faculty when it was shared at public town hall meetings, alumni events and departmental advisory boards. The priorities were to build a functional, flexible and energy-efficient building with active learning spaces that would promote innovation and collaboration within the Faculty. These priorities inspired the early name of the building, the Centre for Engineering Innovation & Entrepreneurship.

Setting a new pace for innovation and entrepreneurship

The Myhal Centre sets a new standard for engineering education and research, strengthening our Faculty's position as the #1-ranked engineering school in Canada and one of the world's best. Located at the heart of the University's St. George campus, the Myhal Centre enables new levels of cross-disciplinary collaboration that accelerates innovation and prepares the next generation of global engineering leaders to address the world's most pressing challenges. The building provides dedicated space and leading-edge teaching facilities for our innovative multidisciplinary undergraduate design courses.

> " The Myhal Centre is a much-needed response to the sweeping changes taking place in engineering—something that has been championed by Dean Cristina Amon since her arrival at the Faculty. Her vision and influence in engineering education and research culminate in this innovative building of which we can all be proud."
>
> – Ron Venter, Chair, Myhal Centre Project Planning Committee, Professor Emeritus, Mechanical & Industrial Engineering, Clarice Chalmers Chair of Engineering Design

Timeline

Myhal Centre

September 2018

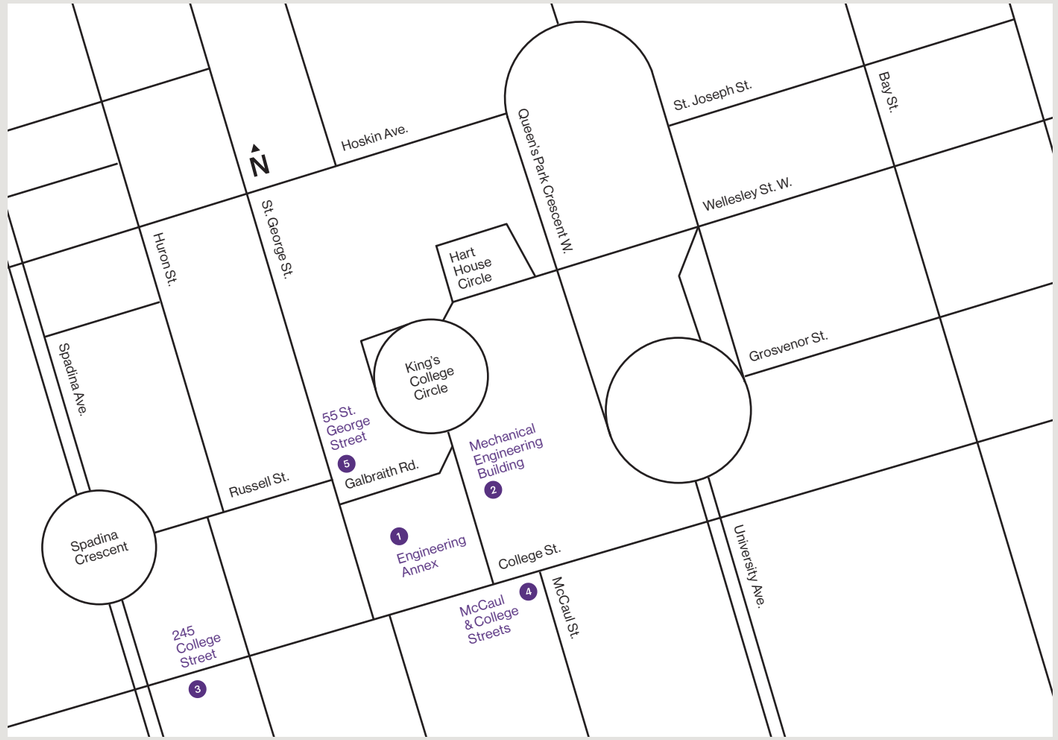
The Faculty hosts a public open house to showcase the Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre) to alumni and the community.

April 2018

The Faculty celebrates the official opening of the Myhal Centre at 55 St. George Street.

March 2018

The graffiti wall installation (construction hoarding) is removed from the site of the Myhal Centre.



The concepts and conflicts behind each proposed site:

1 The Engineering Annex (Site 16) introduced the possibility of creating a 10-storey tower, which would be constructed to bridge the Sandford Fleming and the Wallberg Memorial Building, with access to the tower through the Wallberg Building entrance on College Street. The estimated cost for this design was high as a result of specialized laboratory requirements and the complex infrastructure existing on this site. Additionally, it was difficult to anticipate how the necessary funding for the building would be secured without extensive support and funding from the federal and provincial governments.

2 The Mechanical Engineering Building (Site 17) was seriously considered as it would enable our Faculty to consolidate the Thermodynamics Lab, and to integrate the on-going activities within the adjacent Rosebrugh and Haultain Buildings. The site also presented the opportunity to construct a major 20-storey tower. This proposal brought into question how best to access the construction site during construction and also could have required the partial demolition of the Mechanical Engineering Building.

3 245 College Street was a third possible site considered by our Faculty. Earlier, with the support of the University's administration, we acquired the site at 245 College Street. The site was later returned to the University to allow for the construction of residence-style accommodation.

4 The south-west corner at McCaul and College Streets was also a top choice for the next phase in our Faculty's development. The building was eventually purchased by the University and renovated to provide administrative offices for University of Toronto Communications and the Division of University Advancement.

5 While each of the four potential sites presented opportunities to expand our Faculty's precinct, they also provided challenges in achieving the goals set out in our Academic Plan. The parking lot at 55 St. George Street (Site 10), emerged as an unmatched location for expanding our Faculty's footprint and creating the innovative space necessary to continue to lead the way in engineering education and research in Canada and around the world.

In 2012, the Governing Council approved Site 10 as the new site of our Faculty's expansion with the condition that we raise substantial funding and ensure that we break ground on the site within five years of this approval date.

The Myhal Centre enriches the student experience by creating dynamic, flexible environments that foster collaboration and experiential learning. It boasts five Technology Enhanced Active Learning (TEAL) rooms with reconfigurable spaces, seven design studios and a rapid prototyping facility that enables students to turn their ideas into working models. The innovative tiered 468-seat Lee & Margaret Lau Auditorium on Levels 1 & 2 features small-group seating and highly interactive learning and communications technology. In it, small groups of students collaborate around tables, enabling them to interact more effectively with each other and the instructor. Dedicated space on Level 0, a floor immediately below the auditorium, also provides for meeting rooms and extracurricular student club project activities to further enhance the Myhal Centre's vibrant learning environment.

Our Faculty has a long history of attracting and nurturing exceptional researchers, students, alumni entrepreneurs and leaders who contribute to the local economy and enhance job and wealth creation in the Greater Toronto Area (GTA). The Myhal Centre combines some of the University's premier centres, institutes and incubators under one roof, providing our community with unparalleled resources to take ideas to market and strengthen Toronto's standing as one of the best cities in North America to launch a startup.

Several of our recently launched multidisciplinary research centres and institutes are housed in the Myhal Centre, bringing together innovative minds from across the Faculty and the University to address the world's most pressing challenges, including sustainable energy, clean water and enabling technologies. In 2018, the building housed the Centre for Global Engineering (CGEN), the University of Toronto's Institute for Multidisciplinary Design & Innovation (UT-IMDI), the Institute for Sustainable Energy (ISE), the Institute for Water Innovation (IWI), the Institute for Robotics & Mechatronics (IRM), the Troost Institute for Leadership Education in Engineering (Troost ILead), the Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP), The Entrepreneurship Hatchery (the Hatchery) and offers the flexibility to add other leading centres and institutes in the future.

With remarkable commitment and vision from Dean Cristina Amon and our engineering community, the Myhal Centre launched an extraordinary new era for our Faculty.

Above

The flexible seating in the Lee & Margaret Lau Auditorium enables students to work in groups to collaborate on assignments and lecture material. (Photo: Roberta Baker)

Right

The first-of-its-kind in North America, this adaptable 468-seat auditorium is wired with the latest technology to engage student participation in many meaningful ways. (Photo: Laura Pedersen)

February 2018

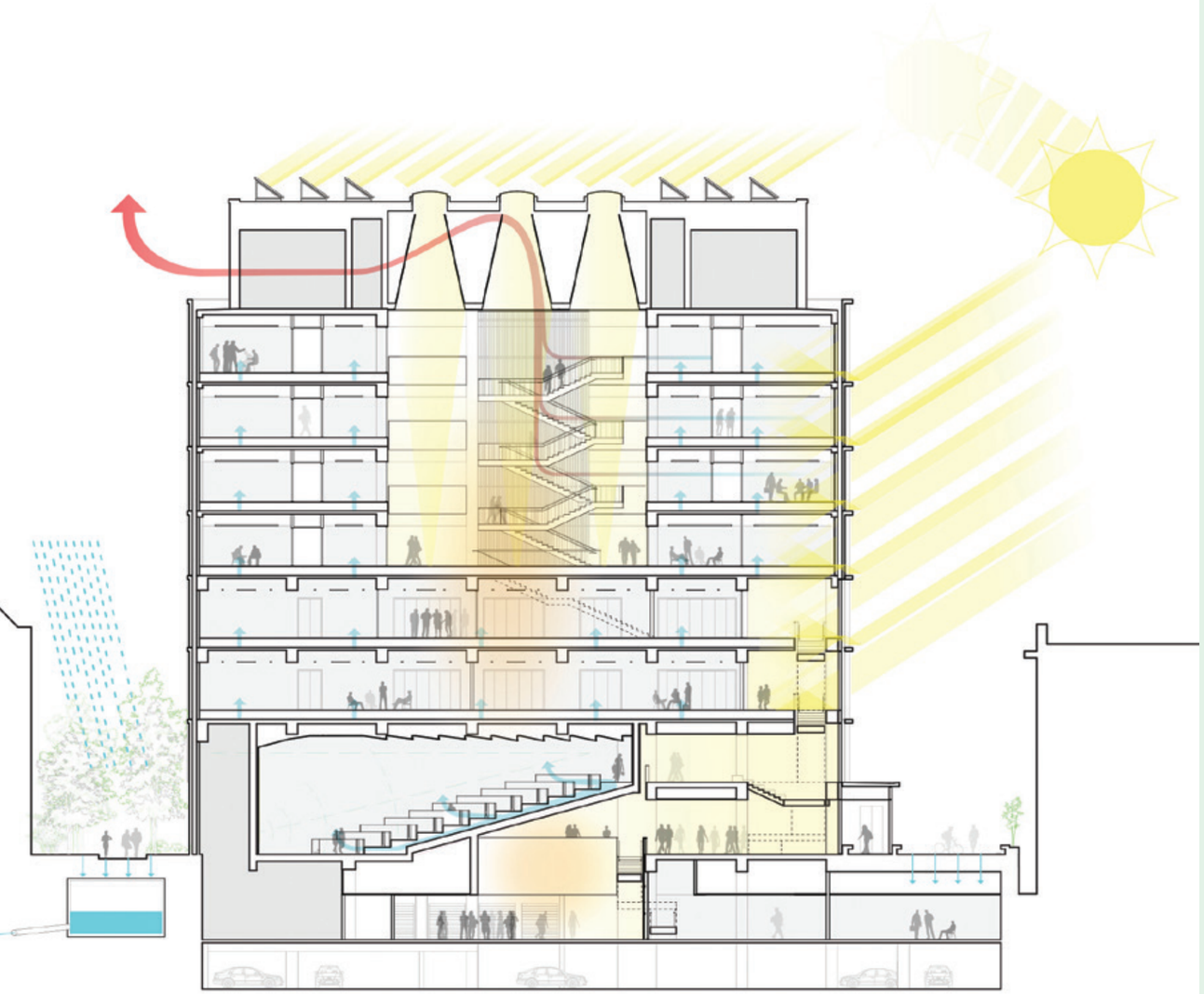
The Myhal Centre for Engineering Innovation & Entrepreneurship is named for longstanding Faculty philanthropists George Myhal (IndE 7T8), his wife, Rayla, and their family.

September 2017

A smudging ceremony is performed at the site of the Myhal Centre.

May 2017

Bird Construction hosts a topping-off event to mark the last concrete pouring into the roof of the building.



The Myhal Centre features sustainable design strategies, including solar shading and passive heating and cooling, making it one of the most energy-efficient buildings on campus. The building exceeds many Tier 2 Toronto Green Standard performance measures. (Rendering courtesy: Montgomery Sisam Architects)

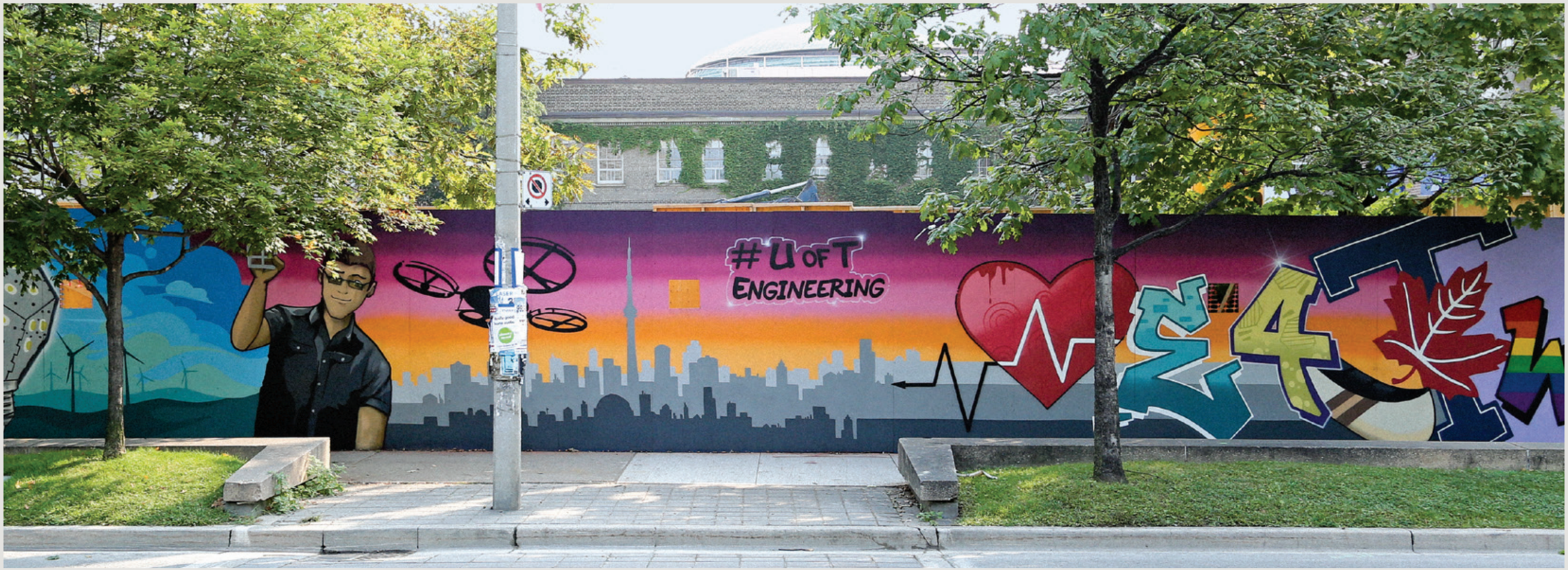
Sustainability by design

The Myhal Centre boasts some of the most sustainable design strategies to maximize energy efficiency. This includes drawing daylight deep into the building, reducing artificial lighting, rainwater collection and retention and advanced air delivery systems. Together, these systems and design elements make the Myhal Centre one of the most energy-efficient buildings at the University, targeting 100 kWh/m² per year of electricity usage; comparable buildings on campus use in the range of 200–300 kWh/m². The Myhal Centre meets or exceeds many of the Tier 2 Toronto Green Standard performance measures for sustainable site and building design.

- An advanced air delivery system distributes conditioned air from under-floor ducts throughout the building, conserving cool air when needed and dispelling warm air in the summer months. Exhausted air is subject to heat-recovery technologies and building occupants are able to control air distribution in their space to maximize comfort.
- Rainwater is collected for landscape irrigation. This water is repurposed for the landscaping of the Myhal Centre, as well as adjacent buildings.
- Rooftop photovoltaic cells harness the sun's energy, generating 70 kWh/m² of electricity annually. A series of skylights draws natural light deep into the building, reducing dependence on artificial lighting.
- Passive solar shading on the building's exterior leverages the angles of the sun throughout the winter and summer season to minimize solar gain.
- Mechanical equipment on the lower level features vibration isolation to reduce the transfer of vibration-generated noise into the building's structure.

The Myhal Centre represents our Faculty's bold and ongoing commitment to excellence in engineering education, research, innovation and entrepreneurship. The leading-edge design and function of the building will inspire generations of our engineering students and encourage them to apply their knowledge to drive progress and lead in complex, global engineering environments.

Sections of the graffiti wall (construction hoarding) surrounding the site of the Myhal Centre. In 2016, it was Toronto's longest single graffiti installation and earned our Engineering Strategic Communications team numerous national and international accolades, including the Faculty's Innovation Award.
(Photos: Roberta Baker)



Top

Technology Enhanced Active Learning (TEAL) rooms feature two-piece hexagonal tables, as pictured in the TEAL pilot room, or larger circular tables with seating for six to nine students. The TEAL pilot room informed the design of these innovative new spaces on the third floor of the Myhal Centre.
(Photo: Roberta Baker)

Bottom

The Taiwan Alumni Technology Enhanced Active Learning Room is one of five TEAL rooms in the Myhal Centre. TEAL rooms encourage dynamic group work, fostering collaboration among students and with the instructor.
(Photo: Daniel Ehrenworth)

A floor by floor overview of the Myhal Centre

Above

A rendering of the Myhal Centre's two-storey drone atrium.
(Rendering courtesy: Montgomery Sisam Architects)

Level 0

Versatile student club space

The Engineering Society Arena houses flexible facilities that directly serve the requirements of most of the 100-plus student clubs functioning within the mandate of the Engineering Society. Many of these clubs develop innovative projects that are built within the arena. The arena features open work areas supported by fabrication studios, convenient project storage adjacent to work areas and meeting rooms. Since many engineering students are accomplished musicians, and active within student music clubs, a music room has been incorporated into the larger arena space envelope.

