Faculty of Applied Science & Engineering
University of Toronto

Alumni Magazine
2016

Skulematters

The Maker: George Klein
Canada's most productive inventor of the 20th century?

New frontiers in health-care innovation
Cutting-edge interdisciplinary research from U of T Engineering

Engineering on the front lines of crisis
Q & A with alumna Sara Badiei

The Future of Health-Care Engineering

Improving lives on a global scale

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Skulematters

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VIDEO

Visit the Faculty's YouTube channel. Our recommended video features **Omar Khan** (ChemE 0T4, MASc 0T8, PhD 1T1). Khan is currently finishing a postdoctoral appointment at the Massachusetts Institute of Technology, where he makes programmable vaccines.

Subscribe to our channel on YouTube
U of T Engineering

A Message from Dean Cristina Amon

Engineers across all of our disciplines play a critical role in human health — from developing affordable prosthetics and growing heart cells, to combining machine learning with genomic science to study genetic diseases. Through these advances, U of T Engineers are improving lives around the globe.

In this issue we celebrate the many U of T Engineering alumni, researchers and students who are at the forefront of addressing the world's most pressing health challenges — and we reflect on the ways we have been doing so for more than a century.

Alumnus George Klein (MechE 2T8) is considered by many to be the most prolific Canadian inventor of the 20th century. Klein designed the first mass-produced electric wheelchair in the mid-1950s — technology that greatly improved quality of life for people with physical disabilities. The joystick control system he implemented is still a common feature of electric wheelchairs today.

While Klein's story underscores U of T Engineering's long history as a leader in health-care engineering, today we remain at the forefront of innovative solutions that will advance human health well into the future. We are making a positive impact on a global scale by fostering multidisciplinary biomedical engineering research. Medicine by Design, led by Peter Zandstra (IBBME), focuses on transformative research in the design and manufacturing of cells, tissues and organs for regenerative medicine. The Translational Biology and Engineering Program, led by Craig Simmons (MIE, IBBME) and part of the Ted Rogers Centre for Heart Research, carries out research in advanced cardiac care, genomic medicine and tissue engineering. And the Centre for Healthcare Engineering, led by Timothy Chan (MIE), is pioneering data-driven approaches to make health-care systems more efficient.

Located in the heart of Canada's largest health sciences network, U of T Engineering is working alongside some of the world's leading teaching hospitals. Our close collaborations with the Hospital for Sick Children, Mount Sinai Hospital, Princess Margaret Cancer Centre and others are generating pioneering engineering health-care research while offering unparalleled educational opportunities for students and practitioners.

The forthcoming Centre for Engineering Innovation & Entrepreneurship (CEIE) will add a new dimension to our excellence in health-related solutions. When it opens in 2017, it will be among the world's finest engineering research and learning environments, providing a new home for our Centre for Global Engineering (CGEN) and the Institute for Robotics & Mechatronics (IRM). The IRM, led by Goldie Nejat (MIE), is developing assistive robots for home health care and emergency response. A team from CGEN, led by Yu-Ling Cheng (ChemE), has designed low-cost, off-grid toilets to prevent the spread of disease in developing nations. Other CGEN researchers are exploring novel ways to improve the nutrition of those in India and Vietnam.

The CEIE will also be home to our renowned Entrepreneurship Hatchery and new prototyping and fabrication facilities that will accelerate student and faculty innovations from concept to commercialization. Recently launched spinoff companies such as ChipCare, Deep Genomics and TARA Biosystems are already leading the way, bringing U of T Engineering discoveries from the lab to a clinical setting to the world.

Our unique educational programs provide our students with remarkable opportunities to develop key competencies that enable them to address health-related challenges across disciplines. These include the undergraduate minor in biomedical engineering and the Engineering Science biomedical systems major. Graduate students benefit from research-based clinical and professional programs, including the new master's degree in biomedical engineering, which focuses on the design and commercialization of biomedical devices.

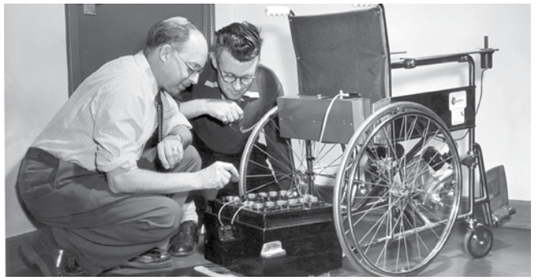
There has never been a more exciting time for health-care engineering innovation in Canada. This issue of *Skulematters* highlights stories of our leadership in this field, past, present and future.

Cristina Amon
Dean

PHOTO/ J. CHRISTOPHER LAWSON PHOTOGRAPHY

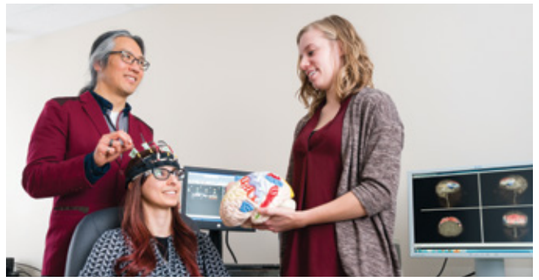
This issue/

Features



THE MAKER: GEORGE KLEIN 14

One of Canada's most prolific inventors of the 20th century, responsible for designing the first electric wheelchair.



NEW FRONTIERS IN HEALTH-CARE INNOVATION 18

Interdisciplinary research from U of T Engineering is helping us live longer, healthier lives.

ENGINEERING ON THE FRONT LINES OF CRISIS 29

Alumna Sara Badiei transitioned a career in the American energy sector to humanitarian aid, rebuilding infrastructure in war zones and providing relief following natural disasters.

BACK TO SKULE™ 44

A busy career as a pharmaceutical industry executive doesn't keep Elaine Campbell from her role as an active member of our vibrant, global alumni community.