Level 0, visibly open to Level 1, supports opportunities for undergraduate students to enhance their curricular and co-curricular experiences, and graduate with the competencies to succeed in their careers. Also located on this floor is a 64-seat computer teaching lab for software instruction and the Stewart L. Blusson Visualization Laboratory for large data analytics with immersive screen technology.

Levels 1 & 2

World-class event space and auditorium

The first and second levels feature grand halls that double as an event space. The 468-seat Lee & Margaret Lau Auditorium is a marquee facility that optimizes audience engagement. It contains a number of features to encourage active learning and nimble transitions between lecturing and student interaction, including tables positioned on tiered platforms to facilitate student group activities, a data communications system that allows students to share content with the instructor and one another, a large stadium-style video wall that allows for individual and simultaneous multiple screen projections, and theatre-quality lighting. The presentation area within the auditorium is large enough to accommodate a vehicle, which can be rolled into the space for special events or presentations. Access into the auditorium is possible from both levels.

February 2016

The Ontario government announces $15 million to support the Myhal Centre.

September 2015

Commissioned by our Faculty, street artist Jason Wing (a.k.a. SKAM) paints a one-of-a-kind 276-foot (84-metre) graffiti installation that spans the construction site hoarding. The installation is recognized as the longest single graffiti mural in Toronto and becomes an exhibit at Scotiabank Nuit Blanche, an annual city-wide celebration of art.

June 2015

Bird Construction is awarded the contract and construction commences. Donors, alumni, faculty, students and staff gather at the Myhal Centre groundbreaking event to celebrate the culmination of Dean Cristina Amon's vision and the unwavering commitment of alumni and donors.

Level 3

Technology Enhanced Active Learning (TEAL) rooms

Level 3 features five TEAL rooms: these are the Singapore Malaysia Alumni TEAL Room, the Taiwan Alumni TEAL Room, the Hong Kong Alumni TEAL Room, the Estate of John Edgar McAllister TEAL Room and the Brookfield TEAL Room. Critical to supporting blended modalities of teaching and design work, TEAL rooms are flexible to accommodate many uses and scenarios. The TEAL rooms feature moveable chairs and group tables serviced by multiple flat-panel screens on the surrounding walls that allow for a variety of configurations. Level 3 also features two of the building's design studios, the Fung Family Design Studio and the Ron Venter Design Studio.

Level 4

Design, fabrication and prototype facilities

Engineering design is integral to the undergraduate engineering experience at U of T. Beginning in their first year, students collaborate in small groups to solve challenges facing communities across the Greater Toronto Area (GTA). As students advance academically, the design challenges they address are often increasingly multifaceted, with social, environmental and economic implications, resulting in sophisticated and complex design concepts and solutions.

Level 4 of the Myhal Centre features a number of design studios with supportive light fabrication spaces where these ideas will take shape. The Jan Walter Szymaszek Design Studio, the John H. Weber 7T9 Design Studio, the William C. Bowman Design Studio and other similar design studios surround a supervised hands-on light fabrication facility, which includes a rapid prototyping space. Student groups plan and execute their projects in the design studios; the proximity of facilities allow students to easily move between fabrication facilities to their respective working group. To enhance the seamless design experience, Level 4 also includes dedicated locker space for student projects.

The upper levels, 5 to 8

Meeting and project rooms

The architectural features of the four upper levels changes dramatically; the revealed atrium creates a second magical architectural experience within the building. A multi-level atrium allows cones of light to stream into the centre of the building and into the exciting interactive spaces on Levels 5 to 8. The expansive floor of the Level 5 atrium, also features a bold staircase leading to the upper levels. It provides an exceptional event space to host gatherings, industry and technology announcements among other activities.

By the numbers

Located at 55 St. George Street, the Myhal Centre is the **14th** building in our engineering precinct on the St. George campus.

The building adds **7,200** net assignable square metres (NASM) to our existing footprint of **65,000** NASM.

Eight multidisciplinary research centres and institutes bring together innovative minds across the Faculty, University and diverse industries.

Eight levels above ground (plus Level 0 below grade and **one** level of parking) with collaborative spaces to enable teamwork in all spheres of activity.

The configuration of the building's **468**-seat Lee & Margaret Lau Auditorium is a first of its kind in North America.

Dedicated student-club space and Engineering Society Arena encompass space for more than **1,700** students to enhance co-curricular experiences.

Exceptional alumni and donor support for the Myhal Centre, including an inspiring $**1 million** from the University of Toronto Engineering Society and $**15 million** from the Government of Ontario.

Five TEAL rooms to enable dynamic group work, rapid-prototyping facilities and **seven** design studios for concept creation.

Four student spaces named after regional alumni groups in Calgary, Hong Kong, Malaysia Singapore and Taiwan.

May 2015

Rezoning is approved by the City of Toronto.

October 2014

A pilot Technology Enhanced Active Learning (TEAL) classroom is established in the Sandford Fleming Building.

February 2014

The Myhal Centre receives approval from the Governing Council of the University of Toronto, a testament to the tremendous contributions and visionary leadership of Dean Cristina Amon.

> " The entrepreneurial spirit is taking hold in U of T Engineering. The Myhal Centre truly propels participants' startups to the next level, allowing them to drive their bold ideas from concept to prototype and beyond. This unique space encourages collaboration, teamwork, and enables the next generation and those that follow to gain guidance and feedback from established entrepreneurs and prospective investors."
>
> – Joseph Orozco, Co-founder and Executive Director, The Entrepreneurship Hatchery

Levels 5 to 8 host 12 meeting rooms and 20 project rooms that have been intentionally created and distributed on these levels. Meeting rooms are available to support all activities by students, faculty and alumni. Project rooms are assigned by the dean in support of special research and development projects undertaken within the Faculty that could potentially lead to new startups by students and faculty. Many of these meeting and project rooms have been appropriately named to recognize donor support.

Level 5

The atrium, multidisciplinary design and robotics

Level 5 is home to our Faculty's University of Toronto Institute for Multidisciplinary Design & Innovation (UT-IMDI) and Institute for Robotics & Mechatronics (IRM). The atrium, supported by an anonymous donor, provides for exceptional event space bounded by the Heuckroth Learning Commons, the Bill Buckley Study Space and IRM's two-storey Norris Walker 5T7 Robotics Laboratory for drone test flights and related research and technology activities.

UT-IMDI provides a project-based learning environment that enables our students to address industry challenges. Projects are completed either through a full-year course—APS490 Multidisciplinary Capstone Project (MCP)—or through summer internships with partner companies. Students experience practical, industry-based training opportunities to further enhance their learning experience.

With automation on the brink of disrupting many sectors of the global economy, IRM builds innovative sensing, actuation and computational technologies. IRM brings together nearly 40 experts in mechanical, civil, mineral, electrical and aerospace engineering and computer science. These facilities also provide a home for Engineering Science's robotics major, which launched in 2015.

Level 5 also houses the Sydney Cooper Project Room, the James Peers Project Room and the Juhan Kalmet Meeting Room.

Level 6

Industry collaboration, The Entrepreneurship Hatchery and the Ajax Alumni Attractor

Launched in 2012, The Entrepreneurship Hatchery (the Hatchery) is a co-curricular program that equips students to advance and deliver innovative ideas to market and launch their own startups. In its new home, the Hatchery provides the space, equipment, mentoring and connections to funders, supporting student ventures from concepts to prototype. The Entrepreneurship Hatchery Suite was supported by Gerald and Geraldine Heffernan who are the founding donors of the Hatchery. (Continued on page 105.)

March 2013

The project-planning report is finalized and Montgomery Sisam Architects working with Feilden Clegg Bradley Studios are invited to undertake the architectural design. The project also receives gifts from Patrick Fung (ChemE 7T1); Claire Kennedy (ChemE 8T9); Hatch; Lee Lau (ECE 7T7, ECE MEng 8T2) and spouse, Margaret Lau; the University of Toronto Engineering Society; the international alumni groups operating in Hong Kong, Indonesia, Malaysia, Singapore, South Korea and Taiwan; the J. Edgar McAllister (CivE 1895) Foundation Trust; Henry Wu (EngSci 7T5, ChemE MASc 7T9) and Gerald Heffernan (MMS 4T3).

George Myhal (IndE 7T8), centre, delivers remarks at the official opening of the Myhal Centre for Engineering Innovation & Entrepreneurship on April 27, 2018. (Courtesy: U of T Engineering)

> “ The ambitious vision of U of T Engineering has come to fruition, a testament to the engagement, pride and affinity of our campaign, donors, faculty, staff, students, alumni and friends, and the impeccable leadership of Dean Cristina Amon. The Myhal Centre will transform our Faculty and will be an important legacy for future generations of engineers.”
>
> – George Myhal, Chair, U of T Engineering Campaign Executive Committee

George and Rayla Myhal: A legacy of innovation through the Myhal Centre for Engineering Innovation & Entrepreneurship

George Myhal (IndE 7T8) and his wife, Rayla, are longstanding supporters of our Faculty with a history as passionate volunteers and advocates for Engineering and the University of Toronto. George served for more than a decade on the University’s Governing Council, and continues to advise the Faculty through the Dean’s Strategic Council. George and Rayla have championed the new building from its inception. In June 2017, George was named a member of the Order of Canada for his achievements as an investment and finance leader, and for his philanthropic contributions, notably in support of innovation in engineering. In fall 2018, he will be recognized with an honorary degree from the University of Toronto.

Our Faculty extends special thanks to those who have supported the Myhal Centre with contributions of $25,000+

John E. Akitt
Anonymous (4)
Stewart L. Blusson
Brookfield
William P. Buckley
Paul M. Cadario
Choong Kong Chang
Robert Chen
Water Cheung
Class of 5T3 Engineering
Sydney & Florence Cooper
Jay Cross
C. William Daniel
Patrick Yuk-Bun Fung
Michael Goutama
Government of Ontario
Koh Yong Guan
Hatch
Gooi Seong Heen
Gerald & Geraldine Heffernan
Lorne Heuckroth
Ian W. & Helen Hollingsworth
Juhan Kalmet
Arthur P. Kennedy
Claire M.C. Kennedy
Donald L. King
Albert Wing-Tak Lam
Lee & Margaret Lau
Michael Lee
Gooi Seong Lim
Nick Lo
J. Edgar McAllister
Murray R. Metcalfe
Anne & Dusan Miklas
Frank & Barbara Milligan
Walter Morris
Myhal Family Foundation
Adediran Otegbade
James A. Peers
Herbert Ross & Debra Pitman
Dorothy Y. Szymaszek
James C. Tai
The Ajax Alumni Group
The Lee Foundation
William & Kathleen Troost
University of Toronto Engineering Society
Carol Mitchell & Richard Venn
Ron Venter
Er Kwong Wah
Norris Walker
John H. Weber
Dave Liu & Lauren Wu
Henry King-cheong Wu
Philip Yeo

A member of the University of Toronto Supermileage Team works on the team's hyper-fuel-efficient vehicle nicknamed "Shadow" at the 2018 Shell Eco-Marathon in Sonoma, California. The team placed second overall in their category at the 2018 competition. (Courtesy: Shell Eco-Marathon)

"The Myhal Centre gives us more space for fabrication, design work and theoretical modeling. This will be important to the future success of the Supermileage Team because it will enable us to take our prototypes to the next level."

– Callum Bartlett (MIE Year 3), Co-captain, University of Toronto Supermileage Team

Bill Gates, front right, studies the waterless toilet prototype designed by our Faculty's Reinvent the Toilet Challenge team, which includes professors Yu-Ling Cheng (ChemE), front left, and Mark Kortschot (EngSci 8T4, MASc ChemE 8T5), back left. Our team received third place for their design at the 2012 showcase event. (Courtesy: Professor Yu-Ling Cheng)

"Technological innovations have a very important role to play in global development, but they need to be created with context in mind. We need engineers, social and political scientists and business leaders to work together. The Myhal Centre fosters this level of collaboration."

– Yu-Ling Cheng, Director, Centre for Global Engineering

A view of the Myhal Centre and downtown Toronto from the rooftop of the Lash Miller Chemical Laboratories. (Photo: Daniel Ehrenworth)

" The Myhal Centre is a state-of-the-art building. It is the venue to teach, learn and collaborate in new ways that will challenge every student and professor to adapt to the social and political changes ahead, including adapting to climate change and mitigating its impact on the planet. The Faculty, in the heart of a great University and diverse metropolitan area, has the opportunity to be at the table on the biggest 21st-century issues, which at their core all involve engineering."

– Paul Cadario (CivE 7T3)

" Once you're engaging in activities that interest you, that are close to your heart, you will naturally meet others in similar spaces. Just by the process of selection you'll be compatible as friends, partners, collaborators. That's what the Myhal Centre is: a place where student teams and entrepreneurs get together under one roof and hopefully have this free flow of ideas."

– Peter Wen (MIE Year 4), Founder, Telehex

Also on Level 6, is the Ajax Alumni Attractor, which is a home on the campus for engineering alumni and professional master's students who need a quiet space for research and meetings. Space in close proximity to these carrels is also available for alumni to mentor and inspire undergraduate students involved in startups and other projects.

The Alumni and Advancement Offices also have a home on Level 6; their new suite was supported by the Class of 5T3 Engineering.

The Adediran Otegbade Project Room, the Dave Liu & Lauren Wu Project Room, the Hatch Project Room, the Wildcat Project Room and the Calgary Alumni Meeting Room can also be found on Level 6. In addition, Richard Venn has supported the Professional Master's Student Lounge.

Level 7

Global engineering and leadership education

Level 7 provides a nexus for U of T's many initiatives to drive innovation and cultivate the next generation of global engineering leaders. It features the Centre for Global Engineering (CGEN), the Troost Institute for Leadership Education in Engineering (Troost ILead) and the Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP).

Our Faculty created CGEN to enable faculty and students to think creatively about the world's most complex and pressing challenges. Since its inception in 2009, CGEN has led several significant projects around the world, including engineering an iron-fortified tea to help fight malnutrition; optimizing a more efficient system for dispatching ambulances in Dhaka, Bangladesh; and creating a new waterless toilet prototype that recently earned its third round of funding from the Bill & Melinda Gates Foundation's Reinvent the Toilet Challenge. The CGEN suite on Level 7 was supported by alumnus and philanthropist Paul Cadario (CivE 7T3). (Continued on page 108.)

Right

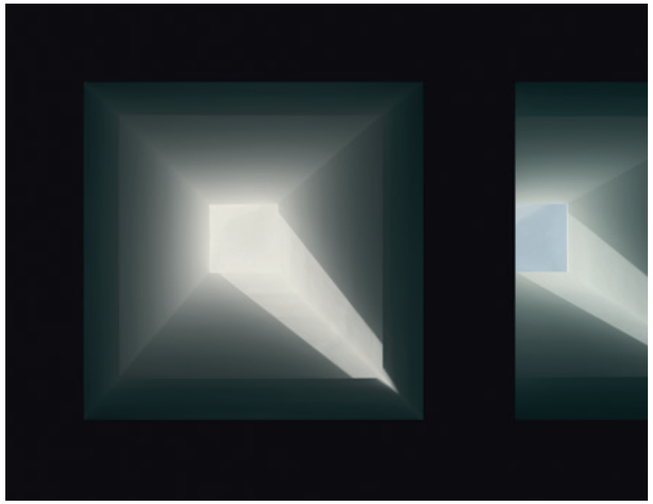
Troost ILead PhD candidate Patricia Sheridan (MechE 0T9, MASc 1T1) is changing the way students learn about teamwork. Her online team-effectiveness system supports over 300 teams of engineering students each year, enabling enhanced collaboration. In 2014, Troost ILead won the national Alan Blizzard Award for Collaborative Teaching. Troost ILead is located on Level 7 of the Myhal Centre. (Photo: Roberta Baker)

Level 1 of the Myhal Centre features an open and flexible seating area for students to study or work on projects in between and after classes. (Photo: Daniel Ehrenworth)

Established in 2010 and the first of its kind in Canada, Troost ILead offers transformative learning opportunities for engineering students and professionals to develop competencies to excel as emerging leaders. We empower our engineering students and alumni to maximize their potential and contribution at Skule™ and beyond. The world demands engineers who are successful problem solvers empowered to tackle complex global issues. Leadership education enables individuals and groups to contribute more effectively to engineering and social innovation. The Troost ILead space, supported by Bill Troost (ChemE 6T7) and his wife, Kathleen, recognizes the significant support and commitment provided by Bill and Kathleen to advance the Institute's key leadership objectives.

The impressive successes of both CGEN and Troost ILead led to the creation of the Institute for Studies in Transdisciplinary Engineering Education & Practice (ISTEP). ISTEP partners with departments and institutes from across the Faculty to foster scholarship in engineering education and engineering practice through a vibrant community of faculty who are influencing and guiding pedagogical development and teaching innovation across the Faculty and beyond.

Level 7 is also home to the Claire M.C. Kennedy Meeting Room, the C. William Daniel-Second Mile Meeting Room, the Frank Milligan Meeting Room, the Murray Metcalfe Project Room and the John E. Akitt Project Room.



Left

A view of the skylights from the revealed atrium on Level 5 of the Myhal Centre. (Photo: Daniel Ehrenworth)

Following spread

Claire Kennedy (ChemE 8T9), Chair of Governing Council, centre, declares the Myhal Centre officially open. Kennedy and the platform party, left to right, Chancellor Michael Wilson, George Myhal (IndE 7T8) and his wife, Rayla, Dean Cristina Amon, President Meric Gertler and Engineering Society President Jonathan Swyers (ECE Year 4), joined more than 400 members of the U of T Engineering community to celebrate the building's opening on April 27, 2018. (Photo: Laura Pedersen)

November 2012

The Governing Council approves Site 10 at 47–55 St. George Street for the construction of a new engineering building. The project receives gifts from Paul Cadario (CivE 7T3), George Myhal (IndE 7T8) and his wife, Rayla, and Bill Troost (ChemE 6T7) and his wife Kathleen.

June 2012

The Faculty's Boundless Campaign is launched within the larger University of Toronto Campaign.

June 2009

Recommendations and observations are submitted for Faculty input; the development of a new building is to proceed as planned.

Engineering students from the University of Toronto Aerospace Team (UTAT) work together to build a drone. UTAT is one of the student clubs and teams with dedicated design space on Level 0 of the Myhal Centre.
(Photo: Roberta Baker)

" Engineering design is about balancing competing goals—between analysis and synthesis; thinking and doing; and conceiving and communicating. The TEAL rooms and design studios provide a rich environment for us, as professors, and for our students to explore new and innovative ways to balance these goals. Together we are designing new ways to teach and learn engineering in this innovative educational environment."

– Jason Foster, Professor,
Engineering Science, Praxis first-year design course


UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
MYHAL CENTRE
FOR ENGINEERING
INNOVATION &
ENTREPRENEURSHIP
TORONTO

“ The Myhal Centre for Engineering Innovation & Entrepreneurship opens a new chapter in the Faculty’s long and proud tradition of excellence in research and teaching. It is the site of scholarship that enhances the quality of life of many throughout our city, across our nation and around the globe.”

Claire Kennedy (ChemE 8T9)
Chair, Governing Council

“ There’s an old Chinese saying that literally means, when you drink water, remember the spring. Giving back is part of the culture I was raised in. It’s about showing appreciation for what one has been provided.”

– Henry Wu (EngSci 7T5, ChemE MASc 7T9)

Level 8

Dr. Woo Hon Fai Innovation Floor

In recognition of alumnus Henry Wu’s (EngSci 7T5, ChemE MASc 7T9) contributions to our Faculty and the Myhal Centre, Level 8 is named the Dr. Woo Hon Fai Innovation Floor in honour of Wu’s late father, who was an influential leader in Hong Kong’s business landscape. Wu was motivated by a desire to support the Faculty’s commitment to excellence in engineering education and the opportunity to commemorate his father, who passed away in 1985.

Through the Dr. Woo Hon Fai Innovation Floor, Wu supports the operational suites for both the Institute for Sustainable Energy (ISE), the Institute for Water Innovation (IWI), four project rooms, two meeting rooms, the interactive Dr. Woo Hon Fai Informal Study Space and the adjacent terrace, which offers a spectacular exterior view of U of T’s iconic front campus.

Founded in 2013, the ISE brings together multidisciplinary researchers and graduate students from across and beyond the Faculty. ISE develops breakthroughs in sustainable energy and enables collaboration with industry and government partners to increase energy efficiency and reduce the environmental impact of energy use and conversion.

Established in 2017, the IWI develops new approaches to improve the stewardship of water resources from conservation to recycling of industrial water. Led by the Departments of Chemical Engineering & Applied Chemistry, Civil & Mineral Engineering and Materials Science & Engineering, researchers at IWI collaborate with the Lassonde Institute of Mining, the Pulp & Paper Centre and the Drinking Water Research Group to solve some of the world’s complex global water issues.

Level 8 also houses project rooms and collaborative research areas that address new research initiatives with the Faculty’s industry partners and emerging University priorities that enable inter-Faculty participation. The Arthur P. Kennedy 4T3 Media & Display Room is also on Level 8 within the IWI.

Right

Members from the Class of 5T3 and their families visit the Office of Advancement & Alumni Relations on Level 6 of the Myhal Centre for Engineering Innovation & Entrepreneurship for the first time. (Photo: Amanda Hacio)

September 2008

The Space Review Committee, established by Dean Cristina Amon, audits the Faculty’s instructional and research spaces to address the requirements of a proposed new building.

In the words of the architects—Robert Davies and Peter Clegg

Mise en place is a French culinary phrase that translates to English as "everything in its place." It refers to the preparation, measurement and arrangement of all ingredients to be used in a recipe before the act of cooking. In a professional kitchen, this is often the work of the sous chef.

Translated to building design, *mise en place* can be compared to an engineer's methodical approach to problem solving. As architects, we always want to know what the engineers on the team think, as early in the design process as possible. We appreciate that they are trained to find the most direct and efficient solution to any given problem using mathematical and scientific methods. Generally, when the problem has been clearly stated, the solution is pragmatic, and ultimately forms an essential part of the building design. There is a certain "calculable truth" that is reassuring and forms the backbone of a project—everything in its place.

Architects follow a similar process, but add elements to a design that are less measurable, such as: how the building will affect the senses; what it will look like; how the sun will shine on it and what shadows will result; what it's like to touch; and how it will make one feel—relaxed, calm, welcomed? We work hard to establish a thesis for each project to produce a building that is articulate in its design and sincere in its meaning. A thesis, in turn, establishes clear guiding principles that are used to measure each design decision and help guide the team to a coherent architectural result.

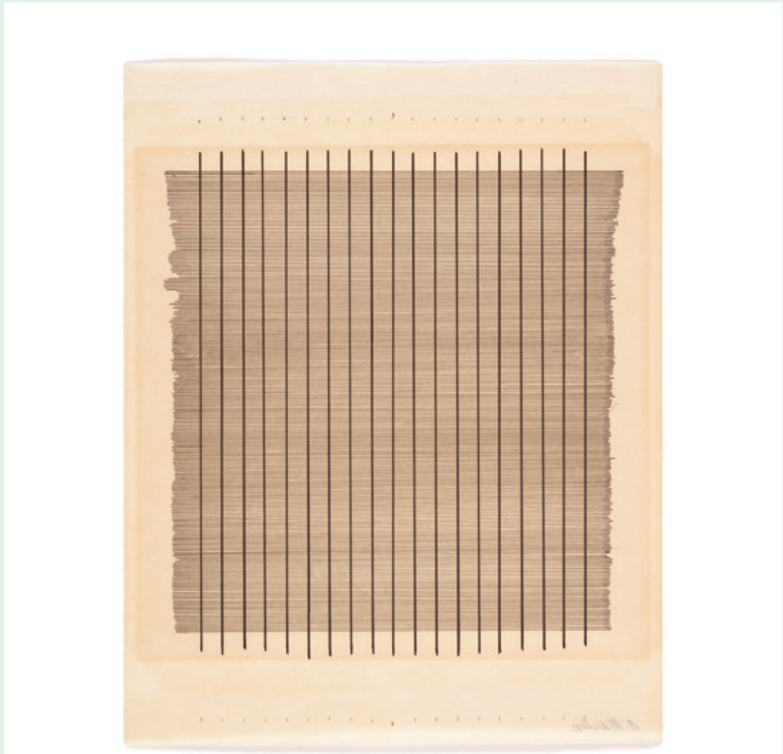
For the design of the Myhal Centre for Engineering Innovation & Entrepreneurship we looked to the work of the painter Agnes Martin. Martin had a life-long interest in Western and Chinese Classicism, sharing the belief that perfection can only exist in the mind. Her paintings appear at first glance to aspire to a kind of engineering precision—or perfection—but are actually about how human beings can never truly achieve perfection. When examined closely one sees that they are freely drawn, touched by human hands and not as perfect as they first appear. In a similar sense, we are interested in architecture that aspires to an idea of engineering precision while encouraging the messy and chaotic activities of human beings, an ideal of the mind with plenty of room for the body. Essentially, it is a building for engineering study, occupied by engineers.

A trio of voids

The Myhal Centre is a cube in form, 44.5 metres wide by 44.6 metres deep by 43.7 metres tall, and is best understood by an analysis of the section, which consists of three significant voids.

The first void is created by the Lee & Margaret Lau Auditorium, which comprises more than 60 per cent of Levels 1 and 2. From two primary entrances on the ground floor, the tiered seating—which can accommodate up to 468 people—rises up to the second level mezzanine, where there are two other entrances.

The underside of the tiered seating of the lecture hall creates the second significant void. Through an opening in the ground floor, the two-storey-high Engineering Society Arena on Level 0 is visible. Supported by a $1 million gift from the students themselves, through the leadership of the Engineering Society, the Arena is uniquely designed to support a rich variety of co-curricular clubs and teams.



Above

The work of abstract painter Agnes Martin, pictured above, inspired the exterior design of the Myhal Centre for Engineering Innovation & Entrepreneurship. (Agnes Martin. *Tremolo*. 1962. © Estate of Agnes Martin/SODRAC [2018])

The third void occupies the centre of the building, rising from Level 5 through to Level 8 and topped by six conical light shafts. This void has come to be known as the "revealed atrium" due to the way it reveals itself without forewarning as you rise up through the building. It is the lungs and heart of the activity centres that make up the innovation and entrepreneurial programs of the Myhal Centre.

The faces of the atrium consist of exposed concrete columns and beams and acoustic panels made of Douglas fir with tiny slots to absorb sound. The north and south faces have vertical windows and panels to provide privacy to an array of offices and meeting rooms. The east and west faces have horizontal openings and panels and provide an overlook to the atrium.

Structural features

Massive concrete transfer beams run through Levels 3 and 4. These four parallel beams carry the loads of the floors above. Such is the required strength of these beams that they are poured of concrete with a compressive strength of 60 megapascals, whereas the adjacent beams and slabs have a compressive strength of only 35 megapascals. There is a noticeable colour differentiation between these two concrete strengths that can be seen as they blend together in the beams at the classrooms, making it an ideal teaching aid for future engineers.

A stair of convenience connects all the floors of the building from Level 0 to Level 8. Each step has a rise of 165 mm and a run of 355 mm, making the stairs gentle to walk and inviting to use. The low iron content of the glass in the balustrade combined with the sandblasted finish creates a white translucent glow from the southern windows. The entire stair is a space for casual gathering, meeting and study.

The stair moves from west to east across the south facade from Level 1 to Level 4 and provides an overlook to both the new court created between Myhal Centre and the Geography Building. It then changes orientation and rises north up and into the revealed atrium. From there it continues switching back from north to south with a generous landing between each floor. The balustrade for the stair in the atrium consists of acoustic panels made of Douglas fir.

Two required fire exit stairs are located at the north east and north west corners of the building each with large landings and windows overlooking the beauty of Knox College. A glazed door with side-light into the stairs provides views and daylight into the corridor. It is imagined that the landings of these stairs will become part of the valuable "in-between" space providing casual spaces for encounters and study.

The exterior facades of the Myhal Centre consist of windows, operable and fixed, and precast concrete and brick panels. The windows span from floor to the underside of the upper beam, thereby casting light deep into the floor plate. The overall window-to-wall ratio is 40:60, and other than a few rooms on Level 0, there are no spaces anywhere in the building that don't have access to daylight and views, often in more than one direction.

Though all four exterior facades of the building consist of the same material, they have different features depending on their orientation to the solar coordinates. The east and west facades have vertical fins that project in front of the plane of the glass to provide early morning and late afternoon shade. The south facade has similar projections that are horizontal to shade the glass from the high summer sun. The north facade has no projecting fins in order to maximize daylight penetration. Of special note is the low-iron glass that allows light through and provides little reflection or colouration.

Ventilation and energy features

Raised flooring has been installed in Levels 3 through 8. Ventilation, power distribution and internet connectivity can occur under this raised floor, leaving the spaces above free of ducts and ceilings, and enabling the concrete structural system of beam and slab to be exposed and easily comprehended. This approach also allows for flexibility over the projected 100-year life span of the building.

For the ventilation system, we worked with consulting engineering firm Smith + Andersen to incorporate four shafts on the building quadrants. This way, no floor diffuser was more than 50 feet from the riser, and the amount of ductwork was reduced. In the Lee & Margaret Lau Auditorium, air flows from under the seats, through the displacement diffusers, and is directed back to the return air system hidden behind the massive projection screen.

The Myhal Centre utilizes the University's district plant steam and condensate services from the Central Utilities Plant, connected through a service tunnel along Galbraith Road. In the basement steam room, the steam is converted into two heating water distribution systems: perimeter heating and air handler coil heating. For humidification, steam is generated by a steam-to-steam generator. A study of the University's district plant chilled water services concluded that the most cost effective solution for the building was a dedicated central chiller plant.

In total, nine air handling units and two heat recovery units are used in this building. Air handlers with heat recovery are located in the basement and penthouse mechanical rooms and are capable of 100 per cent free cooling. Most of the air handlers are equipped with heat pipes for greater dehumidification, due to higher occupancy and latent heat. Air is returned to the penthouse via the multi-storey central atrium.

A large amount of ductwork is saved by using the penthouse mechanical room as a relief air plenum, which was designed to reduce noise transmission to neighbouring buildings. The mechanical penthouse also contains a continuous walking path specifically designed to allow students to observe the functions of the physical plant as part of a course offering. The roof of the penthouse is filled to capacity with an array of photovoltaic cells.

The decision to include operable windows led to an "operable window mode" for the ventilation system. The system is partitioned into a perimeter zone and an internal zone that surround the revealed atrium. When outside conditions, such as temperature and humidity, are ideal for opening windows, the following steps take place:

1. Air movement to the perimeter zone will be stopped by closing the dampers
2. Users will be alerted.
3. Supply air for perimeter zone ventilation will be drawn though the window and mechanically transferred to the penthouse.
4. The internal zone works as a "normal" condition.

Although LEED certification was considered, the project decision was to focus on Toronto Green Standard Tier 2 and energy savings. The Myhal Centre has an anticipated energy use intensity (EUI) of 110 kWh/m^2, compared with 200–300 kWh/m^2 for the typical existing St. George Campus buildings. This figure represents a 25 per cent efficiency improvement over the Ontario Building Code. The annual energy production of the building is estimated at approximately 70,000 kWh, leading to a first year cost savings of approximately $8,800.

Some of the features leading to this enhanced energy profile include:

- A high-performance building envelope, including R-22 walls and an R-26 roof
- Energy-efficient LED lighting, with occupancy sensors and perimeter daylight harvesting controls
- Collection of storm water for irrigation
- Localized instantaneous electric domestic hot water heaters, to avoid the energy loss of a domestic hot water recirculation system.
- An 80 kW rooftop photovoltaic system

Materials and aesthetic

The aesthetic of the building is quiet and simple, and the material selections reflect this, starting with the decision to expose the cast-in-place concrete structure. Considerable care in the specification and workmanship of the concrete has yielded a good quality finish with square tight corners.

This is complimented by Baltic birch wood panels and millwork, bronze railings and trim pieces, low iron glass balustrades and dark grey cork wall finishes. The main public floors of the building consist of terrazzo, which is hard wearing and easy to maintain. The finish on the raised floor is concrete tile in the public areas and carpet in the classrooms. The colour palette is intentionally muted so that the occupants of the building can provide the colour through their clothing choices as seasons and fashions change over the next 100 years.

In conclusion, the Myhal Centre showcases an architecture that is disciplined and quiet, even understated. It is not about itself, but about the activities that will occur within it and change over time. This is an architecture that is robust and enduring.

A look inside the engineering precinct

Above

The Office of the Dean is located in the historic Chadwick House, which was built in 1878. The House was incorporated into the Bahen Centre for Information Technology in 2001 and is often referred to as the Dean's House. (Photo: Daniel Ehrenworth)

Opposite

A view of the Myhal Centre from St. George Street. Mechanical facilities are located on the roof together with an array of solar panels. (Photo: Daniel Ehrenworth)

Remembered by generations of our alumni for its distinctive red bricks, the Little Red Schoolhouse, our Faculty's first building (demolished in 1967), was at the forefront of engineering education in Ontario since 1878. Since the opening of the Little Red Schoolhouse, we have added 14 buildings to our precinct at the University's St. George campus. In 2018, under the leadership of Dean Cristina Amon, we celebrated our Faculty's ambitious commitment to excellence in engineering education, innovation and research with the opening of the Myhal Centre for Engineering Innovation & Entrepreneurship at 55 St. George Street.

The Dean's Office

44 St. George Street

Incorporated 2009

When the Galbraith Building opened in 1961, the Dean's Office was located on the ground floor of the building, adjacent to the Registrar's Office, which was home to many of our deans for nearly 50 years.

As research activity and graduate programs expanded, demands on the Dean's administrative offices changed and internal and external communications efforts were prioritized. It became increasingly important that senior administrative personnel share office space to facilitate collaboration, co-ordination and enhance communication and idea sharing.

In 2009, Dean Cristina Amon made the bold decision to relocate the Dean's Office to the house incorporated into the Bahen Centre at 44 St. George Street. This move consolidated the dean's administrative staff and brought the Vice-Deans into a shared space to provide the appropriate services to adequately represent the Faculty and its interests within the University community. The move also created room for an in-house communications team, Engineering Strategic Communications, and enabled us to introduce new, joint-Faculty programs and initiatives, including undergraduate and graduate certificates and minors, the immensely successful TrackOne, Undeclared Engineering first-year option. It also enhanced graduate program offerings, particularly the revamping and growth of our MEng programs with industry partners.

In 2009, the space within the Offices at 44 St. George Street was actively supporting the Professional Experience Year (PEY) offices, elements of the Engineering Science program and an Electrical and Computer Engineering undergraduate common room. All these units were eventually relocated, which enabled a more comprehensive and cohesive use of the space. It also had the added advantage of providing a visible street-level presence for the Dean's Office on campus. The redesign was undertaken by architect Thom Pratt of Diamond Schmitt Architects, who also played a leading role in the Bahen Centre development.

In Memory of John and Margaret Bahen

In November 2016, the University of Toronto lost two outstanding alumni and supporters when John (CivE 5T4) and Margaret Bahen passed away within days of each other. Their commitment to advancing engineering and medical scholarship and their contributions to the campus through their support of the Bahen Centre for Information Technology leave a lasting mark on our precinct and in the lives of millions of Canadians.