Sections

Skule™ in Photos

1

Young Alumni Reunion 1
June 15, 2016
Jessica Xie (ElecE 1T3 + PEY) gets creative with her pizza dough at Cibo Wine Bar in Toronto, the venue for this year's Young Alumni Reunion.
PHOTO/ TOBIAS WANG

2

Spring Reunion 2
May 28, 2016
From exhibits and lectures to departmental lunches and dinners, Skule™ grads of all ages reminisced and reconnected at Spring Reunion. (L–R): **Robert Wong** (ElecE 8T6); **Sohayla Praysner** (ElecE 8T6) and **Dino Priore** (ElecE 8T6) pose for a photo at the Engineering Reception and Dinner at the Hyatt Regency Toronto.
PHOTO/ MICHAEL TENAGLIA

3

The Entrepreneurship Hatchery Accelerator Weekend 3
January 22–23,2016
Fuelled by coffee, snacks and sage advice, students worked furiously to transform their entrepreneurial ideas into viable business models in just 28 hours. Their business ideas were judged by a panel of industry experts, entrepreneurs and alumni. (L–R): **Yuri Sagalov** (EngSci 0T8 + PEY), CEO and co-founder of AeroFS, partner at Y Combinator; Kat Manalac, partner and director of outreach at Y Combinator and **Joseph Orozco**, founder and executive director of The Entrepreneurship Hatchery.
PHOTO/ CHERRY FAN

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Leadership Luncheon 4

April 15, 2016

Corporate partners, alumni, faculty and students gathered at Massey College for a luncheon to celebrate the success of the Institute for Leadership Education in Engineering (ILead).

BizSkule 5

April 28, June 16 & June 23, 2016

Engineering leadership in business was showcased at BizSkule events in Toronto, Calgary and Sunnyvale, Calif. this year:

PICTURED A/ Alumnus **Somen Mondal** (CompE 0T2), co-founder and CEO of Ideal Candidate, moderated the Toronto BizSkule panel, "The Business, Benefits and Risks of the New Sharing Economy," which included alumni **Ashley Lawrence** (IndE 0T0), CEO of Kijiji Canada; and **Keith Cochrane** (CivE MASc 1T2), operations and logistics manager at Uber. PHOTO/ BRIAN SUMMERS

PICTURED B/ (L–R) Professor **Timothy Chan** (MIE), guest lecturer at the Calgary BizSkule event, "Engineering Moneyball in Hockey, Baseball and Beyond," stands with **Claire Kennedy** (ChemE 8T9), BizSkule founder; Dean **Cristina Amon** and Professor **Grant Allen** (ChemE). PHOTO/ CAITLIN MCCOY

PICTURED C/ (L–R) BizSkule California guest lecturer Professor **Brendan Frey** (ECE) stands beside **Rami Rahim** (ElecE 9T4), CEO of Juniper Networks; Dean **Cristina Amon** and Professor **Farid Najm** (ECE). Frey's talk, "Deep Genomics," presented the "genotype-phenotype gap" and how the value of closing this gap exceeds Google's $200B ad market. PHOTO/ CARLOS FOGEL

Engineering Society Heritage & Awards Celebration 6

March 24, 2016

Generations of Engineering Society presidents reconnected at the Engineering Society Heritage and Awards Celebration, demonstrating a history of leadership.

L–R: **Bill Hollings** (EngSci 8T5), **Márta Ecsedi** (CivE 7T6), **Kevin Sui** (EngSci 1T1), **Teresa Nguyen** (CivE 1T5), **Ernesto Díaz Lozano Patiño** (CivE 1T6 + PEY), **David Cheung** (CivE 1T1 + PEY), **Milan Maljković** (Year 4 CompE + PEY), **Scott Jolliffe** (ChemE 7T3) and **Howard Malone** (CivE 6T1).

University of Toronto (Hong Kong) Foundation 20th Anniversary Gala 7

November 28, 2015

Members of the U of T Engineering Alumni Association's Hong Kong Chapter, Hong Kong Campaign Cabinet, Dean **Cristina Amon**, alumni and friends celebrate an important milestone.

Dean's Visit to Singapore 8

November 30, 2015

Dean Cristina Amon joined members of the alumni community in Singapore for an intimate dinner at Shang Palace. The visit to Singapore was part of a trip to celebrate the 20th anniversary of the University of Toronto's Hong Kong Foundation and Asia Pacific Convocation.

Back Row (L–R): **Robert Fu** (MechE 7T4), **Lim Ming Seong** (MechE 7T0), **Er Kwong Wah** (ElecE 7T0) and **CK Chang** (MechE 6T8). Front Row (L–R): Dean **Cristina Amon**, Jennifer Lancaster and Sui-Sim Chang. PHOTO/ COURTESY OF CK CHANG

5A

5B

5C

6

7

Our vibrant and global alumni community is the heartbeat of U of T Engineering. If you want to get involved in a particular program or event, email us at engineering.advancement@utoronto.ca to let us know.

8

CEIE: A Year in Review

In the year since breaking ground, we continue to make remarkable progress, despite some delays, on what will be one of the finest teaching and learning environments in the world when it opens in 2017. The Centre for Engineering Innovation & Entrepreneurship (CEIE) made headlines in 2016, from a landmark funding announcement from the Ontario government to participating in a city-wide contemporary art event.

Visit **uoft.me/CEIE** for time-lapse construction photos, a floor-by-floor tour, fly-through video, timeline of philanthropic leadership, overview of sustainable features and more.