Left

The Bahen Centre for Information Technology is home to our Division of Engineering Science, Department of Mechanical & Industrial Engineering and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering.
(Photo: Daniel Ehrenworth)

Opposite

The Donnelly Centre for Cellular & Biomolecular Research, completed in 2005, provides collaborative lab space for researchers in the Faculties of Applied Science & Engineering, Medicine and Dentistry.
(Photo: Daniel Ehrenworth)

Right

The Fields Institute houses our Engineering Career Centre (ECC), the home of our Professional Experience Year Co-op Program. The ECC oversees the hiring of more than 700 engineering students each year.
(Photo: Daniel Ehrenworth)

Terrence Donnelly Centre for Cellular & Biomolecular Research
160 College St.
Opened 2005

The Terrence Donnelly Centre for Cellular & Biomolecular Research (Donnelly Centre) was conceptualized in response to the new genomic technologies enhancing biomolecular research. Financial support, exceeding $60 million, was provided through a significant Canada Foundation for Innovation (CFI) allocation, including matching support by the Ontario government. Named after philanthropist Terrence J. Donnelly, the Centre opened in 2005 and became home to interdisciplinary research in engineering, biology, medicine, chemistry and dentistry. The open-concept labs and social spaces that are hallmarks of the building's architecture are ideal for collaboration between medical scientists and engineers.

The Faculty of Applied Science & Engineering occupies 30 per cent of the building. In the Donnelly Centre, our professors and researchers are at the forefront of advancements in regenerative medicine and biomedical engineering. The Institute of Biomaterials & Biomedical Engineering, Medicine by Design (MbD), Centre for Commercialization of Regenerative Medicine (CCRM) are among some of our multidisciplinary research centres that are catalyzing innovative approaches to stem cell biology in the Donnelly Centre.

Bahen Centre for Information Technology
40 St. George St.
Opened 2002

As enrolment in computer engineering, electrical and industrial engineering increased, so too was there a demand for a large, more technologically advanced facility for engineering. Foreseeing this need, our Faculty embarked on the award-winning 20,000-square-metre Bahen Centre for Information Technology. It as designed by Diamond Schmitt Architects and constructed between 2000 and 2002. The building is named after the late John (CivE 5T4) and Margaret Bahen, who were remarkable supporters of and contributors to the Faculty.

Unique to the Bahen Centre at the time of its construction was the incorporation of the historic Koffler Student Centre into the interior of the building, successfully integrating the old exterior of the Student Centre into the new lobby. It was funded by government grants, corporate support, philanthropic donations and ongoing funding from the University of Toronto. The building houses the Division of Engineering Science and the Engineering Science student lounge, 50 laboratories, 10 lecture theatres, 13 tutorial rooms, nine seminar rooms and about 300 office spaces. It has become a multidisciplinary space, now also housing the University's Department of Computer Science and Department of Mathematics. The Entrepreneurship Hatchery (the Hatchery) got its start in the Bahen Centre in 2012, and moved to the Myhal Centre in 2018. The building has also received awards and honourable mentions for its innovative design, including the Ontario Association of Architects Award of Excellence (2003), Toronto Architecture and Urban Design Award of Excellence (2003) and bronze in the National Post Design Exchange Award in the environmental category.

The Galbraith Building is named after the first dean of our Faculty, John Galbraith (1846–1914). It houses our Department of Civil & Mineral Engineering and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering. (Photo: Daniel Ehrenworth)

The Haultain Building is named after late Professor H.E.T. Haultain (1869–1961). Haultain was a leader at our Faculty, commissioning The Ritual of the Calling of an Engineer and establishing the Iron Ring Ceremony. (Photo: Daniel Ehrenworth)

The Fields Institute
222 College St.
Opened 1995
Named after Canadian mathematician John Charles Fields, the Fields Institute is a leading institute for the study of mathematics, providing a space for mathematicians from around the world to expand and apply their research. The Fields Institute was initially founded at the University of Waterloo in 1992, but was relocated to U of T in 1995, residing at its College Street location. KPMB Architects designed the building to make best use of natural light, provide top-tier research space and house a comprehensive mathematics library. It is also known for its impressive spiral staircase. The Fields Institute is also home to our Engineering Career Centre, which administers our long-standing Professional Experience Year (PEY Co-op) program, as well as our Human Resources office.

D.L. Pratt Building
6 King's College Rd.
Opened 1991
In 1991, the D.L. Pratt Building was a significant addition to the engineering precinct, made possible by a $6.2 million donation from Mrs. Lucile Pratt on behalf of her late husband, Lorne Pratt (CivE 2T2). As a result of this timely contribution, a substantial three-floor addition was made to the Metallurgy Wing of the Wallberg Memorial Building. Lorne Pratt left the bulk of his estate to the Faculty in the late 1960s with the condition that the Faculty sustain his spouse until her death. In 1987, Dean Gary Heinke, faced with a shortage of space to accommodate the Centres of Excellence, approached Mrs. Pratt to explore using the estate funds to address the space requirement while honouring the Faculty's obligations to support her. Following extensive negotiations, the Pratt Building became a reality in 1991. These initiatives allowed Lucile Pratt to enjoy the significant contribution on behalf of her husband prior to her passing in 2005. Today the D.L. Pratt Building is primarily home to electrical, computer and materials science and engineering research laboratories.

Galbraith Building
35 St. George St.
Opened 1961
Named after John Galbraith, the first engineering professor and dean of our Faculty, the Galbraith Building is home to the Department of Civil & Mineral Engineering and The Edward S. Rogers Sr. Department of Electrical & Computer Engineering (ECE). Designed by Page & Steele Architects, the building's design reflects the iconic architecture of its time.

Connected to the Sandford Fleming Building, the Galbraith Building was constructed to meet a growing demand in the fields of civil and electrical engineering. The Galbraith Building maintains the Structural Testing Facility, the Cadario Facility and the Nora Vaughan Environmental Laboratories, as well as sophisticated photogrammetry equipment for aerial surveying. The building also houses ECE photonics groups on the fourth floor.

A common legend at the Faculty suggests that the original barrel of the Skule™ Cannon was laid into the cornerstone of the building, but the validity of this fact remains unknown.

Lucile's Lament

Why can't people get along
together?
Why can't people give and take?
Why can't nations see eye to eye
together?
What a lovely world it would make!

Why can't people work together,
every colour and creed?
And why can't people give each
other love
Instead of hate and greed?

Lucile Pratt, 1986

Left
The Pratt Building was first known as the Metallurgy Building. It was constructed in 1955 as a single-storey building, and reopened as the D.L. Pratt Building in 1991 following the addition of three floors. (Photo: Daniel Ehrenworth)

Right
The University of Toronto Institute for Aerospace Studies' Microsatellite Science and Technology Centre opened in 2013. It adds 1,200 net assignable square metres to the original UTIAS building. The Centre was designed to accommodate the anticipated growth in microsatellite research. (Photo: Double Space Photography)

University of Toronto Institute for Aerospace Studies (UTIAS)
4925 Dufferin St.
Opened 1950; relocated in 1959
In 1950, the University of Toronto Institute of Aerophysics (UTIA), renamed the University of Toronto Institute for Aerospace Studies (UTIAS) in 1963, moved to a renovated Royal Canadian Air Force hangar in Downsview, Ontario. Its defining architectural feature, a 12-metre steel sphere, housed a supersonic wind tunnel, shock tubes and a state-of-the-art flight simulator. Between 1958 and 1959 the Institute moved to a new location on University of Toronto property at Downsview and has since expanded to include research centres that study sustainable aviation, robotics, unmanned aerial vehicles, combustion, and spacecraft dynamics and control. Facilities at UTIAS have also expanded to include the MarsDome, which is used for robotics testing, and the Microsatellite Science and Technology Centre (MSTC). Established in 2012, MSTC is a leading-edge research facility that houses the latest test equipment, including a large liquid-nitrogen-cooled thermal vacuum chamber, vibration table and anechoic chamber for spacecraft-level environmental testing. It also houses the Space Flight Lab (SFL). The SFL is an award-winning laboratory that is one of the world's leading producers of low-cost, innovative micro and nanosatellites. It was established at UTIAS in 1998 and is recognized as Canada's most prolific satellite builder and exporter of satellites, internationally. The Institute also houses the Flight Research Simulator, which is a state-of-the-art motion-based flight simulator, used to improve pilot training to increase air-travel safety and to study the handling qualities of aircraft designs.

Wallberg Memorial Building
184 College St.
Opened 1949
During the Great Depression in the 1930s, the provincial government was required to scale back funding to the University, despite student enrolment rising to an all-time high. In 1933, an unexpected private donation of $1 million made to the Faculty by the estate of Ida Marie Wallberg—in memory of her late brother, Emil Andrew (E.A.) Wallberg, an engineer-industrialist—enabled the construction of a new building. This donation came as a surprise to the Faculty, as E.A. Wallberg was not an alumnus nor did the family hold a connection to the University. Many believe his experience working with Faculty graduates throughout his career inspired him to donate to the Faculty. Wallberg also built his fortune in numerous Canadian mining and manufacturing ventures, which may be the reason behind the bequest to the Faculty.

Since its completion, the Wallberg Building has been integral to the study of chemical engineering and applied chemistry, and materials science and engineering at our Faculty, where generations of our students have had the opportunity to gain insight and experience in the day-to-day responsibilities of a chemical engineer in training in the Unit Operations Lab. In 2012, a top floor was constructed for the BioZone, a multidisciplinary research centre that works at the interface of biology and engineering to use the most advanced and innovative biotechnology to address pressing global challenges related to energy, environment and health.

Opposite
Opened in 1949, the Wallberg Building is home to our Department of Chemical Engineering & Applied Chemistry and our Department of Materials Science & Engineering. (Photo: Daniel Ehrenworth)

The Engineering Annex was formerly known as the University of Toronto Press Building when it opened in 1920. In 2018, the building is home to student design teams and researchers from across our Faculty. (Photo: Daniel Ehrenworth)

Engineering Annex
11 King's College Rd.
Opened 1920; renovated and renamed 1976
Previously the home of the University of Toronto Press, this building was added to our precinct in 1976, when it was renamed the Engineering Annex. Originally designed by architects Darling & Pearson, the Press Building maintained a large library and reading room until the space was renovated to accommodate growing engineering undergraduate and graduate classes. In 2016, the building housed the Blue Sky Solar Racing design studio and the University of Toronto Electric Vehicle Research Centre (UTEV), which is a university-industry partnership between our Faculty and The Havelaar Group initiated in 2016. The Centre focuses on the development of groundbreaking technologies for electric vehicles.

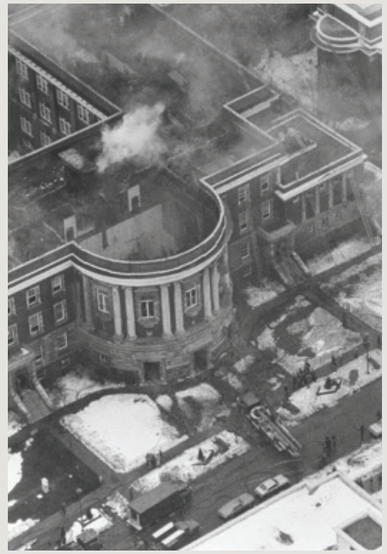
Rosebrugh Building
164 College St.
Opened 1920; renamed 1936
Following the First World War, our Faculty experienced the greatest increase in student enrolment in its history, which again called for added space within our precinct. This demand, and the hope of alleviating postwar unemployment, spurred the creation of the Electrical Building, later named the Rosebrugh Building after the first Head of the Electrical Engineering Department, Thomas Reeve Rosebrugh. Electrical engineering was the most popular choice of the incoming class in 1919, which sparked the immediate excavation of the new building site, even before the design of the building was finalized by Darling & Pearson.

The Electrical Building was officially in use by the fall of 1920. One of only two facilities instructing electrical engineering in Canada until the 1960s, the Rosebrugh Building housed an impressive laboratory for testing structural materials and was also used for the office of the applied mechanics teaching department. Subsequently, in 1965, the department expanded to include computer engineering alongside electrical, control and communications engineering. The east wing of the building was later incorporated into the Donnelly Centre for Cellular & Biomolecular Research in 2005. The building is also home to researchers and students studying mechanical, industrial, biomaterials and biomedical engineering.

Mechanical Engineering Building
5 King's College Rd.
Opened in 1909; Renamed 1948
From 1900 to 1908, our Faculty experienced another significant wave of growth. Due to industrialization and an expanding Ontario population, student enrolment increased threefold in just eight years.

The construction of the Thermodynamics Building was the proposed solution to the increase in student population. Designed by Darling & Pearson, the building housed an extensive laboratory and a separate wing for classrooms and offices. The building was finished and opened to students in the fall of 1909 and held steam, gas and hydraulic power equipment and offices for mechanical engineering faculty and staff.

In 1948, an addition was added to the Thermodynamics Building, and it was renamed the Mechanical Engineering Building. The building is located on the west side of the precinct and is one of Toronto's most significant modern buildings.



Opposite

The Mechanical Engineering Building opened in 1948. In 2018, it is still recognized as a master-piece of Bauhaus architecture. (Photo: Daniel Ehrenworth)

Top

The Sandford Fleming fire of 1977 required the extensive reconstruction of the interior of the building due to smoke and water damage. Quick thinking by staff and firefighters enabled much of the work of master's and doctoral students to be salvaged. (Courtesy: U of T Engineering & Computer Science Library)

Bottom

The Rosebrugh Building connects the Lassonde Mining Building with the Donnelly Centre for Cellular & Biomolecular Research. It is a hub for multidisciplinary collaboration among our engineering researchers. (Photo: Daniel Ehrenworth)

Engineering & Computer Science Library

Located on the second floor of the Sandford Fleming Building, the Engineering & Computer Science Library has been a resource for engineering and computer science students since 1969. Previously, each engineering department, division and institute had maintained its own library, until the University of Toronto Library integrated the civil and electrical engineering collections into one branch of the Central Library in 1965. Shortly after merging, the collection grew from 7,800 publications to 18,000. Anticipating additional growth, the expansion of the library to the Sandford Fleming Building was initiated by former Dean, James Ham. Once relocated, the library consolidated publications from the departments of civil, electrical, mechanical, industrial, chemical, metallurgical and mining engineering to form the Engineering & Computer Science Library in 1969, with our University of Toronto Institute for Aerospace Studies maintaining its own collection at its Downsview campus. As of 2016, the library maintains a print collection of 200,000 books and 1,200 journal subscriptions with access to over 100,000 electronic journals and books. One of the most defining features of the library is its concrete spiral staircase located in the centre of the first floor. Some alumni will also remember the countless number of paper airplanes strategically wedged into the library's perforated metal ceiling by generations of engineering and computer science students.

Opposite

The Sandford Fleming Building first served the Faculty of Physics. U of T Engineering acquired the building in 1967 – today it is the heart of student life in our Faculty and home to The Edward S. Rogers Sr. Department of Electrical & Computer Engineering.
(Photo: Daniel Ehrenworth)

Sandford Fleming Building

10 King's College Rd.

Opened 1907; Sandford Fleming fire 1977; rebuilt 1982

As the student population of chemical, mineral and civil engineering occupied the majority of the existing buildings, little room was left for physics. The Sandford Fleming Building was designed by Darling & Pearson to accommodate the Department of Physics. It was built in 1907, and named after Sir Sandford Fleming in 1967, former Chief Engineer of the Intercolonial Railway of Canada.

In the early morning hours of February 11, 1977, a catastrophic fire broke out in the east-corner lecture room and spread throughout the Sandford Fleming Building, burning for eight hours before it could be brought under control. Fortunately, no one was injured and emergency crews salvaged the computer centre in the south wing, but the central rotunda and entire north wing were destroyed. The adjoining Galbraith Building also suffered substantial smoke and water damage, and about 15,000 square metres of usable space was lost. Geological engineering students at the time remember arriving to campus early to write an exam, only to witness flames engulfing the building. The fire also affected the Engineering & Computer Science Library. Fortunately, many of the collections remained untouched by the flames. The combination of water from the fire trucks and freezing temperatures presented some trouble to the library collection. Luckily, the quick thinking of library staff, including archivist L.E. Jones, managed to save much of the existing collection by flash-freezing the books in a freezer room in the Wallberg Building. Research and computer tapes were salvaged, and over 50,000 volumes recovered.

The Sandford Fleming Building was rebuilt five years later with financial assistance from the Ontario government. The rebuild was designed by Page & Steele Architects. When opened to students and faculty, the renovated building boasted new facilities for electrical engineering and computer science, a second phase to the structure's laboratory for civil engineering and an improved Faculty library.

It became the hub of engineering student activity and home to the Engineering Society, Engineering Stores, the Lady Godiva Memorial Bnad room (relocated to the Myhal Centre in 2018) the Hard Hat Café, and a common area popular with students, referred to as "The Pit." The building is also home to the engineering Hall of Distinction, which recognizes and celebrates exceptional alumni of the Faculty.

Lassonde Mining Building

170 College St.

Opened 1905; renovated 1990 and 2009

In the early 1900s, more than a decade after the expansion of the Little Red Schoolhouse, a faculty and student-led demand for greater space allocation at the University prompted the provincial government to support the expansion of the SPS. This enabled the construction of the Chemistry and Mining Building in 1902, later named the Mining Building, a four-storey stone structure designed by Frank Darling and Francis Riley Heakes. Twice the size of the Little Red Schoolhouse, the new building hosted lectures in chemistry, mining, mineralogy and geology. Despite its size, the building could not meet the increasing number of SPS students, which nearly doubled in the time it took to complete construction. New buildings were required to accommodate a growing student population.

In 1990, the Mining Building underwent its first substantive renovation, which

provided increased space for the Department of Mechanical Engineering and the Department of Materials Science & Engineering. It also required the relocation of the Department of Geology to the Earth Sciences Centre. With the financial support of the provincial government and generous contributions from numerous donors whose names are listed at the southern entrance, the full expansion of the eastern half of the building was made possible. The building is a designated heritage property for its importance as a work of Edwardian Classicism.

In 2009, the Mining Building was renamed the Lassonde Mining Building after donor, Canadian mining expert and entrepreneur Pierre Lassonde. Initiated by Dean Cristina Amon and with contributions from the federal government, the Faculty of Applied Science & Engineering, Dr. Lassonde and Goldcorp, the building underwent a second $22-million renovation in 2011, turning the previously unusable attic space into a multi-purpose design studio and event space. The Goldcorp Mining Innovation Suite hosts 100 workstations for civil and mineral engineering students. The revitalization included the installation of a distinctive glass elevator, inspired by lifts typically found in mineshafts. The renovated attic also pays tribute to the history of the Faculty with the preservation of student-signed bricks from the Little Red Schoolhouse and the previously unfinished attic. Special design elements of the Goldcorp Mining Innovation Suite include automated smart-blinds moderating temperature fluctuations, thermal buffer zones to naturally heat the space and ample skylights that decrease glare and promote light distribution. In 2014, the suite won the Canadian Green Building Award for its innovative and sustainable design and construction.