RENDERINGS/ COURTESY OF MONTGOMERY SISAM ARCHITECTS + FEILDEN CLEGG BRADLEY STUDIOS

Toronto's longest single graffiti installation celebrates the CEIE

A bold, colourful and unconventional collaboration with street artist Jason Wing, also known as SKAM, (pictured with Dean **Cristina Amon**), came together in September 2015. SKAM painted a massive 84-metre-long installation that spans the outer wall around the construction site of the CEIE. It is currently the longest single graffiti installation in Toronto. With a surface area that rivals that of a standard tennis court, the work contains more than 50 unique design elements. They depict innovations such as Horizon, the solar vehicle created by the Blue Sky Solar Racing team, and Nanoleaf, the world's most energy-efficient light bulb, invented by alumni **Gimmy Chu** (ElecE 0T6), **Tom Rodinger** (IBBME PhD 0T7) and **Christian Yan** (ElecE 0T6). Other images such as wind turbines, a streetcar, a satellite and a human heart illustrate the multidisciplinary and collaborative research and industry partnerships for which U of T Engineering is known around the world. The artwork also includes the Lady Godiva Memorial Bnad [sic], Skule™ Cannon and other examples of the Faculty's energetic student community and traditions. Visit **uoft.me/CEIExSKAM** for more information about this iconic St. George campus landmark.

#CEIExSKAM at Scotiabank Nuit Blanche

From sunset on Oct. 3 to sunrise on Oct. 4, 2015, more than 5,000 Scotiabank Nuit Blanche revellers interacted with graffiti surrounding the CEIE construction site. The 10th anniversary of Toronto's free all-night contemporary art event provided the perfect opportunity to highlight the connections between the University of Toronto and the vibrant city of which it is part. Titled *#CEIExSKAM*, the installation was one of five exhibits on the St. George campus. Lit by floodlights, the mural was interpreted for visitors by engineering student ambassadors, who distributed buttons and used the imagery as a starting point to share their own stories of what engineering means to them.

Province backs CEIE with $15-million investment

The Government of Ontario announced $15 million in support for the CEIE, introduced in the 2016 Ontario Budget delivered on Feb. 25. The investment is designed to strengthen the Innovation SuperCorridor in Ontario. The CEIE will bring together smart building design and state-of-the-art learning technologies, enabling students, faculty, alumni and industry partners to work together in addressing some of Canada's most pressing economic challenges. "U of T Engineering is at the heart of Ontario's innovation economy," Dean **Cristina Amon** said. "This investment in the CEIE will catalyze multidisciplinary research and set new standards for engineering education and student experiential learning."

$31.6M investment supports lab infrastructure at U of T Engineering

The Faculty will benefit from a major investment through the Lab Innovation for Toronto (LIFT) project, which will accelerate infrastructure improvements across U of T Engineering, enabling world-class research and enhancing the student experience. A total investment of $31.6 million will support renovations to 89 laboratory facilities. The work will benefit more than 330 U of T Engineering researchers, including professors, graduate students and undergraduate students. The funding includes contributions from the federal government through its Post-Secondary Institutions Strategic Investment Fund.

CEIE Tables & Benches Campaign

Be a part of U of T's history through our tables and benches sponsorship campaign. A limited number of tables are available to be named in perpetuity in the CEIE's state-of-the-art auditorium. U of T Engineering will place a nameplate above the table in your honour. Interior and exterior benches on the ground floor of the CEIE are also available to be named. Visit **uoft.me/CEIEtablesandbenches** to find out how you can become a benefactor.

Entrepreneurship News

The innovators, makers and creators of U of T Engineering

Cutting-edge innovation to help you breathe easy

U of T researchers want to clear the air: Professor and alumnus **Greg Evans** (ChemE) and his colleague, **Jeffrey Brook**, a senior research scientist at Environment Canada and adjunct professor in the Department of Chemical Engineering & Applied Chemistry and Dalla Lana School of Public Health, are developing AirSENCE (Air SENsor for Chemicals in the Environment), a portable, easy-to-use air quality monitor, pictured below. A panel of sensors gauge the levels of five common types of air pollutants: nitrogen oxides, ozone, carbon monoxide, carbon dioxide and particulate matter. AirSENCE can be mounted virtually anywhere, and users have instant access to air quality data via a complimentary smartphone app. Evans and Brook are currently collaborating with the Canadian company AUG Signals on an advanced prototype. Prototypes are being tested in Beijing and the collaborators aim to see AirSENCE devices on the market within a few years.

PHOTO/ COURTESY OF GREG EVANS

Health data for firefighters

Smartphones could soon join axes, ladders and helmets as indispensable tools of the firefighting trade. As part of their fourth-year Multidisciplinary Capstone Program course, U of T Engineering students **Shatha Abuelaish** (CompE 1T5), **Priyadeep Jaswal** (CompE 1T5), **Fei Ba** (IndE 1T5) and **Alex Liu** (IndE 1T5) developed an app called Xposure, pictured above, that can help firefighters take control of their health by tracking the hazards they are exposed to as part of their jobs. The app's multi-level menu adapts to a given user's responses, zeroing in on the most relevant questions for particular exposure, making it more intuitive — and faster — than a paper questionnaire.

A few clicks to better mental health

Struggling with anxiety and stress? Cognitive behavioral therapy (CBT) can help. But finding a practitioner and scheduling regular visits can be both expensive and inconvenient. Alumna **Chakameh Shafii** (MechE 1T2, MASc 1T4), pictured right, experienced this first-hand, which inspired her to co-found TranQool — an online CBT service that pairs users with licensed therapists for 45-minute secure video therapy sessions. Within a few clicks, clients find themselves matched up with a therapist based on their needs, preferred language and location in the comfort and calm of their own homes. **tranqool.com**

PHOTO/ COURTESY OF TRANQOOL

Seize the Diem Pouch

Almost half of all unplanned pregnancies in the U.S. occur in women who are using birth control, according to a 2014 report from the Guttmacher Institute. This information inspired **Simon Bromberg** (EngSci 1T3, IBBME MHSc 1T5), **Sandra Fiset** (IBBME MHSc 1T6), **Eric Ma** (EngSci 1T3, IBBME MASc candidate), **Valentin Peretroukhin** (EngSci 1T3, UTIAS PhD candidate), Courtney Smith (MPH Epidemiology candidate) and **Tony Zhang** (EngSci 1T3, UTIAS MASc candidate) to develop the Diem Pouch (formerly Pillsy), a startup that aims to address this issue. Pills are stored in a leather pouch, which is twinned with a smartphone app via Bluetooth. The pouch, pictured above, registers when a pill is taken and provides accurate and useful information about consumption habits. The app sends notifications when a pill is missed and can also alert users when the Bluetooth connection is severed, indicating that the pouch may have been forgotten. **diempouch.com**

PHOTO/ JEFF COMBER

Reject-me-not biomaterial

If you need to have your hip replaced, the last thing you want is for your body to reject the implant. Alumnus **Kyle Battiston** (EngSci 0T9, IBBME PhD 1T5), pictured above, has developed a novel biomaterial to be used as an implant for regenerative tissue and a coating on medical devices such as screws, plates and dental implants. The product is made from a family of polymers found to reduce inflammation, specifically when they interact with white blood cells. The coating calms the body's immune response, eliminating the risk of both implant failure as well as the need for anti-inflammatory drugs. Battiston's innovative product will be developed through Polumiros Inc., a startup he co-founded with alumna **Soror Sharifpoor** (EngSci 0T3, IBBME PhD 1T1), and is expected to be on the market within five years. **polumiros.com**

PHOTO/ PHOTO/ COURTESY OF IMERCIV

Feel the buzz, not the bump

For those with vision loss, walking through busy urban neighbourhoods can be treacherous. Traditional navigational aids such as canes and guide dogs often don't detect obstacles above waist height. In response to this challenge, iMerciv co-founders **Bin Liu** (CivE 1T4) and Arjun Mali developed the BuzzClip, pictured above, a small wearable mobility tool that can snap on to virtually any item of clothing. The BuzzClip vibrates to indicate obstacles one- and two-metres away so users can gauge the distance to an object in front of them. **imerciv.com**

Do you have a startup, spinoff or remarkable innovation to share with your Skule™ community? Email **skulealumninews@ecf.utoronto.ca** with details. Visit **uoft.me/engineering-entrepreneurship** for more entrepreneurship news.

Point-of-care disease testing

A startup driven by unique U of T Engineering-developed technology is poised to revolutionize in-the-field work, allowing doctors to perform HIV-related testing — and deliver results — within minutes. U of T Engineering researchers **James Dou** (ECE MASc 0T6) and Professor **Stewart Aitchison** (ECE), along with biological testing expert Rakesh Nayyar, founded ChipCare Corporation, a socially driven global health venture, in 2009. The company is researching solutions for a wide range of tests, including for other sexually transmitted infections, tropical diseases and fetal development. To date, ChipCare has raised more than $10 million in financing, and is currently testing its hand-held prototype, pictured right, in regions around the globe. **chipcare.ca**

PHOTO/ COURTESY OF CHIPCARE

Awards

U of T Engineers and engineering researchers continue to earn more awards and honours than faculty at any other Canadian school. Their ground-breaking work is a source of pride for our Faculty and alumni around the world. Visit **uoft.me/engineeringawards** for a complete list of Faculty awards and honours.

Selected Faculty Awards

Highlights

Elizabeth Edwards (ChemE)
Edwards, who holds the Canada Research Chair in Anaerobic Biotechnology, was one of the five recipients of this year's **Killam Prizes**, presented by the Canada Council for the Arts. The awards honour eminent Canadian scholars and scientists actively engaged in research.

Milica Radisic (IBBME, ChemE)
Radisic, the Canada Research Chair in Functional Cardiovascular Tissue Engineering, received the **Canadian Society for Chemical Engineering Hatch Innovation Award**.

Edward (Ted) H. Sargent (ECE)
Sargent and Professor Shana Kelley of U of T's Faculties of Pharmacy and Medicine are co-recipients of this year's **Brockhouse Canada Prize for Interdisciplinary Research in Science and Engineering**.

Molly Shoichet (ChemE, IBBME)
Shoichet was one of four Canadians elected as Foreign Members of the **U.S. National Academy of Engineering (NAE)** this year. Members of the NAE rank among the world's most accomplished engineers.

Craig Simmons (MIE, IBBME)
Simmons, the scientific director for the new Translational Biology and Engineering Program, was named **U of T Distinguished Professor of Mechanobiology**.

David Zingg (UTIAS)
Zingg, former director of UTIAS and founding director of the Centre for Research in Sustainable Aviation, was named the **U of T Distinguished Professor of Computational Aerodynamics and Sustainable Aviation.**

Awards

American Society of Mechanical Engineers
Fellow
Kamran Behdinan (MIE)

American Society of Mechanical Engineers
Honorary Member
Cristina Amon (MIE)

Canadian Academy of Engineering
Fellow
Nazir Kherani (ECE, MSE)
Deepa Kundur (ECE)
Milica Radisic (IBBME, ChemE)
Murray Thomson (MIE)
Honghi Tran (ChemE)
Sankar das Gupta (MSE)

The Combustion Institute and Elsevier
Hiroshi Tsuji Early Career Researcher Award
Adam Steinberg (UTIAS)

Engineering Institute of Canada
Fellow
Kamran Behdinan (MIE)
Hugh Liu (UTIAS)
Heather MacLean (CivE)

Engineering Institute of Canada
Julian C. Smith Medal
Doug Hooton (CivE)

European Society for Biomaterials International Award
Michael Sefton (ChemE, IBBME)

Institute of Electrical and Electronics Engineers
Fellow
Dimitrios Hatzinakos (ECE)

International Institute for Nanotechnology
Kabiller Young Investigator Award
Warren Chan (IBBME)

March of Dimes Canada
Jonas Salk Pioneer Award
Tom Chau (IBBME)

NSERC: E.W.R. Steacie Fellowship
David Sinton (MIE)

Ontario Professional Engineers Award
Engineering Excellence Medal
Vaughn Betz (ECE)

Ontario Professional Engineers Award
Research and Development Medal
Stewart Aitchison (ECE)

Ontario Confederation of University Faculty Associations
Teaching Award
Greg Evans (ChemE)