The original Canadian Mining Hall of Fame is also located in the Lassonde Mining Building. This century-old hallway located on the first floor of the building recognizes and honours leaders and innovators in the Canadian mining industry. Names and pictures of alumni and friends of our Faculty are found on the wall, with open spaces for the next generation of mining innovators. The Lassonde Mining Building is home of the Lassonde Mineral Engineering Program and the Lassonde Institute of Mining.

Haultain Building
170 College St.
Opened 1903; renovated and renamed 1931
The Haultain Building, formerly the Mill Building, was designed by Frank Darling in association with Francis Riley Heakes in 1903 and renovated in 1931. Tucked away on King's College Road between the Mechanical Engineering Building and the Roseburgh Building, the building was constructed as a milling building for the School of Practical Science (SPS), which housed machinery for experiments on the mechanical processing of ore. The 1931 expansion added several floors with new space for classrooms and offices.

In 1971, a Safe Low-Power Kritical Experiment reactor (SLOWPOKE) was installed in the basement of the Haultain Building, which expanded the capability of nuclear research at the University and in Canada. The building continues to serve as the centre for neutron activation analysis in the Faculties of Medicine, Arts & Science and Applied Science & Engineering.

Pierre Lassonde

Over the past 20 years, Pierre Lassonde has pledged more than $10 million in philanthropic support to several Faculty projects, beginning in 1996 with a landmark gift of $5 million to our Mineral Engineering Program, renamed the Lassonde Mineral Engineering Program. Lassonde's ongoing support of our undergraduate and graduate scholarships, faculty research and industry collaborations, and his investments in the Lassonde Mining Building, enable us to enhance our impact on the mining industry and lead the way on all frontiers of mining education and research innovation.

Opposite

Opened in 1905, the Lassonde Mining Building is the oldest building in our precinct. It is home to the Lassonde Mineral Engineering Program and the Lassonde Institute of Mining, both supported by Canadian mining mogul Pierre Lassonde. (Photo: Daniel Ehrenworth)

Edward S. Rogers Sr.

In June 2000, Edward Rogers Jr. made a landmark donation of $25 million to our Department of Electrical & Computer Engineering in honour of his late father, our alumnus, inventor and radio pioneer Edward S. Rogers Sr. The department is now recognized as The Edward S. Rogers Sr. Department of Electrical & Computer Engineering. The significant contribution enabled the creation of scholarships and bursaries to attract top students from across Canada and around the world.

Engineering Building ("Little Red Schoolhouse")

Opened 1878; demolished 1967

As Richard White explains in *The Skule Story,* to ensure the School of Practical Science (SPS) was accessible to University of Toronto faculty members and prospective students, the provincial government purchased a piece of land to the west of Queen's Park, just south of University College in Toronto. The three-storey red schoolhouse, designed by architect Kivas Tully, was built in two phases: the first phase incorporated the northern one-third of the building, housing classrooms and laboratory space, which was completed for the school's official opening in 1878. The second phase, completed more than 11 years later, included the remaining two-thirds of the facility. It added four drafting rooms, three lecture rooms, a cloakroom, library, instrument room and examination hall, and a full-scale engineering laboratory. The engineering laboratory, completed in 1892, gave the school a uniquely equipped facility with machinery for testing structural beams, posts and shafts, a power lab with steam engines, electric generators and hydraulic equipment. It also incorporated a geodetic and astronomical laboratory equipped with cutting-edge, high-grade measuring and surveying equipment. These additions enabled the establishment of mechanical engineering as the first engineering specialty at the SPS.

As the study and research of engineering expanded at the University, so did many other Faculties. To properly accommodate the growth of the Faculty and to make way for the new medical school, the Little Red Schoolhouse, or "Skulehouse" as it became known after the Second World War, was demolished. The original stone frieze, reading "School of Practical Science," is now located in the foyer of the Galbraith Building, above the bust of the school's first engineering professor and Dean, John Galbraith.

Opposite

The School of Practical Science was located at the present-day location of the Medical Sciences Building. (Courtesy: U of T Archives & Records Management Services)

Right

Students, alumni, faculty and staff gather outside the School of Practical Science to commemorate the impending demolition of the building in 1966. (Photo: Jack Marshall Photography)

A view of University College and Bloor St. and Yonge St. from the Dr. Woo Hon Fai Terrace on Level 8 of the Myhal Centre.
(Photo: Daniel Ehrenworth)

REFLECTIONS ON EXCELLENCE

CHAPTER

5

Professor Paul Jowlabar (ChemE) and two undergraduate research students conduct experiments in the Unit Operations Lab. The lab, affectionately known as the Unit Ops Lab by generations of our alumni, was opened in 1949. (Photo: Daniel Ehrenworth)

Previous spread

Completed in 2010, the Goldcorp Mining Innovation Suite boasts flexible spaces for students, faculty and industry partners to meet and collaborate. (Photo: Daniel Ehrenworth)

Right

Dean Cristina Amon, far right, with five former U of T Engineering deans. From left: Bernard (Ben) Etkin, Gordon Slemon, Gary Heinke, Michael Charles and Anastasios (Tas) Venetsanopoulos. (Photo: Mark Neil Balson)

Our student experience is unparalleled. Through curricular, co-curricular and experiential learning opportunities, our students develop the competencies required to lead in a rapidly changing world.

Reflecting on a history of excellence in engineering education

Ambition, innovation and excellence have long been the hallmarks of our Faculty since its beginnings as the School of Practical Science in 1873. In the pages that follow, three timelines have been assembled to showcase program developments and Faculty leadership from 1970 to 2018, as well as the remarkable achievements under the leadership of Dean Cristina Amon.

The chapter concludes with features by each of the five departments, two institutes and our Division of Engineering Science. Each has recorded selected silver threads of past achievements within their unit—many of which will be fondly remembered by alumni. Woven together, these unique threads provide the reader with a glimmer of the depth and breadth of achievements that have contributed to our vibrant community and world-class standing.[1]

1. Those who wish to fully appreciate the early days of the faculty and its historical developments are encouraged to read *The Skule Story: The University of Toronto Faculty of Applied Science and Engineering, 1873–2000* by Richard White.

Leadership Timeline
1970–2018

The University and Faculty leadership presented below spans nearly four decades, beginning at the start of the second century of engineering education in Canada and concluding in the special third term of Dean Cristina Amon. This table acknowledges the many individuals who have contributed to the shining success and the growth of the University and our Faculty in leadership positions.

- University Administration
- Dean & Departments
- Divisions
- Institutes


1966: Ham


1974: Etkin


1979: Slemon


1986: Heinke


1992: Charles


2001: Venetsanopolous


2006: Amon

	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
President	BISSEL	EVANS	HAM	STRANGWAY / CONNELL	PRICHARD		BIRGENAU	IACOBUCCI (INTERIM) / NAYLOR	GERTLER	
Provost	SWORD	FORSTER	CHANT	STRANGWAY / IACOBUCCI	FOLEY	SEDRA	NEUMAN	GOEL	MISAK	REGEHR
Dean	HAM	ETKIN	SLEMON	HEINKE	CHARLES		VENETSANOPOLOUS	AMON		
Speaker of Faculty Council		ANDERSON	TRASS	CRAIG / LEE	KENNY	MILLER	MCLEAN	PARADI	ADAMS / CHENG / ROSE / SINCLAIR	REEVE
Registrar			ALLEYNE	LEITH / MCCANN						MACMILLAN
Department of Civil & Mineral Engineering	KENNEY	HEINKE		UZUMERI	SOBERMAN	ADAMS	YOUNG	MCCABE	SLEEP	
Lassonde Institute of Mining	NUFFIELD / GEOLOGICAL ENGINEERING	DELORY	GEO-ENGINEERING	SCOTT / GEOLOGICAL & MINERAL ENGINEERING (1989)			BAWDEN / LASSONDE INSTITUTE OF MINING	INCORPORATED INTO DEPT. OF CIVIL ENGINEERING / HADJIGEORGIOU	SLEEP	WARREN
Division of Environmental Engineering & Energy Systems						BYER, DIRECTOR / DIVISION OF ENVIRONMENTAL ENGINEERING		KARNEY, DIRECTOR / DIVISION OF ENVIRONMENTAL ENGINEERING & ENERGY SYSTEMS		
Department of Mechanical & Industrial Engineering	LORD	BAINES	SCOTT	VENTER	MCCAMMOND	CURRIE / DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING	WALLACE	SINCLAIR	ZU	BUSSMANN
	BERNHOLTZ / INDUSTRIAL ENGINEERING	PORTER	BERNHOLTZ	FOLEY	JARDINE					
Department of Chemical Engineering & Applied Chemistry		GRAYDON	CHARLES	SMITH	BOOCOCK		REEVE		ALLEN	
The Edward S. Rogers Sr. Department of Electrical & Computer Engineering	SLEMON / ELECTRICAL ENGINEERING	K. SMITH	H. SMITH	SEDRA	ZAKY / DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING		ROSE	NAJM		
Department of Materials Science & Engineering		ALCOCK / METALLURGY & MATERIALS SCIENCE	TOGURI	MILLER	MCLEAN	PEROVIC / DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING		NOGAMI		
Division of Engineering Science	ETKIN	STOICHEFF	HOOPER	TENNYSON / HAMACHER / BALMAIN	JAMES	VRANESIC	CHENG	CLUETT	KORTSCHOT	KUNDUR
University of Toronto Institute for Aerospace Studies	PATTERSON / UNIVERSITY OF TORONTO INSTITUTE FOR AEROSPACE STUDIES	DE LEEUW		TENNYSON	HAASZ			ZINGG		DAMAREN
Institute of Biomaterials & Biomedical Engineering	MOODY / INSTITUTE OF BIOMEDICAL ENGINEERING	COBBOLD	ZINGG	SMITH / CENTRE OF BIOMATERIALS, FACULTY OF DENTISTRY / PILLAR	KUNOV		SEFTON / INSTITUTE OF BIOMATERIALS & BIOMEDICAL ENGINEERING	ETHIER	SANTERRE / YIP	CHAN

Spotlight on Achievement
2007–2018

Professor Cristina Amon is the longest serving dean (2006–2019) in our Faculty's last half century, and the first woman Dean in our history. The following timeline celebrates selected highlights of our Faculty's achievements under her transformational leadership.

- Educating Future Engineers & Student Experience
- Research Foci
- Outreach, Collaboration & Influence
- Resource Allocation

2007–2008

Created first MEng emphasis: Entrepreneurship, Leadership, Innovation & Technology in Engineering (ELITE)

Welcomed first cohort of TrackOne students

Hosted first Dean's Student Town Hall, a forum for Faculty leadership and the Engineering Society to foster student engagement

Launched Skule Sisters women's mentorship program, pairing current U of T Engineering students with high school students

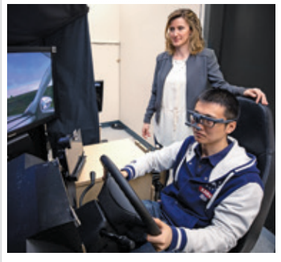
Established Office of the Vice-Dean, Graduate Studies

Phased out Professional Development Centre and partnered with the School of Continuing Studies

2008–2009

Launched undergraduate minors in Sustainable Energy and in Environmental Engineering

Established the Task Force on Globalization and Engineering



Launched Centre for Research in Healthcare Engineering (renamed Centre for Healthcare Engineering in 2015)

Prioritized physical space improvement as a result of year-long Comprehensive Divisional Space Review

2009–2010

Created the Cross-Disciplinary Programs Office to administer undergraduate engineering minors

Launched First Year Office to support incoming undergraduate students

Established the Centre for Global Engineering (CGEN)

Created the Identity, Privacy & Security Institute (IPSI)

Established the Engineering Outreach Office to coordinate pre-university STEM programs with a focus on engaging under-represented communities

Created in-house communications team: Engineering Strategic Communications

2010–2011

Launched a minor in Engineering Business

Established the Institute for Leadership Education in Engineering (ILead), renamed Troost ILead in 2018.

Launched the Institute for Robotics & Mechatronics (IRM)

Earned the Canadian Green Building Award for the Goldcorp Mining Innovation Suite in the Lassonde Mining Building

Created the Dean's Strategic Fund to provide seed funding for strategic Faculty initiatives

2011–2012

Launched BioZone, a centre of applied bioscience and bioengineering

Launched the Centre for Resilience of Critical Infrastructure (CRCI)

U of T allocated Site 10 location for the new Centre for Engineering Innovation & Entrepreneurship (CEIE), renamed the Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre) in 2018.

Implemented new budget allocation model

Developed and hosted the first educational technology (EdTech) conference for U of T community

Hosted inaugural Girls' Leadership in Engineering Experience (GLEE) event for top female applicants

2012–2013

Launched The Entrepreneurship Hatchery

Established the U of T Institute for Multidisciplinary Design & Innovation (UT-IMDI)

Created the Centre for Research in Sustainable Aviation (CRSA)

Held first Faculty-wide industry partners reception

Set $200M fundraising goal as part of U of T's Boundless campaign

Launched the Engineering Instructional Innovation Program (EIIP)

Opened new space flight laboratory for microsatellite research at UTIAS

Spotlight on Achievement
2007–2018

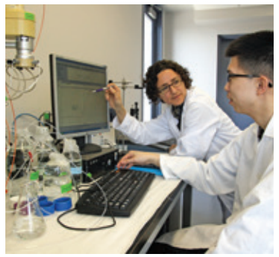
A time capsule encased on Level 1 in the Myhal Centre for Engineering Innovation & Entrepreneurship, will be opened on the occasion of the Faculty's 200th anniversary in 2073. In it, future faculty members and students will find icons representing this important period of our history, including a copy of this book.

- Educating Future Engineers & Student Experience
- Research Foci
- Outreach, Collaboration & Influence
- Resource Allocation

2013–2014

First cohort of students completed multi-disciplinary capstone projects with industry clients

Formed strategic partnerships with five Canadian universities to promote engineering graduate studies across the country



Institute for Sustainable Energy (ISE) expanded to a cross-Faculty research unit

Completed construction of new floor in the Wallberg Building to house BioZone

2014–2015

Established Collaborative Program in Engineering Education in partnership with OISE

Piloted new broadbased undergraduate admissions process

Launched the Toronto Institute of Advanced Manufacturing (TIAM)

Established the Ontario Centre for the Characterisation of Advanced Materials (OCCAM)

Launched U of T Transportation Research Institute (UTTRI)

Hosted inaugural Young Women in Engineering Symposium (YWIES)

Opened first Technology Enhanced Active Learning (TEAL) Classroom

2015–2016

Launched Start@UTIAS entrepreneurship incubator program

Hosted top domestic prospective graduate students at the first Faculty-wide Graduate Research Days event

Established Medicine by Design, supported by the largest single research grant in U of T history

Launched the Translational Biology and Engineering Program (TBEP) at the Ted Rogers Centre for Heart Research in partnership with the Faculties of Medicine and Dentistry

Established the Institute for Water Innovation (IWI)

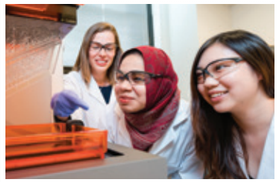
Partnered with Google Canada and Actua to host Innovate U, Canada's largest STEM event for kids

Broke ground on construction of the CEIE

Ontario government announced $15M investment in the CEIE

2016–2017

Reached 40% women among first-year undergraduates



Launched a new MEng program in biomedical engineering

Established the Percy Edward Hart and Erwin Edward Hart Professorships and Hart Teaching Innovation Professorships from a $20M endowment

Formed Engineering Indigenous Initiatives Steering Committee

Expanded CONNECT alumni network social media platform across all departments

Achieved Boundless fundraising goal of $200M and expanded target to $230M

Began upgrades on 89 lab spaces through the Lab Innovation for Toronto (LIFT) fund

2017–2018

Launched a new era of engineering education and research with the opening of the Myhal Centre for Engineering Innovation & Entrepreneurship (Myhal Centre)

Established the Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP), which brings together the Troost ILead, Engineering Communication Program, Engineering Business Minor and Collaborative Specialization in Engineering Education

Established a new Engineering Science major in Machine Intelligence, the first of its kind in Canada

Created the OPTIONS (Opportunities for PhDs: Transitions, Industry Options, Networking, and Skills) program for doctoral students pursuing careers in industry

Established the Diversity & Inclusion Committee and the Eagles' Longhouse, a group of faculty and staff dedicated to improving the Faculty's engagement with Indigenous communities (from left: Professor Jason Bazylak, Dean Cristina Amon and Elder Kim Running Bear McDougall)

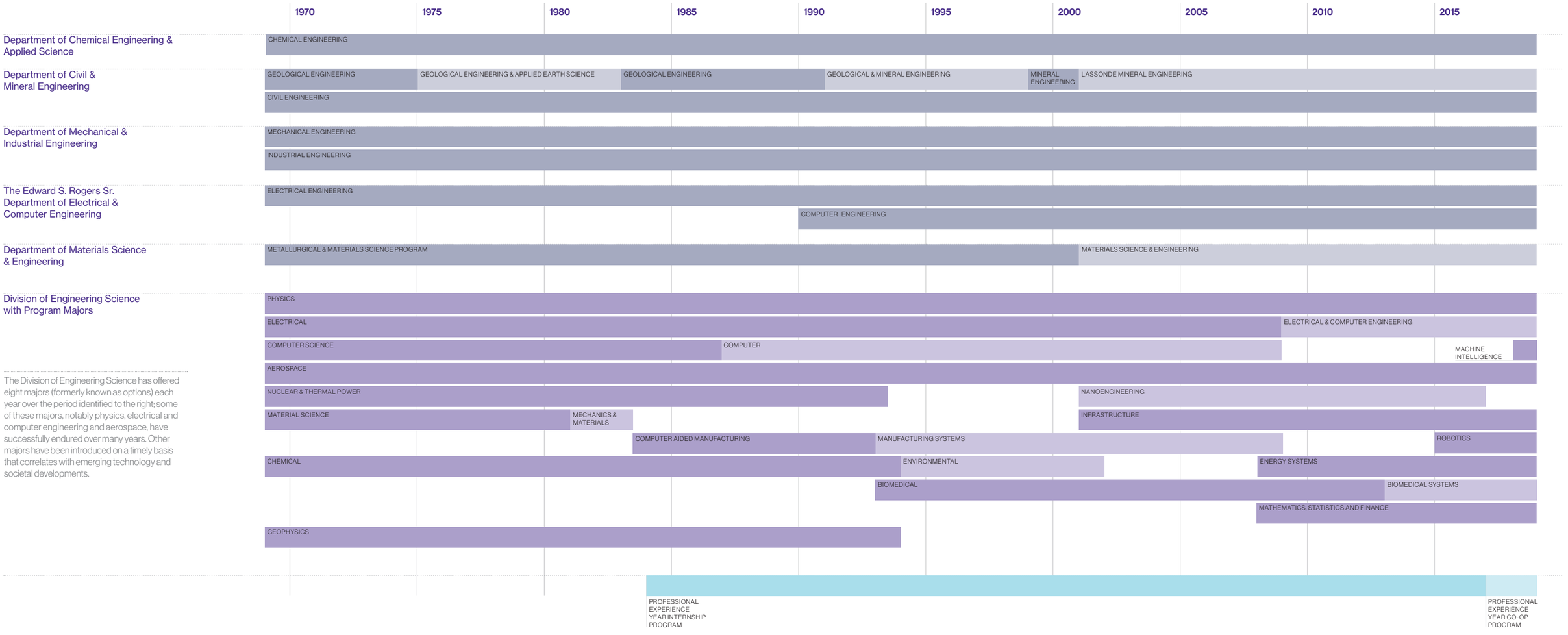
Collaborated with the Faculty of Music to launch an undergraduate minor in Music Performance and certificate in Music Technology

Created the first Dean's Advisor on Black Inclusivity Initiatives and Student Inclusion & Transition Mentor position, pictured is Mikhail Burke (MSE 1T2, IBBME PhD 1T8), the first appointee to the role

Engineering Program Timeline
1970–2018

The extensive range of programs offered within the Faculty of Applied Science & Engineering is presented below by department and division. Programs change over the years and some are renamed to more accurately reflect the requirements of our society and the engineering profession. This is particularly applicable to the various program majors within Engineering Science. All programs also enable students to select minors and to undertake internships within the Professional Experience Year Co-op Program.