Royal Canadian Institute
Fleming Medal and Citation
Molly Shoichet (ChemE, IBBME)

Royal Society of Canada
Fellow
Levente Diosady (ChemE)
Brendan Frey (ECE)

Royal Society of Canada Member, College of New Scholars, Artists and Scientists
David Sinton (MIE)

Terumo Foundation for Life Sciences and Arts
Terumo Global Science Prize
Michael Sefton (ChemE, IBBME)

U of T Celebrates Innovation
Invention of the Year
Brendan Frey (ECE)

University Professor
Peter Zandstra (IBBME)

Selected Alumni Awards

Canadian Academy of Engineering
Fellow
William Breukelman (ChemE 5T5)
Elizabeth Croft (MIE PhD 9T5)
Samantha Espley (GEO 8T8)
John Gruzleski (MMS PhD 6T8)
Georges Kipouros (MMS MASc 7T7, PhD 8T2)

Engineers Canada
Meritorious Service Award for Community Service
Marisa Sterling (ChemE 9T1)

Engineering Institute of Canada
John B. Stirling Medal
Marc Rosen (MechE 8T1, MASc 8T3, PhD 8T7)

Institute of Electrical and Electronics Engineers
Robotics and Automation Award
Raffaello D'Andrea (EngSci 9T1)

Ontario Professional Engineers Award
Citizenship Medal
Valerie Davidson (ChemE PhD 8T3)
Ted Maulucci (MechE 8T9)

Ontario Professional Engineers Award
Engineering Excellence Medal
George Anders (ECE PhD 8T0)
John Yeow (ElecE 9T7, MIE MASc 0T0, PhD 0T3)

Ontario Professional Engineers Award
Gold Medal
Larry Seeley (ChemE 6T6, MASc 6T8, PhD 7T2)

Women's Executive Network
Canada's Most Powerful Women Top 100
Siobhan Robinson (ChemE 0T9, MSE MASc 1T0)
Jeanette Southwood (ChemE 8T6, MASc 8T8)

Selected Student Awards

Canadian Interuniversity Sport (CIS)
Academic All-Canadian
Sasha Gollish (CivE MEng 1T0, EngEd PhD Candidate)

Ontario Professional Engineers Foundation Scholarships*
Chia Hang (Kevin) Chang (Year 4 ElecE)
Lia Orders Codrington (Year 2 EngSci)
Kun Yi Antonio Juan Ding (Year 4 ChemE)
Haya Elaraby (Year 4 IndE)
Savannah Forest (CivE 1T6)
Ran Hong (Year 4 MSE)
Katherine Lonergan (Year 4 MechE)
Connor Jackson Smith (CompE 1T6 + PEY)
Paul Minkang Suk (Year 3 EngSci)

Schulich Leader Scholarship
Christopher Choquette-Choo (Year 2 EngSci)
Daniel McInnis (Year 2 MechE)

U of T Gordon Cressy Student Leadership Award*
Nikola Andric (ChemE 1T6 + PEY)
Ming Yi Bian (ElecE 1T6 + PEY)
Ernesto Diaz Lozano Patiño (CivE 1T6 + PEY)
Andrew Fisher (CivE MASc 1T6)
Rahul Goel (EngSci 1T6 + PEY)
Brandon Jacobs (CivE 1T6 + PEY)
Camila Londono (EngSci 0T8, IBBME PhD 1T6)
Devangini Mishra (ElecE 1T6 + PEY)
Jaquelyn Monis Rodriguez (IndE 1T6 + PEY)
Charles (Tae Joon) Park (EngSci 1T6 + PEY)
Ribhu Rampersad (ChemE 1T6 + PEY)
Sharon Ravindran (EngSci 1T6 + PEY)
Rachel Reding (EngSci 1T6 + PEY)
Michael Sabatini (MSE 1T6 + PEY)
Rong Yao (IndE 1T6 + PEY)

Alumni were students at the time they received the awards.

2016 EAA Awards

Diverse, accomplished and fascinating — meet this year's Engineering Alumni Association (EAA) Award recipients.

Engineering Alumni Medal

The EAA's highest honour, this award recognizes outstanding achievement, superior accomplishments and flair, and excellence in response to challenges.

David Colcleugh
(ChemE 5T9, MASc 6T0, PhD 6T2)
David Colcleugh's leadership in commercial organizations forms an impressive record of personal growth and development through many levels at DuPont, rising to be president of DuPont Asia-Pacific and then chairman, president and CEO of DuPont Canada. Since his retirement in 2003, Colcleugh has been using his leadership expertise to build companies and teach the next generation of entrepreneurs, executives and engineers. His leadership philosophy and pedagogy has had a profound influence at U of T Engineering.

Engineering Alumni Hall of Distinction Award

The EAA is proud to present this assembly of extraordinary alumni selected by their peers for their lifelong accomplishments. Commemorated in a display in the Sandford Fleming Building, Hall of Distinction members are a familiar daily presence in the lives of students and serve as examples to future generations of U of T engineers.

Paul Henderson
(EngBus 5T7)
As a young boy spending his summers on Toronto Island, Paul Henderson dreamed of becoming a competitive sailor. His dream would become reality. Henderson holds the record of having competed in all of the Canadian Olympic Sailing Trials from 1948 to 1984. He competed in three Olympic Games: 1964, 1968 and 1972, and would have represented Canada in 1980 if not for the Olympic boycott against the Soviet Union. He served for over 30 years in the International Sailing Federation (ISAF), the governing body for sailing officially recognized by the International Olympic Committee. For 10 years, from 1994 to 2004, he served as the ISAF's first non-European president. In his professional life, Henderson transitioned a plumbing contracting business into a leading commercial food equipment company.

Ali Khademhosseini
(ChemE 9T9, IBBME MASc 0T1)
Ali Khademhosseini is a professor at the Harvard-MIT Division of Health Sciences and Technology and Harvard Medical School. His research is based on developing micro- and nano-scale technologies to control cellular behaviour, with particular emphasis in developing micro-scale biomaterials and engineering systems for tissue engineering and drug delivery. He is an author of more than 450 peer-reviewed journal articles, editorials and review papers and he has been cited over 25,000 times.

Ronald Bertram Sidon
(IndE 6T6)
Ron Sidon was born in Woodstock, Ont., where his parents met and farmed after emigrating from Germany and Czechoslovakia. Up to age 19, he worked alongside his parents to develop and modernize their dairy farm. This business exposure taught him how to manage other workers, to be ingenious at fixing equipment, and to find unique solutions to problems. In 1966, Sidon graduated from the University of Toronto with a BASc in industrial engineering, and in 1968 he received his MBA from York University. He joined IBM in 1968 as a systems engineer and later as a sales engineer before leaving in 1971 to start the first of five unique entrepreneurial business ventures.

John Weber
(MechE 7T9)
John Weber's career has focused on engineering and technology corporations at both the CEO and board of director levels. He has led several highly successful enterprises, including positions within GE, AlliedSignal, Honeywell, as well as high-tech ventures such as VIA Motors and Enphase Energy. However, his achievements at Remy International, a leading manufacturer, re-manufacturer and distributor of heavy-duty systems, starters and alternators, and hybrid power technology, stands as the clearest testament to his technical and leadership skills. When Weber was appointed CEO of Remy in 2006, the company was on the brink of bankruptcy. In 2015, Remy's revenues amounted to $1.1 billion with more than 6,000 employees worldwide. He is also a highly committed volunteer. From 2010 to 2015 he was the founder and chair of the Department of Mechanical & Industrial Engineering (MIE) Board of Advisors. Weber is currently the chair of the MIE Fundraising Committee.

2T5 Mid-Career Achievement Award

Celebrates an individual who has earned respect within the profession and broader community and attained significant achievement within 25 years of graduation.

Raffaello D'Andrea
(EngSci 9T1)
Spanning academics, business and the arts, Raffaello D'Andrea's career is built on his ability to bridge theory and practice. At the Swiss Federal Institute of Technology (ETH) in Zurich, his research redefines what autonomous systems are capable of. He is co-founder of Kiva Systems (acquired by Amazon in 2012, and now operating as Amazon Robotics), a robotics and logistics company that develops and deploys intelligent automated warehouse systems. He was the faculty advisor and system architect of the Cornell Robot Soccer Team, four-time world champions at the international RoboCup competition. With his startup, Verity Studios, he recently created the flying machine design and choreography for Cirque du Soleil's *Paramour* on Broadway.

7T6 Early Career Award

Recognizes an individual who has become distinguished in their profession and community within 10 years of graduation.

Gimmy Chu
(ElecE 0T6)
Gimmy Chu has demonstrated outstanding leadership and entrepreneurial acumen. Chu co-founded Nanoleaf, a lighting products company, and has taken it to the level of winning top international awards for excellence in design and product innovation. Under Chu's leadership as CEO and product development manager, Nanoleaf has achieved enviable recognition in its few years of existence, having received the Global Efficiency Medal from the international Super-efficient Equipment and Appliance Deployment Initiative and the prestigious Red Dot award for excellence in design. Furthermore, its latest product, the Aurora lighting panels, has been praised for its innovative features and high artistic merit.

Malcolm F. McGrath Alumni Achievement Award

Recognizes contributions to the Faculty, University or community, in honour of Malcolm McGrath, past Assistant Dean, Alumni Relations.

Ross Pitman
(GeoE 7T4)
Ross Pitman is a senior exploration geologist that specializes in finding and developing unconventional hydrocarbon reservoirs. Over his successful 40-year career, he has continuously bridged the gap between geology and various engineering disciplines. He has been a long-standing and committed alumni leader, founding the Engineering Alumni Association — Calgary Chapter, serving as the chapter's chair from 2008 to 2016. He also created the Calgary Skule™ Admissions Scholarship, which has assisted 11 students in its eight-year history. Pitman has guest lectured for numerous departments and programs and has served as a mentor for nearly 10 years.

L.E. (Ted) Jones Award of Distinction

Honours students who exemplify Professor Emeritus L.E. (Ted) Jones' great appreciation of the arts and his love of music.

Fionna Gan
(EngSci 1T6)
Fionna Gan exhibited tremendous dedication to the arts throughout her time at U of T Engineering. With a passion for graphic design, she was elected as the F!rosh Handbook editor and published an eye-catching guidebook for first-year students. She also initiated a T-shirt design contest in her first year and continued to learn and take on creative challenges. As the sole director of marketing for the You're Next Career Network's Career Fair team, Gan created and helped launch one of the most memorable marketing campaigns to date and brought new ideas and marketing strategies to the organization. In addition to design, she also danced at the engineering talent show and at the U of T Dance Festival.

Did you know?

Donna Vakalis (CivE PhD Candidate) participated in the Modern Pentathlon at the 2016 Summer Olympics.

THE MAKER

by **DICK BOURGEOIS-DOYLE**

Many consider George Klein (MechE 2T8) to be one of Canada's most prolific inventors of the 20th century.* More than 1,000 novel and useful devices were shaped by his imagination, including the world's first electric wheelchair.

Pictured: George Klein (c. 1955) demonstrates the electric wheelchair he designed.

In many ways, George Klein rivaled Thomas Edison, Alexander Graham Bell and other icons in the scope of his inventiveness and impact — certainly in his effect on society. His project areas ranged from aviation, defense systems and nuclear energy to construction safety, communications and space technologies.

At the same time, Klein's work could be overstated if not placed in the context of his fruitful collaborations and the contributions of others. Many remarkable people not only helped and inspired him, but also applied his inventions to daily practice. Klein's career and experience is a model for innovation in any field, particularly, health-care engineering.