- Departments
- Division of Engineering Science with program majors
- Professional Experience Year Co-op Program



The Division of Engineering Science has offered eight majors (formerly known as options) each year over the period identified to the right; some of these majors, notably physics, electrical and computer engineering and aerospace, have successfully endured over many years. Other majors have been introduced on a timely basis that correlates with emerging technology and societal developments.

Department of Chemical Engineering & Applied Chemistry

Selected Highlights

2010
The Department introduces BioZone, an innovative multidisciplinary research centre. The centre's team, led by inaugural Director, Professor Elizabeth Edwards, uses advanced biotechnology to address urgent societal needs in energy, environment and health.

1994
Professor David Boocock creates a more efficient method of converting cooking grease, waste animal fats, recycled vegetable oils and agricultural seed oils into environmentally friendly biodiesel.

1974
University Professor Michael Sefton (ChemE 7T1) joins the Department as a faculty member and introduces biomedical engineering to the Department. Sefton has made significant contributions to research advances in biomaterials, biomedical engineering and regenerative medicine. He was one of the first engineering researchers to combine living cells with polymers, effectively launching the field of tissue engineering.

1970s
A Canadian pioneer in environmental chemistry, Professor Donald Mackay gains international recognition in the field of oil spill research by developing equations and mathematical models to describe spill behaviour and effects in temperate and arctic oceans. He was hired as a professor in the Department in 1967, and went on to develop an environmental modeling system, which provides valuable insight into the behaviour of chemicals in the natural environment as well as a framework for projections for their spread. These models are used to help guide regulatory and international environmental policy decisions.

1964
M. Jane Phillips (ChemE 5T3) becomes the first woman professor in the Department. Phillips went on to become the second woman President of Professional Engineer Ontario and the first woman to be elected for the position.

1953
Professor Howard Rapson joins the Department. Rapson is considered a leader and innovator in the pulp and paper industry for his research on chlorine dioxide bleaching. Rapson's successors include Professor Doug Reeve (ChemE MASc 6T9, PhD 7T1) who founded our Pulp and Paper Centre (PPC) in 1987, and Honghi Tran (ChemE PhD 8T2) who, since 2003, heads the PPC. Over the last several decades, the PPC has become internationally recognized for facilitating partnerships between the Faculty and the pulp and paper industry.

1949
The Wallberg Memorial Building, home to the Department, is completed. The Unit Operations (Unit Ops) Lab is also opened, furnished with industrial-scale equipment, including a gas absorption tower, a liquid-liquid extraction column, a climbing-film evaporator and an evaporating still. More than 60 years later, Unit Ops remains central to the undergraduate chemical engineering program.

Right
Chemical engineering students operate a pilot scale apparatus in the Unit Operations Lab. (Photo: Roberta Baker)

Inspiring generations of chemical engineering students through experiential learning in the Unit Operations Lab

The Unit Operations Lab, or Unit Ops as one will hear students refer to it in the halls of the Wallberg Memorial Building, has provided a unique learning space for aspiring chemical engineers at our Faculty since 1949. From the date of its launch, Unit Ops has been an integral part of a chemical engineering student's experience. It is the exemplary experiential learning lab, providing exposure to process units found in the chemical industry; it is a space where abstract concepts learned in the classroom come to life.

In Unit Ops, students can look at a pressure gauge and appreciate the physical force being measured rather than looking at just a number on a screen. The glass distillation columns enable students to look inside to see what processes such as flooding and weeping look like, which provides a lasting mental image of what is occurring inside the process units. This experiential learning opportunity enables students to experience engineering principles applied to complex engineering challenges, bridging the gap between the theoretical and practical, and preparing the students for a career in chemical engineering.

To continue to inspire innovation and excellence in both undergraduate and graduate students, Unit Ops has undergone a major transformation. A new facility consisting of 5L, 50L and 100L batch reactors instrumented with state-of-the-art equipment was introduced for the first time in 2014. This versatile batch system allows students to carry out the synthesis of octyl acetate over a three-day lab. In addition, renovations in 2015 increased the amount of useable space by almost 2,000-square-feet. Unit Ops has become the leading wet lab for our Faculty, providing students from across our Faculty the opportunity to benefit from this world-class facility.

In addition to the practical learning experience offered by the lab, students look forward to solving engineering challenges in a team environment. Unit Ops is a collaborative space where students and faculty come together to find solutions to global challenges in areas such as health care, energy and the environment.

As contemporary education changes, the experiential learning that takes place in Unit Ops will remain an integral part of the Department's student experience. The Department looks forward to evolving this space, enabling students to achieve their greatest potential and creating the leaders of tomorrow.

Department of Civil & Mineral Engineering

Selected Highlights

2018
The Department is renamed the Department of Civil & Mineral Engineering from the Department of Civil Engineering to reflect the interdisciplinary nature of the Department's programs and research.

2006
Brenda McCabe becomes the first woman appointed Chair of the Department.

2001
Pierre Lassonde supports mineral engineering education through ongoing philanthropic support, creating the Lassonde Institute of Mining and the Lassonde Mineral Engineering Program.

1985
Steel materials and joints are tested for the SkyDome in the Structures Lab.

1973
Reinforced concrete for the CN Tower is tested in the Structures Lab.

1947
Marcia Lamont Scott is the first woman to graduate with a degree in civil engineering at U of T.

1919
The University purchases land at Gull Lake near Minden, Ontario, to be used by the Department for civil engineering students to learn the practice of surveying.

1878
Courses in civil engineering are offered through University College prior to the opening of the School of Practical Science in 1878.

Top

Near the Faculty's Survey Camp at Gull Lake, Civil and mineral engineering students spend their afternoon surveying a creek. Camp presents a unique opportunity for our civil and mineral engineering students to learn the fundamentals of route surveying in a practical setting. (Photo: Neil Ta)

Bottom

A student calibrates a total station to complete a surveying assignment at Camp. (Photo: Neil Ta)

A step outside the engineering precinct: Survey Camp at Gull Lake

Every year in August, before the beginning of third-year classes, civil and Lassonde mineral engineering students travel to the northern shores of Gull Lake near Minden, Ontario, to immerse themselves in the craft of land surveying, integrated water systems and geology. This experience is known as Civil and Mineral Practicals, which students refer to as "Survey Camp" (Camp).

Camp has been a fixture in civil and mineral engineering student life since 1919, when the University purchased the 175-acre property for the Faculty as a practical setting for students to learn surveying and project management techniques. Civil engineering students entering their second year also have the opportunity to experience Gull Lake for one night before they spend two weeks at Camp the following summer. While the fundamentals of Camp have remained much the same since it opened in 1920—students work together to learn and practise the essentials of route and construction surveying, as well as topographic mapping—it has evolved into more than a requirement of the curriculum; it has become an experience that forms lifelong friendships among students.

The daily activities, which run from 7:30 a.m. until 6 p.m., foster teamwork, collaboration and communication skills. Before Camp begins, professors divide students into groups to encourage camaraderie among those who might not otherwise have the opportunity to meet. A camp-wide siren wakes everyone each day, followed by breakfast in the dining hall (one of the original buildings, renovated in 1992). After breakfast, students gather in the schoolhouse for the day's instruction, which is followed by fieldwork until the lunchtime siren sounds at 12:30 p.m. Following lunch, students spend the rest of the day in their groups, completing assignments. The days are tiring, but students say the memories created often make up for the long hours.

In the evenings, some students venture to the Red Umbrella or the Rockcliff Tavern, local favourites in the neighbouring community. For others, downtime means relaxing in the bunkhouses, singing songs by the campfire, pranking fellow classmates, admiring the picturesque scenery, walking to hidden waterfalls or taking the pontoon, 'Sir Veyor,' to Rackety Creek. Class monuments are a further manifestation of the bond between students, each monument created to commemorate a class's time at Camp and enhance the student experience. Some of the monuments include an earthquake-proof canoe rack, a gazebo, a bridge and an entrance sign to Camp.

The campsite also welcomes on-site visitors, including alumni, faculty members and the occasional passersby. A number of alumni participate as guest lecturers on their topics of expertise, to provide students with industry insight, and also sit on the Gull Lake Committee, volunteering their time to better the student and Camp experience. The class of 5T6 is an example of the lifelong relationships formed at Survey Camp. Each year the former classmates reunite for a night at Camp to relive what was a formative event of their undergraduate careers. To celebrate this bond, the class of 5T6 created a scholarship specific to Survey Camp.

The history of friendship is also found written on the walls of the nearly century-old buildings—buildings that could tell more stories than any returning faculty member. Signatures of students dating back to the 1920s decorate the bunkhouse walls, illustrating that the eternal campfire flame of camaraderie never goes out at Survey Camp.

Excellence in mineral engineering education and research in the Goldcorp Mining Innovation Suite

For over a century, our mining, geological and mineral engineering students have inscribed their names on the historic brick walls of the Lassonde Mining Building. Between classes or during study breaks, students could be found sneaking up to the fourth-floor attic to write messages on the beams and bricks of the century-old structure. In 2010, the previously vacant space was re-imagined as the Goldcorp Mining Innovation Suite, a renovation enabled by contributions from Goldcorp Inc., Pierre Lassonde, our Faculty and provincial and federal funding. The award-winning site accommodates sought-after studio design labs for 400 civil and mineral engineering students, 24 graduate student offices and a world-class conference room.

The reworking of the attic has created a meeting place for faculty, students and industry professionals. The open-concept, multi-purpose layout allows students and faculty to move easily from one room to another—a design element intended to foster teamwork, idea sharing and mentoring. Our students can also be found working on capstone projects, independently researching and testing ideas, attending public seminars and lectures, or presenting their research posters to academic and industry leaders on Lassonde Research Day. This inclusive, diverse venue has become a vibrant social hub and learning environment for our civil and mineral engineering student community. It also maintains an intergenerational connection by hosting alumni events and networking opportunities for students.

The Goldcorp Mining Innovation Suite was created to support continued excellence in student experience and mining education. It has been recognized several times by notable Canadian organizations and publications for its innovative design that harmonizes early 20th-century architecture with sustainable energy systems. The Suite also boasts leading industry-standard software in mine planning, optimization, scheduling and mineral resource estimation, contributing to our commitment to experiential learning and an interactive student experience.

The space celebrates our legacy as a leader in mineral engineering education with the names of our students from generations past intact on the brick walls of the reclaimed attic, inspiring the next generation of civil and mineral engineering students to make their mark on the Canadian mining industry.

Completed in 2011, the Goldcorp Mining Innovation Suite provides a world-class space for our Lassonde Mineral Engineering students to collaborate and spark ideas that will transform the mining industry. (Photo: Daniel Ehrenworth)

The Edward S. Rogers Sr. Department of Electrical & Computer Engineering

Selected Highlights

2017
Canadian astronaut Julie Payette (ECE MASc 9T0) is appointed Canada's 29th Governor General.

2016
Professor George Eleftheriades and his team develop a solution for the three billion people in the world without internet access: designing a new metamaterial surface that can focus electromagnetic waves into a concentrated beam; he plans to affix thin panels housing this technology to the back of tablets.

2010
Professor Brendan Frey's groundbreaking Enigma Machine Program bridges a decade-old gap between the understanding of genomes and the activity of complex processes within cells. It could one day help predict or prevent diseases such as certain cancers and neurodegenerative disorders.

1997
Professor Steve Mann's "Augmented Reality Through Wearable Computing" moves computation from the desktop to the user. A body-worn computer can assist the user more intelligently, consistently and continuously than a desktop system, adapting to the user's environment.

1982
Microelectronic Circuits, written by professors K.C. Smith and Adel Sedra, is published; the market-leading textbook is in its seventh edition and has sold over one million copies. It is the definitive text for this subject matter.

1958
Professor Marion Bassett is the first woman to join the Faculty's permanent academic staff. She joins the Faculty's Department of Applied Physics as a lecturer in illumination; she later joins the Department of Electrical Engineering.

1927
Elsie Gregory MacGill (1905–1980) is the first woman to graduate from the University of Toronto with an engineering degree, and the first Canadian woman to earn a degree in electrical engineering.

Above
Programmable bidirectional DC power supply and configurable distribution panels in the generator room in the Energy Systems Lab. This new infrastructure was installed after the first phase of the lab renewal project, which was supported by the Dean's Strategic Fund. (Courtesy: The Edward S. Rogers Sr. Department of Electrical & Computer Engineering)

Knowledge is power: creating the next electrical engineering leaders in the Energy Systems Lab

In The Edward S. Rogers Sr. Department of Electrical & Computer Engineering (ECE), students have long studied the generation, transmission and distribution of electrical power in the Energy Systems Lab (ESL), built in the mid-1950s. In the lab, undergraduate electrical engineering students are provided with experiential learning opportunities, working with power systems at specifications found in industry. While the study of power and energy systems has taken place in ECE for decades, the laboratory equipment has evolved as our power systems and needs have—what has remained constant is that the lab prepares students for a career in electrical engineering.

Alumna Marija Mijalkovic (9T6) recalls working on a converter box in the lab while supervised by Professor Richard Bonert. Hired as a Technical Laboratory Assistant in the summer of 1995, Mijalkovic was part of a team who assisted in the design, production, testing and implementation of 13 new Voltage Source Inverters (VSI). Designed by Professor Bonert, the VSI allows the user to convert Direct Current (DC) supply to Alternating Current (AC) supply and has been used in every lab since, by both undergraduate and graduate students as well as professors and researchers in ECE. When Mijalkovic returned to campus for Spring Reunion more than two decades after completing her summer job in the Energy Systems Lab, it was to her great surprise that the converter box she had helped to build in the mid-90s was still used in the lab. Over the years, modifications to the converter box had been made, but it was designed with the foresight to be both functional and versatile.

With the support of Dean Cristina Amon, the Energy Systems Lab underwent significant renovations between 2014 and 2016 to improve safety, increase power and ensure students are at the forefront of energy systems education. Some of the renovations included replacing the electrical switch gear, installing a new DC power supply, dismantling the old switch gear and replacing hundreds of metres of electrical cabling. New custom-designed programmable workstations were also installed, along with fibre-optic network cablings, which has created a facility that enables students to study the control and management of microgrids. Due to these enhancements, the ESL remains a world-class facility, preparing the next generation of electrical engineers to be leaders in their field.

Though alumni who graduated decades ago may not recognize the interior of the ESL and its equipment, they would certainly identify with the continued commitment to experiential learning. For engineers to design robust systems to handle the unpredictable energy demands of today and of the future, engineering students must have access to experiential learning opportunities to work with and understand power, communications and smart-grid systems. ECE's Energy Systems Lab puts the latest technology in the hands of students, giving them the power to design the future.

Division of Engineering Science

Selected Highlights

2015
Raffaello D'Andrea (EngSci 9T1) receives the Engelberger Award from the Robotic Industries Association—sometimes referred to as the "Nobel Prize" for robotics—for his development of autonomous mobile robots that can juggle, play soccer and much more. His autonomous flying machines perform alongside human actors in Cirque du Soleil.

1970
Former Chairs Bernard Etkin (4T1) and Rod Tennyson (6T0) are part of a six-person team of faculty members (with Barry French, Philip Sullivan, Peter Hughes and Irvine Glass) that helped avert the Apollo 13. Their job was to calculate precisely the amount of pressure required to safely jettison the lunar module from the command module so that the astronauts could return to Earth. They only had a few hours to do the calculations by hand.

1945
Sarah Beverley MacDonald becomes the first woman graduate of EngSci.

1936
A key feature of the program, the 2+2 model, is introduced: two years focused on a solid grounding in the fundamentals, followed by two years of specialization in one of the program's majors. The idea of specializing in the second half of the program has been central to Engineering Science since the start of the program. Options were first offered 1936–37, when the first class reached its junior year. The number and specifics of the specializations has changed over the years, to keep up with scientific and technological trends.

1934
The launch of the program was an important milestone for the University of Toronto. At the time, the course calendar described it as providing training in math and physics beyond what other engineering undergraduate programs could offer. The curriculum gave students a wider and more thorough introduction to the basic sciences, to provide them with a greater appreciation of the nature of the technical problems and greater facilities and equipment to find solutions. This idea is still at the heart of the program.

Right
Niema Binth Mohammad (EngSci Year 3) left, and Denise Yap (EngSci Year 3) work together to program a robotic arm as part of their major courses in biomedical engineering. (Photo: Neil Ta)

Engineering Science students at the heart of innovation in robotics and mechatronics
Introducing Freddie Firebot, Egg Smash, the Sensiteer and Monsieur Fabrique. These are the names of some of the hundreds of robots and machines created by second-year Engineering Science students in their engineering design course. Throughout the years, projects have been as diverse as self-riding bicycles, voice-controlled wheelchairs, automatic muffin makers and mine detectors. Since 1972, more than 4,500 students have completed the course, which was founded at a time when design was not yet a significant component of our engineering curriculum. Former dean, Bernard Etkin, who also served as Chair of Engineering Science, was an early champion of the course. It was intentionally placed in second year so students could synthesize the theory they learned in their first-year courses.

For decades, students have collaborated in small teams on a variety of open-ended, multidisciplinary design problems. Many remember the time they spent scavenging for used parts or sifting through bins at the electronics stores on Queen Street to find the right piece to complete their project. At the end of the course, each team presents its final design during the annual "Demo Days," where prototypes are matched against each other and tested under strict protocols.

The course has evolved as technologies and instructors have changed, but the foundation has remained unchanged. The focus of the course is experiential learning, teamwork and problem solving. Advice such as, "work in wood, it's much faster to cut than metal," is shared from generation to generation.

Some projects have demonstrated advanced prototyping and programming for their time. After microprocessors were first used in the course in 1980, Professor David Zingg introduced the first tag-playing robot project in 1989, in which two robots were pitted against each other in the classic children's playground game. Several decades before self-driving cars were part of the public imagination, second year Engineering Science students were creating autonomous robots that could find their way around unassisted—sometimes with unexpected comical effects. At the annual end-of-semester competition, one robot had a distinct "personality," seeming to hide behind a garbage can and peeking out from behind it, only to retreat when its competitor was in view. Additionally, former instructor Matt

Malone remembers a Rubik's Cube solving robot in which students based their algorithm on a PhD thesis in group theory—an outstanding example of students thinking "outside the box."

Professor Anthony Haasz, who led the course for two decades starting in 1973, reflects on his enjoyment of watching students develop innovative ideas and take them to unexpected places. This course has often brought out tenacity and enthusiasm in Engineering Science students. Professor Haasz also remembers sending students home late at night to get some sleep. Much to his astonishment, they were reluctant to stop working on their projects, even in the early hours of the morning. There are times during the winter term when the design and aerospace labs and the machine shop on the fourth floor of the Sandford Fleming Building become sought-after spaces, with teams working on their robots at all hours of the day. Students can also be found setting up obstacle courses in hallways to test their machine's abilities in preparation for Demo Day.

The experience of working under pressure builds an unparalleled camaraderie among team members, and students come away with an experience that stays with them well beyond their Skule™ years. Alumnus Raffaello D'Andrea (EngSci 9T1) launched a career pushing autonomous robots to their limits and described the course the course as a pivotal part of his engineering education. D'Andrea went on to develop the Kiva robotics system, which is implemented in Amazon warehouses around the world.

Left

Engineering Science students collaborate to design and build a pipe-inspecting robot for Demo Day 2016. (Photo: Courtesy of Division of Engineering Science)

Department of Materials Science & Engineering

Selected Highlights

2013
The Department celebrates its centennial anniversary, 100 Years of Materials Innovation. It is recognized as a world leader in materials engineering research and education.

2011
The Department celebrates the 10th anniversary of the annual academic exchange program between the materials science and engineering departments at the University of Tokyo and the University of Toronto.

2010
The first Canada Research Chair in Organic Optoelectronics was established in the Department.

1980s & 1990s
The Department expanded in research and industry grants and partnerships under the leadership of Professor W. Alfred Miller, who served as Chair from 1982 to 1992. The Department held the highest number of NSERC Industrial Research Chairs (IRCs) for a single academic department in Canada at that time. IRCs established included: Steelmaking, Welding, Chemical Process Engineering, Nuclear Engineering, Electromagnetic Processing and Nanomaterials Engineering.

1967
Ursula Franklin joins the Department as its first woman professor and the second woman professor at our Faculty.

Educating future engineers through a legacy of strong leadership

In our Department of Materials Science & Engineering, the sharing of knowledge from teacher to student extends over several generations—beginning with the appointment of Professor Lloyd Montgomery Pidgeon.

Widely regarded as the father of metallurgical research in Canada for his discovery of the Pidgeon Process, which was critical to the production of magnesium during the Second World War, Pidgeon was responsible for creating the initial stages of what would become a world-class graduate program at our Faculty. His respected reputation in the field of metallurgy attracted many post-graduate students and post-doctoral fellows who aspired to further their research studies under his guidance. Many of Pidgeon's students made renowned contributions to metallurgical and materials engineering in Canada and around the world. One of these students was Jim Toguri.

After completing high school, James Makoto Toguri joined the Department of Metallurgy as a laboratory technician. Professor Pidgeon was impressed by the performance of his new colleague and suggested he consider registering at our Faculty for an undergraduate degree in metallurgical engineering. Toguri followed this guidance and obtained a Bachelor of Applied Science in 1955, follow by a Master of Applied Science in 1957, and a doctorate in 1959, working under the supervision of Professor Pidgeon. With over 200 publications in journals and conference proceedings, and the holder of several patents, Toguri was internationally renowned for his extensive research in pyrometallurgy. He served as Chair of the Department from 1977 to 1982. Subsequent chairs of the Department, including professors W. Alfred Miller, Alex McLean, Doug Perovic and Jun Nogami, continued the traditions of strong leadership and innovation established by George A. Guess, Pidgeon and Toguri.

Left

Graduate students from our Department of Materials Science & Engineering (MSE), from left, Anastasia Alksnis (MSE MASc candidate), Alexandra Tavasoli (MSE PhD candidate) and Ayesha David (MSE MASc candidate) are three of 19 woman graduate students in the Department. (Photo: Laura Pedersen)

As Chair of the Department from 1982 to 1992, Professor W. Alfred Miller is widely recognized for his dedication to fostering partnerships with NSERC and industry. During his tenure, the Department held the highest number of NSERC Industrial Research Chairs (IRCs) in a single academic department in Canada at that time. Professor Alex McLean was appointed Chair of the Department when Miller stepped down from the role, and was the next in line to uphold the Department's legacy of innovation. McLean established the Departmental Strategic Planning Committee, which led to a transformation of the undergraduate curriculum. This evolution developed the fundamentals of the program, while also broadening experiential learning opportunities. To better reflect the Department's new direction, it was renamed the Department of Materials Engineering.

Professor Doug Perovic was the next to hold the position of Department Chair. Perovic established the Faculty's first Departmental External Advisory Board, which included Canadian leaders in metallurgy and materials engineering. Under Perovic's direction, the Department name changed again in 2001, to the Department of Materials Science & Engineering. This change reflected new faculty appointments in advanced materials science and engineering. Additionally, during Perovic's term, undergraduate admissions increased by approximately 50 per cent per year and the Department became one of the largest materials science and engineering departments in North America. Perovic also created the world's first nanoengineering major in 2000 through the Engineering Science program, and developed a course in forensic engineering that became the core of the forensic engineering certificate offered to all undergraduate students in the Faculty beginning in fall 2017.

Succeeding Perovic in 2009 was Professor Jun Nogami (Eng Sci 8T0). Under the leadership of Nogami, the number of women undergraduate students increased, comprising more than one third of the undergraduate student body. Additionally, the number of female faculty increased to four of 20 professors. During Nogami's term, strategic faculty hires were made to reinvigorate the Department's involvement in extractive metallurgy and build upon innovative sustainable materials processing research. The interdisciplinary field of materials science and engineering was also emphasized through the addition of jointly appointed faculty members, whose research strengthened existing relationships and created new linkages between materials science and other engineering disciplines within our Faculty.

Nogami also founded the annual Winegard Lecture Series, made possible through the support of the Honourable Dr. William C. Winegard (MMS 4T9, MASc 5T0, PhD 5T2). The lecture series brings world-renowned academics and industry professionals to the Department to share their expertise with students, professors, researchers and alumni.

The legacies left by the Department leaders of Materials Science & Engineering have contributed to our Faculty's ranking as among the world's best engineering schools, and the Department's ongoing leadership excellence continues to inspire the next generation of engineering innovators.

Department of Mechanical & Industrial Engineering

Selected Highlights

2016
Female student enrolment comprises more than 40 per cent and 50 per cent of the first-year class in mechanical and industrial engineering programs respectively—the highest levels ever in the Department.

2009
Professor Jean Zu becomes the first woman appointed Chair of the Department.

1996
The Department of Mechanical & Industrial Engineering is established following the amalgamation of the Departments of Mechanical Engineering & Industrial Engineering respectively.

1992
The Design Engineering Chairs, named the Wallace G. Chalmers Chair and the Clarice Chalmers Chair in Engineering Design, are established.

1990
Mechanical Engineering celebrates its centennial anniversary.

1984
First multi-workstation undergraduate Computer Aided Design Lab is opened on the fourth floor of the Mechanical Engineering Building in partnership with IBM Canada; students have access to CADAM, CATIA software.

1978
The Department of Mechanical Engineering initiates the Professional Experience Year Co-op Program (PEY Co-op) placing the first four students into internship positions within industry. In 2018, more than 50 per cent of all engineering students participated in the PEY Co-op Program.

1970
A student team led by Doug Venn with the active support of Professors I.W. Smith and Frank Hooper prepared their entry into the Intercollegiate Clean Air Car Race to be run from the Massachusetts Institute of Technology in Boston to Caltech in Pasedena. The entry, named Miss Purity, was powered by an electric/propane hybrid engine. It was built in seven months and crossed the finish line in California after six days on the road, first in its class and sixth overall. This was the first of many successful student and faculty collaborations on the international scene. Press coverage was exceptional with the unmistakable message that students were learning how to remedy the world's environmental crisis.

1961
The first industrial engineering class graduates.

1890
Robert Alexander Ross is the first student to graduate with a three-year mechanical engineering diploma.

Experiential learning in The Energy Lab

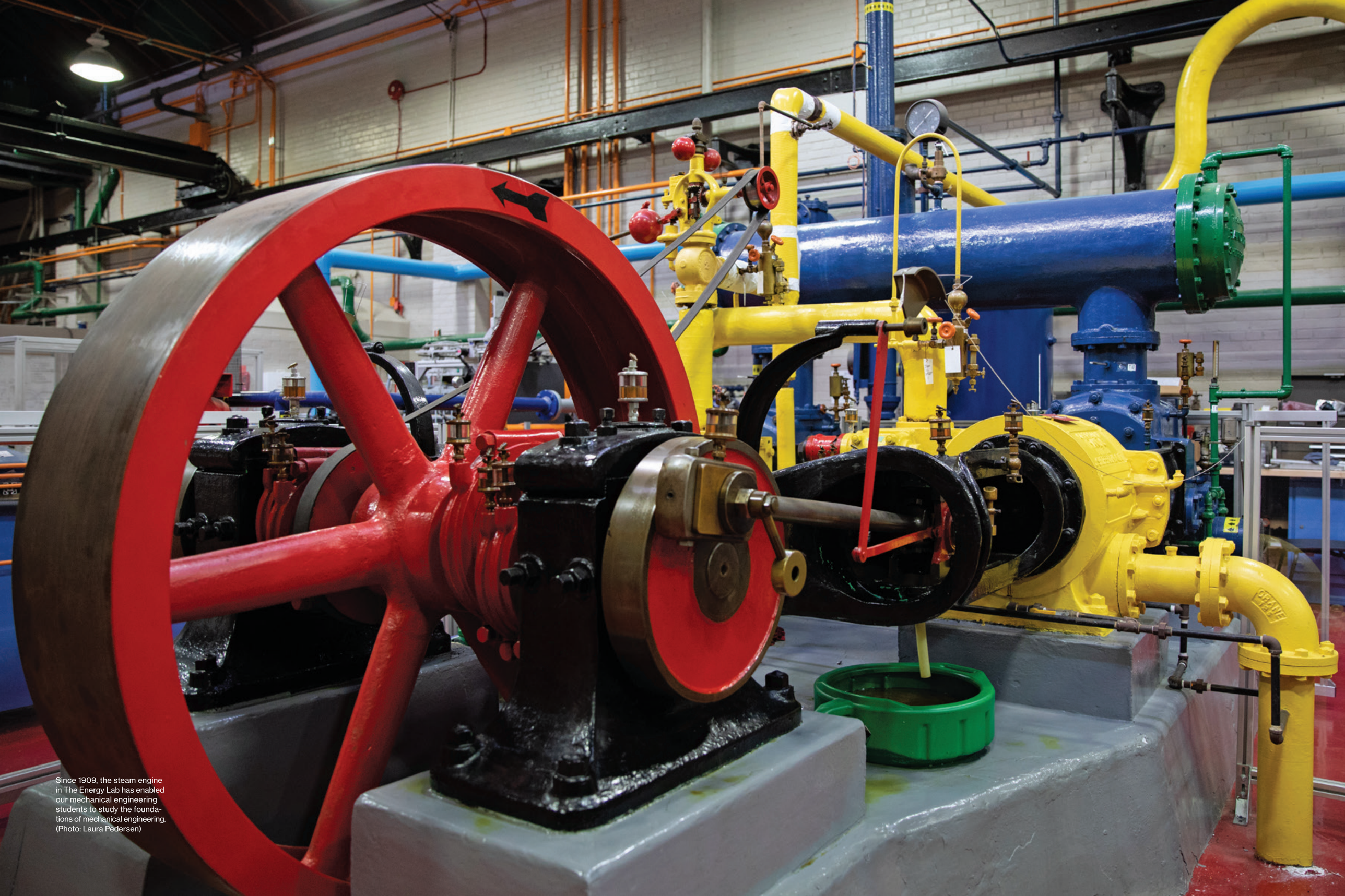
For more than 100 years, every mechanical engineering undergraduate at the University of Toronto has studied the foundations of mechanical engineering in The Energy Laboratory. With the transition of the Steam Age in 1880 and the beginnings of the Electric Age, the enrolment in our mechanical engineering program tripled to more than 750 students by 1908, leading the Board of Governors at the University to agree to construct a new facility to accommodate this growing student population.

Architects Darling & Pearson were presented with the challenge of designing a building suitable for laboratory instruction with provision for an outdoor boiler room to facilitate the delivery of coal and the removal of ashes. Stacks were also required along with large instructional rooms having adequate natural lighting. The architects elected to position the boiler room such that the surrounding buildings would serve to hide it or to at least provide some measure of camouflage. This building was opened in 1909 and was appropriately named the Thermodynamics Building. Today, its northern facade, with large elegant windows, is clearly visible immediately south of the Medical Sciences Building and is affectionately referred to as the Old Mechanical Building. With the completion of this new building, students were introduced to the then-state-of-the-art Heat Engines Lab, which has over time evolved into The Energy Lab.

Professor Robert Angus, the first professor of mechanical engineering and Head of the Department from 1907 to 1944, fostered what became a long-standing commitment to teaching hydraulics and open-channel flows to both civil and mechanical engineering students in these labs. This area of study was a priority for the Faculty, as Canada was experiencing rapid growth in the development of power, particularly hydropower, in the early 1900s. Driving this development was the introduction of high-voltage, alternating current transmission lines, which made long-distance hydropower transmission possible. The gas engine, too, was becoming more reliable, and the availability of fuel produced from coal presented numerous possibilities, making it an important source of energy.

The laboratory is a memorable space for thousands of mechanical engineering alumni. It presents a unique opportunity for students to observe and interact with large-scale equipment. It demonstrates how coal-fired furnaces would convert water into steam, which was then fed into the magnificent stationary steam engine cylinders to directly convert the steam power into rotary power to drive generators to create electrical power for an electrical distribution grid. The laboratory presented a stunning array of equipment to evaluate thermodynamic principles at work; students would calculate the thermodynamic cycle of the steam engine using principles they had learned in the classroom, helping them to connect theoretical calculations to industry-grade machines.

Many graduates of the mechanical engineering and engineering science programs would consider their time spent in The Energy Lab a transformative experience, leading to tremendous success in their careers. The magnificence of this particular experimentation demonstrated by the steam engine is that the principles that lead to James Watt's first experimental steam engine have not and will not change over time. Additionally, the large-scale character of the equipment, while somewhat nostalgic in many respects, provides students with a visible appreciation of these principles and the power of steam.



Since 1909, the steam engine in The Energy Lab has enabled our mechanical engineering students to study the foundations of mechanical engineering. (Photo: Laura Pedersen)

Industrial Engineering: At the forefront of systems optimization

Established in 1961, our Department of Industrial Engineering was among the first of its kind in the world. The program brings systems-level engineering approaches to bear on complex industrial challenges, incorporating human, technical and economic considerations. The roots of the industrial engineering program reach back to the early Engineering and Business programs offered in the Faculty from 1946 to 1959. Professor E.A. Allcut, Head of the Department of Mechanical Engineering, was an early advocate of establishing an industrial engineering program and had already employed some of its concepts in his course on industrial management. Professor Arthur Porter, a physicist, became the founding Head of the Department of Industrial Engineering and initiated the growth of the discipline within the Faculty.

In 1996, the mechanical and industrial engineering programs were amalgamated within the Department of Mechanical & Industrial Engineering. This consolidation of administrative requirements has enabled enhanced collaboration among faculty members in both disciplines.