Born in Hamilton, Ont. in 1904, Klein spent his spare time as a child hanging out at his father's jewellery store and watch factory where the artistic work of gold and silversmiths ran in parallel to the micro-mechanics of the watch makers. He often referred to it as a gymnasium for creativity and the touchstone for many of the ingenious mechanical devices he later designed and built. Not a great student academically, he nevertheless showed talent in the workshop and earned technical school marks strong enough to gain entry to the Univeristy of Toronto's Faculty of Applied Science & Engineering. Here, he learned the benefits of collaboration and the skills that would shape his career.

For 40 years of that career, Klein worked as a mechanical engineer and designer at the National Research Council of Canada (NRC) labs in Ottawa where he came in 1929 to join his former U of T Engineering professor **John Hamilton Parkin** (MIE). At NRC, Klein collaborated not only with doctorate-level colleagues, but also the tradespeople, machinists and technicians who could rapidly build and tweak his many prototypes.

Multidisciplinary collaboration fuelled his innovations in many of the same ways it inspires engineering research today.

PHOTO/ COURTESY OF THE NATIONAL RESEARCH COUNCIL OF CANADA (NRC)

*Source: Canadian Encyclopedia

The first electric wheelchair

Atypical collaboration is at the core of thousands of innovations in the health-care engineering field and more than a few involve Klein. But one of the most vivid examples is the development of the first mass-produced electric wheelchair — a design known in its day as "The Klein Chair."

The story begins with the discovery and refinement of penicillin, which dramatically reduced the number of fatalities from wartime spinal cord injuries. During the First World War, a spinal injury resulted in almost certain death from ensuing infection. But by the Second World War, soldiers had an 80-90 per cent rate of survival from spinal injuries thanks to the revolutionary new antibiotic.

One of those Second World War survivors was John Counsell, a Canadian officer shot through the back at Dieppe. He would live the rest of his life with paraplegia. At first satisfied with manual wheelchairs, it became clear to Counsell that quadriplegics would need something more. His advocacy, and Canada's particular commitment to health care and veterans support, came together in the post-war period to manifest as a request to NRC and Klein to build an entirely new wheelchair.

Klein considered the project to be the most rewarding of his career. In the end, he developed a unique package of technologies including the joystick, tighter turning systems and separate wheel drives that are still features of electric wheelchairs today. After Canadian veterans were provided with their electric chairs, an international effort was made to engage manufacturers. This culminated in the formal transfer of the prototype chair to the United States Ambassador to Canada and the head of the U.S. Department of Veterans Affairs with patent-free rights to encourage production in the U.S. Within a few years, major wheelchair manufacturing companies had embraced the technology and made it available to disabled civilians en masse.

That prototype wheelchair was kept at the Smithsonian in Washington for years, but returned to Canada in 2004 and is now part of the Canada Science and Technology Museum collection in Ottawa. When visitors look at it in the display case, they are informed not only of Klein, but also that the wheelchair was a project that engaged health-care workers, doctors, therapists, mechanical designers, electrical engineers, administrators and, uniquely, the patients.

Klein (left) and his NRC colleague Robert Owens with an early prototype.

PHOTO/ COURTESY OF THE NATIONAL RESEARCH COUNCIL OF CANADA (NRC)

Today, patients in research projects are routinely regarded as participants and collaborators in the process who participate, with consent, and provide valued feedback. But in the early 1950s, it was an enlightened approach to include them in the early stages of a project. Klein was particularly empowered by his respect for the views of patients — those who would ultimately benefit from his innovation.

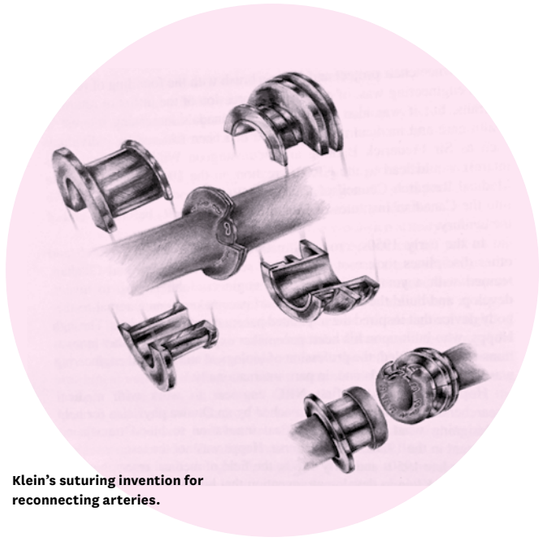
Lifesaving microsurgical suturing device

Though listed among Klein's inventions, the microsurgical suturing device is also rightly catalogued in patents as "the NRC-Vogelfanger" instrument. The Vogelfanger cited here was Klein's key co-inventor — a respected university professor and physician — known as one of the most skilled surgeons in Canada.

Motivated by gruesome experiences in Joseph Stalin's prison system, Isaac Vogelfanger was looking for more effective ways of connecting severed arteries and veins when he approached Klein's NRC lab for assistance in the late 1950s.

Klein's skill as a mechanical designer and his access to workshop colleagues who could make ideas real with relative ease led to the development of a stapler that easily enveloped severed blood vessels, folded back the tissue and connected the pieces with a snap. Cumbersome and crude by the standards of today's advanced technologies, the tool did the trick and was used in hundreds of experimental surgeries in the 1960s and 1970s. It was eventually licensed to a Montreal manufacturer that did well with its commercialization.

Using this device, Vogelfanger performed the first kidney transplant at Ottawa's Civic Hospital and the first double transplant with organ transfers between two hospitals — anywhere.



Klein's suturing invention for reconnecting arteries.

Legacy

Never seeking credit, Klein only gained recognition when others referenced his accomplishments. Among the many awards he received over the course of his career, Klein was appointed an Officer of the Order of Canada and inducted into the Canadian Science and Engineering Hall of Fame — remarkable accolades that emphasize his impact on the growth of Canadian engineering, science and technology.