In 2018, the Faculty's industrial engineering program is a vibrant hub of multidisciplinary collaboration, bringing together students, researchers and industry leaders across many sectors, from manufacturing to banking to retail. They apply engineering innovation to solve theoretical and practical challenges that generate meaningful improvements to daily lives across Canada and around the world.

Left

Nazli Kaya (MIE MASc candidate), front, wears an eye-tracking device used to accurately assess where drivers look when turning at intersections. Kaya studies ways to reduce driver distraction as a graduate student in Professor Birsen Donmez's (IndE) lab. (Photo: Laura Pedersen)

Health care

Professor Michael Carter has been an international leader working at the forefront of health care research in industrial engineering. In 1994, he introduced the first fourth-year course on health care systems to educate students on the challenges and opportunities in the field. His research explores national policies in the health care industry, work that is amplified through the Centre for Healthcare Engineering (CHE), which he founded in 2008. CHE bridges academic research with health care practice to make a direct impact on organizations and systems within the province of Ontario and beyond.

Smart cities

Current models predict that the Greater Toronto Area will grow from 6.5 million to 9.4 million people, and the population of the core City of Toronto will increase by 50 per cent by 2045. To ensure cities are healthy and thriving, our engineering researchers are developing innovative solutions to improving systems within cities. Professor Mark Fox is a pioneer in the theory and application of artificial intelligence in industrial systems. Fox uses mathematical models, known as ontologies, to represent knowledge about cities, including services and infrastructure. He also facilitates multidisciplinary collaboration through the Centre for Social Services. The Centre works closely with industry and government to develop innovative solutions to address health and welfare challenges facing vulnerable populations in urban centres. In 2018, the Centre is focused on developing an online Social Needs Marketplace to provide more efficient means of redistributing new and used goods and enabling more efficient use of NGOs by consolidating their resources.

Professor Scott Sanner is developing novel machine-learning and optimization methods to make our cities smarter. Sensors now collect massive amounts of data about all aspects of urban systems. Sanner is researching ways to manipulate this data to make it more effective in the development of smart cities. The impact of analyzing high-fidelity predictive models of urban systems from sensor data and optimizing these models in real time is far reaching—our buildings will use less energy, our traffic will be less congested, pollution can be reduced and government services will be better able to anticipate our needs.

Human factors

Professor Birsen Donmez's expertise is focused on human adaptation to technology and designing feedback to guide operator behaviour. Her research compares different types of in-vehicle technologies, such as dashboard displays, smartphones, smartwatches and Google Glass, with respect to driver distraction. She is also investigating their potential to improve safety by providing relevant driving-related information—for example, an eye-tracker could be used to let drivers know if their eyes have been off the road for a certain number of seconds.

University of Toronto Institute for Aerospace Studies

Selected Highlights

2017
A collaborative design lab with state-of-the-art infrastructure is launched. The lab includes a high-resolution display wall with over 30 million pixels coupled to multitouch table command and control centres and a dedicated cluster of computing nodes equipped with floating point accelerators such as Intel Xeon Phi coprocessors and Graphics Processing Units. This infrastructure allows visualization of both CFD solutions and design spaces.

2015
The Advanced Combustion Energy Research (ACER) facility is opened. The ACER facility is capable of replicating the conditions found in industry-grade aeronautical and power generation combustors in a controlled laboratory environment and with remarkable optical access. This allows the application of laser measurement techniques that can help unravel the fundamentals of reacting flows and solve practical engineering challenges.

2009
The Experimental Fluid Mechanics Lab opens, equipped with state-of-the-art experimental facilities and instrumentation, including a large-scale re-circulating water channel, a planar Particle Image Velocimetry (PIV) system, a Stereoscopic Particle Image Velocimetry (SPIV) system, a Volumetric 3-Component Velocimetry (V3V) system and a hydrogen bubble visualization system, among others. This infrastructure, together with other facilities available at UTIAS, leads to a unique capability to conduct several experimental projects in the area of fluid mechanics.

2008
The Flow Control and Experimental Turbulence (FCET) Lab is created. The focus of the FCET group is to investigate the fundamental dynamics of attached and separated shear layers, and how these can be manipulated to improve flow characteristics with respect to specific goals, such as mitigating noise emissions.

2007
The Autonomous Space Robotics Lab (ASRL), is established at the Institute. The research from this laboratory enables space and terrestrial applications of mobile robots. In 2017, the ASRL is developing vision-based navigation to allow mobile robots to drive in outdoor, unstructured environments over long periods of time.

2007
Alis Ekmekci is the first woman faculty member to join the UTIAS.

Right
"Eta," pictured right, reached a top speed of 139.45 kilometres per hour (86.65 miles per hour) at the Human Powered Speed Challenge in fall 2015. With help from a team of U of T Engineering students, Eta was designed by alumni Todd Reichert and Cameron Robertson. (Courtesy: Aerovelo)

Making history through innovation at the University of Toronto Institute for Aerospace Studies
The University of Toronto Institute for Aerospace Studies (UTIAS) has participated in remarkable, history-making moments, one of which began on April 13, 1970, when Apollo 13 issued the famous message, "Houston, we've had a problem here." Three days later, on April 16, 1970, UTIAS Professor Barry French received a phone call from Richard Oman of Grumman Aerospace, builder of the lunar module (LM), asking for help with the rescue of Apollo 13.

The Apollo 13 aircraft comprised three modules: a service module providing both life support and rocket thrust for most of the voyage, a lunar module to land on the moon and a module for both the voyage and terrestrial re-entry. When an explosion disabled the service module, the LM became a lifeboat and the oxygen atmosphere in the tunnel, which would have been evacuated, would now need to be used to jettison the LM before re-entry.

UTIAS professors Ben Etkin, Barry French, Irvine Glass, Peter Hughes, Phil Sullivan and Rod Tennyson were tasked with determining the tunnel pressure that would provide sufficient separation speed to jettison the LM, while minimizing the risk of damage to the re-entry module. The professors divided themselves into two teams, and armed with slide rulers, a blackboard and an open telephone line to allow immediate access to data on spacecraft geometry, masses and other quantities, the teams set to work to determine the optimal pounds per square inch in the tunnel. The UTIAS calculations were the basis for the decision to lower the tunnel pressure and complete a successful rescue. In 2011, Apollo 13 LM pilot, Fred Haise, visited UTIAS and met with the surviving professors who assisted in the rescue of the three Apollo 13 astronauts.

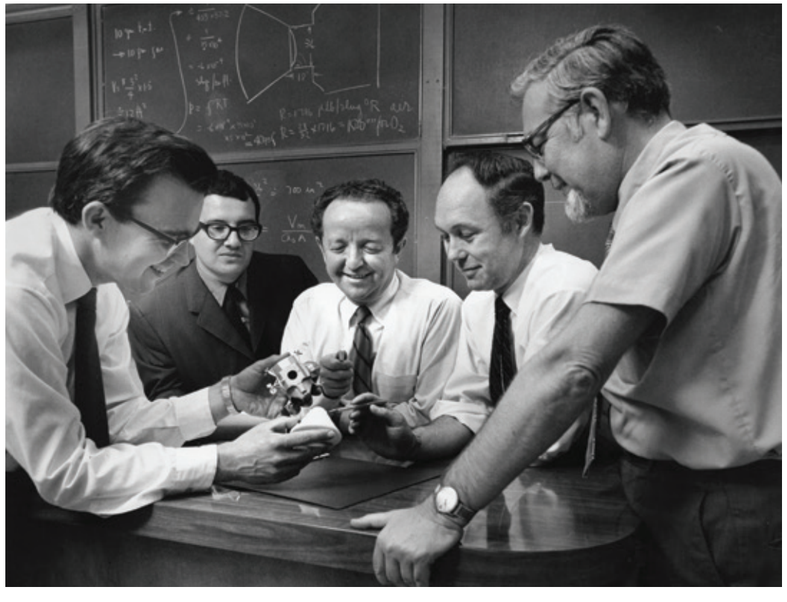
In 1975, just five years after the rescue of Apollo 13, UTIAS Professor Peter Hughes was asked by former aerospace company, SPAR, to analyze Canadarm. Hughes, known for consulting on altitude control and structural flexibility for several space crafts, including the famed Alouette 1 & 2 and ISIS 1 & 2 satellites, performed complex technical analyses for Canadarm between 1975 and 1978, which led to the development of a new approach to the dynamics of robotic arms with elastic links. This approach was used by SPAR to great success in its Canadarm1

design. SPAR's senior management stated that the creation of the arm would not have been possible without the work of Professor Hughes.

The Canadarm launched in 1981, and six years later, in 1987, Professor Hughes's help was again enlisted, this time for the International Space Station. Hughes added UTIAS professor Gabriele D'Eleuterio and UTIAS alumnus Glen Sincarsin (EngSci 7T4, UTIAS MASc 7T6, PhD 8T2) to the team. Together, they worked to extend Hughes's earlier analysis to encompass the additional difficulties posed by the Special Purpose Dexterous Manipulator, which paved the way for the successful design of Canadarm2. Canadarm is considered by many to be one of the most significant Canadian inventions.

While the Canadarm program was retired in 2011, the technology continues to be used in space robotics and in surgical advancements in medicine. Hughes was the recipient of the prestigious Alouette Award in 2006 for "his truly outstanding contributions to Canada's space program spanning over four decades." The fact that its photo graces the back of our five-dollar bill is further testament to Canadarm's importance in the records of Canadian aerospace history.

The UTIAS involvement in the rescue of Apollo 13, and in the development of Canadarm1 and Canadarm2, was little known until many years later. However, UTIAS has been at the forefront of contemporary stories related to innovation and historic achievements in aerospace engineering; The Sikorsky Challenge is another example.



Left

Left to right: UTIAS professors Phil Sullivan, Rod Tennyson, Irvine Glass, Barry French and Ben Etkin were instrumental in the rescue of the astronauts on Apollo 13. (Courtesy: UTIAS)

The Sikorsky Challenge was first issued in 1980 by the American Helicopter Society (AHS). The challenge required that a helicopter, powered solely by the strength of a pilot, attain an altitude of three meters and stay aloft for at least one minute while remaining within a 10-metre by 10-metre square. Countless teams from around the world took on the challenge, but none were successful until two alumni from UTIAS, Todd Reichert and Cameron Robertson, entered their human-powered helicopter (HPH) and were the first team to win the prize, 33 years after the challenge was introduced.

The road to the Sikorsky Challenge began with the work of UTIAS Professor James DeLaurier, who developed an analysis for an efficient flapping wing that led to a successful flight of the world's first engine-powered, remotely-piloted ornithopter in 1991, and then to the world's first flight of a full-scale, piloted ornithopter in 2006. In 2007, PhD candidate Todd Reichert and MASc candidate Cameron Robertson began researching the design of a human-powered ornithopter (HPO). Reichert refined Professor DeLaurier's analytical model for an efficient flapping wing and Robertson's non-linear structural modelling became a crucial component of Reichert's computer code.

Additionally, on July 31, 2010, piloted by Reichert, "Snowbird" made its historic flight and garnered headlines around the world. With their graduate studies completed, Reichert and Robertson formed Aerovelo, and building on the success of the HPO design, Aerovelo entered the race to win the Sikorsky Challenge in January 2012. Designing and assembling the HPO took approximately three years. When completed, the HPO, named "Snowbird," was just 94 lbs, a remarkable accomplishment given it had a wingspan comparable to that of a Boeing 737.

To design the human-powered helicopter for the Sikorsky Challenge, Aerovelo modified and applied techniques they developed for the HPO. The final, and winning, configuration of the HPH, called "Atlas," was 122 lbs with a maximum diagonal dimension of 46.9 metres. It is the most efficient helicopter ever constructed. On June 13, 2013, Atlas won the Sikorsky Challenge and the $250,000 prize, making news headlines around the world.

Since its inception in 1947, UTIAS has been a site of Faculty innovation and excellence, contributing to national and international milestones in aerospace study. The Apollo 13 rescue, Canadarm1 and Canadarm2, the HPO flight and the Sikorsky Challenge are among many examples of how UTIAS excels in research and creates an enriched student experience that makes aerospace engineering history.

Institute of Biomaterials & Biomedical Engineering

Selected Highlights

2015
More than 50 researchers from the University and its partner hospitals collaborate to launch Medicine by Design, an initiative to enhance fundamental discoveries and develop new therapies to treat degenerative diseases. The initiative received an historic $114-million grant from the Canada First Research Excellence Fund in 2016.

2014
Professor Milos Popovic (MIE PhD 9T6) is the recipient of the University Health Network's Inventor of the Year Award for his creation of MyndMove, a non-invasive device that delivers electrical stimulation to paralyzed muscles, producing movement in arms and hands.

2012
The Institute of Biomaterials & Biomedical Engineering (IBBME) celebrates 50 years of biomedical engineering innovation at the University.

2011
A PhD concentration in Clinical Engineering is offered at the Institute.

2001
The Biomedical Engineering graduate program launches, enabling students to register for graduate studies directly in the Institute. The Institute is uniquely situated at the intersection of three Faculties: Applied Science & Engineering, Medicine and Dentistry.

Above
Shuai (Sam) Shi (ChemE 1T5, IBBME MHSc 1T7) demonstrates a medical device engineered to help people with severe physical disabilities walk again and be physically active. (Photo: Neil Ta)

Biomedical Engineering: Creating partnerships in health care innovation

Since 1984, our students enrolled in the Masters of Health Science in Clinical Engineering (MHSc) at the Institute of Biomaterials & Biomedical Engineering (IBBME) have made important contributions to innovation in health care technology. The program integrates engineering with medicine to allow students to understand the requirements of hospitals, medical professionals and patients, to offer solutions and strategies to a breadth of challenges surrounding medical equipment.

Unique to the University of Toronto, the two-year graduate program teaches students how to apply and implement medical technologies to modern health care. The program was conceptualized in preparation for a surge in international demand for research and development in medical equipment. With 10 partner hospitals and many biomedical companies eager to engage with clinical engineering students, significant contributions have been made to health care delivery in Canada and abroad.

IBBME collaborates with its partner hospitals to provide students with exposure to the ways in which clinical instruments are used within a hospital environment. Three courses, BME1405 and BME1439H, Clinical Engineering Instrumentation I & II, and BME1436H, Clinical Engineering—Surgery, provide a unique educational experience for students as they learn about clinical instrumentation and observe medical procedures taking place in the operating room. Afterward, students must report back on solutions to improve the process. The patient- and client-centred focus of the program ensures students contribute meaningful insight to the industry.

MHSc candidates Harminder Sandhu and Kunji Upadhyaya are two examples of students who are helping hospitals and private-sector companies break ground in biomedical engineering. As a placement student at the Toronto General Hospital (TGH) in 2016, Sandhu focused on bettering the hospital experience for patients and staff, with the end goal of alleviating stress and a patient's tendency to be overwhelmed in the event of alarms sounding to indicate medical issues. Sandhu was part of a team that developed and implemented a new alarm management strategy specific to the needs of TGH, allowing staff to track data from medical equipment to eliminate unnecessary alarms, with an aim to reduce caregiver workload and improve patient care.

Similarly, Upadhyaya aimed to enhance the abilities of medical professionals, creating medical-training simulations with OtoSim through Toronto's Hospital for Sick Children (SickKids). His projects focus on discovering approaches to simulate real-life scenarios for medical students, including the creation of a human ear from silicone that students can look inside using a modified otoscope. This enables students to learn to identify potential issues or illnesses in ways similar to what they will experience in their careers.

The impact MHSc students have had on the medical field is one of many ways IBBME has been instrumental to advancing modern health care. With students and faculty discovering innovative areas of specialization, the societal importance of biomedical and biomaterial engineering will continue to grow for decades to come.

Afterword by Professor Ron Venter

"The Myhal Centre is a shining beacon of innovation in engineering education and the site of collaborative research and learning. Now, more than ever before, we must teach our engineering students the importance of working together across disciplines to inspire and create change."

Much has changed since the Faculty opened its doors as the School of Practical Science in 1878, yet the unwavering commitment of engineers to make a positive impact on society and enhance the way we experience the world has persisted for generations. We see this commitment manifested in our everyday lives—from the safety features in our sophisticated vehicles to life-saving medical devices—engineers play a vital role in all aspects of our society.

Since joining the Faculty in 1975, I have seen thousands of students pass through the halls of our engineering precinct, many of whom have gone on to become global engineering change makers and leaders across many industries and societal endeavours. They have set high standards for the profession by anticipating global issues. Their solutions to pressing challenges related to health care, transportation, climate change and water, among others, have resulted in new employment opportunities and industries, and innovative devices that are improving the quality of life for millions of people in Canada and around the world.

The Faculty's rigorous engineering program has established a robust foundation for developing these key leadership and design competencies. In 2018, the Faculty showcased its ongoing commitment to engineering education and research with the opening of the Myhal Centre for Engineering Innovation & Entrepreneurship.

This book is a companion piece to Richard White's *The Skule Story: The University of Toronto Faculty of Applied Science and Engineering, 1873–2000*. It has been published at a time when the Faculty has reached a pivotal moment in its history with the opening of the Myhal Centre and approaching the conclusion of Professor Cristina Amon's truly remarkable third term as dean. Her transformational leadership has accelerated our pace of change and excellence in teaching and research. The Myhal Centre is a shining beacon of innovation in engineering education and the site of collaborative research and learning. Now, more than ever before, we must teach our engineering students the importance of working together across disciplines to inspire and create change. The future of the Faculty and profession is very bright.

Ron Venter
Professor Emeritus & Clarice Chalmers Chair of Engineering Design, Department of Mechanical & Industrial Engineering
University of Toronto

A view from the Myhal Centre of the CN Tower with the Art Gallery of Ontario in the foreground. (Photo: Daniel Ehrenworth)

U of T Engineering graduates walk along King's College Circle in front of Simcoe Hall and the Myhal Centre for Engineering Innovation & Entrepreneurship to their graduation ceremony in June 2018. (Photo: Roberta Baker)

Colophon

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FACULTY OF APPLIED SCIENCE & ENGINEERING