His modest nature helped him work with people from varied technical fields and with different interests, but Klein said that he was particularly motivated to collaborate with others on the projects that bridged health care and engineering — fields that engage researchers in common purpose to help people while solving some of the world's greatest challenges.

By the time he passed away on Nov. 4, 1992 at the age of 88, Klein had contributed inventions to a World War, the dawning of the Space Age and one of the most significant technological health-care projects of the 20th century, among countless others.

About the author

Dick Bourgeois-Doyle lives in Ottawa and is secretary general of the National Research Council of Canada. He previously served as chief of staff to the minister of science and technology and the minister of fisheries and oceans. A former broadcaster and journalist, he has contributed to many articles, TV features, and radio programs on the history of Canadian science and creativity. A noted biographer, Bourgeois-Doyle's book George J. Klein: The Great Inventor *is available as an e-book at* **http://bit.ly/2birNJD**.

ILLUSTRATION/ MOZHGAN KERMANSHAHY COURTESY OF THE CANADA SCIENCE AND TECHNOLOGY MUSEUM

Innovations Aplenty

Beyond the electric wheelchair and suturing device, Klein spent his time at the NRC working on projects that ran from "the stick and string" era of aviation to the Space Shuttle. Here are five of his most renowned inventions:

A Mighty Wind

He contributed significantly to the construction and design of the first NRC wind tunnels, helping to not only guide development of the Canadian aircraft industry, but also the first streamliner locomotives, bridges and buildings across Canada.

Wartime and the Weasel

Klein's work played a critical role in many of our country's scientific and technical contributions to the Second World War. The mechanical instruments that his team built for the military often transferred to private industry to contribute to the post-war industrial development. His expertise in mechanics and materials brought him to work on the first military snow vehicle, the Weasel, one of his wartime projects and once tied to the First Special Service Force, The Devil's Brigade.

First Canadian nuclear reactor

Klein was also the chief engineer and mechanical designer for the Zero Energy Experimental Pile (ZEEP). Located near Chalk River, Ont., ZEEP was the first nuclear reactor to operate outside the U.S.

Putting skis on planes

He was a leading expert in the design of aircraft skis and made it practical to put them on bushplanes, indirectly opening up vast areas of Canada to exploration and air transport services. This work led him to establish a practical system for ground-cover snow classification that became the international standard and framed research in construction, transportation and avalanche prevention.

The Space Race

In the early 1960s, Klein's retractable Storable Tubular Extendible Member (STEM) antenna gave Canada a special place in the Space Age. It was used in all Mercury, Gemini and Apollo spacecrafts, famous satellite projects and over 100 other innovations. After retirement and well past the age of 70, Klein worked as chief consultant on gear design for the first Canadarm and then after his 80th birthday, he contributed to the system's further development within the Shuttle program. Turn to **page 35** to see how one EngSci alumnus is building on Klein's technology and applying it to pediatric surgery.

NEW FRONTIERS IN HEALTH-CARE INNOVATION

by TYLER IRVING & MARIT MITCHELL

Interdisciplinary research from U of T Engineering is helping us live longer, healthier lives.

Optimizing surgical schedules

Long wait lists for elective surgeries are a major challenge in the Canadian health care system. According to Professor **Dionne Aleman** (MIE), pictured below, right, the problem may not necessarily be a lack of resources, but rather a result of not using the resources we have as efficiently as we could.

"Hospitals have rules that indicate who gets operated on when, but the schedules that result are sub-optimal," she said. Aleman and her team are addressing this problem by building mathematical models that can optimize the matches between patients, surgeons and operating rooms to generate the most efficient schedule.

One technique the team uses involves pooling resources. Rather than each hospital maintaining its own waiting list, patients would be treated as a single large waiting list. Patients would be assigned to a given surgeon or operating room to minimize the time when resources are unused. Using mathematical optimization tools, the team has generated schedules that could increase the number of patients treated in a given time period by up to 30 per cent.

Aleman collaborates closely with Dr. David Urbach, a surgeon and senior scientist at the Toronto General Research Institute. Her models are based on data from Toronto General Hospital, Toronto Western Hospital and the Princess Margaret Cancer Centre.

"Right now we're adding workload balancing into our models," Aleman said. "We want to ensure that all surgeons and hospitals are being used to an equitable level."

Some hospitals are already using patient pooling on a small scale, and Aleman hopes that her models will help the technique be applied more broadly.

"I like research that has a positive impact on the world," she said. "In health care it's very obvious to see how any improvements can have a wide-ranging impact, so it's a very fulfilling type of work to do."

"WE WANT TO ENSURE THAT ALL SURGEONS AND HOSPITALS ARE BEING USED TO AN EQUITABLE LEVEL."

Walk this way

Jan Andrysek's research helps amputees walk tall. A professor at IBBME and scientist at the Bloorview Research Institute in the Holland Bloorview Kids Rehabilitation Hospital, he is the engineer behind the AT-Knee (short for "all-terrain") — a mechanical prosthetic knee joint that is natural feeling, durable, energy-efficient and inexpensive.

"Most affordable prosthetic knees rely on mechanisms that are not designed to concurrently provide safe and efficient mobility, so they often feel awkward and unstable during walking," said Andrysek, pictured above, right. "The AT-Knee is designed to lock and unlock smoothly as you walk, and move just like the human knee joint."

While typical prosthetic knees can carry price tags of $1,000 to $50,000, the AT-Knee is available at a much lower cost through NGOs, making it a huge step forward for patients with lower-limb impairments, especially in war-torn or developing nations. His team has tested their design in over 15 countries around the world. In April 2014, Andrysek along with three co-founders launched the company LegWorks to commercialize the AT-Knee technology. As of January 2016, the AT-Knee is commercially available in many countries globally.

Andrysek and his research group are now working to improve communication between people's bodies and their artificial limbs. His lab is designing a non-invasive biofeedback system to improve the wearer's awareness of limb position.

"Basically, using small vibratory signals, the system provides amputees with information about the position and loading of the artificial limb to improve mobility," he said.

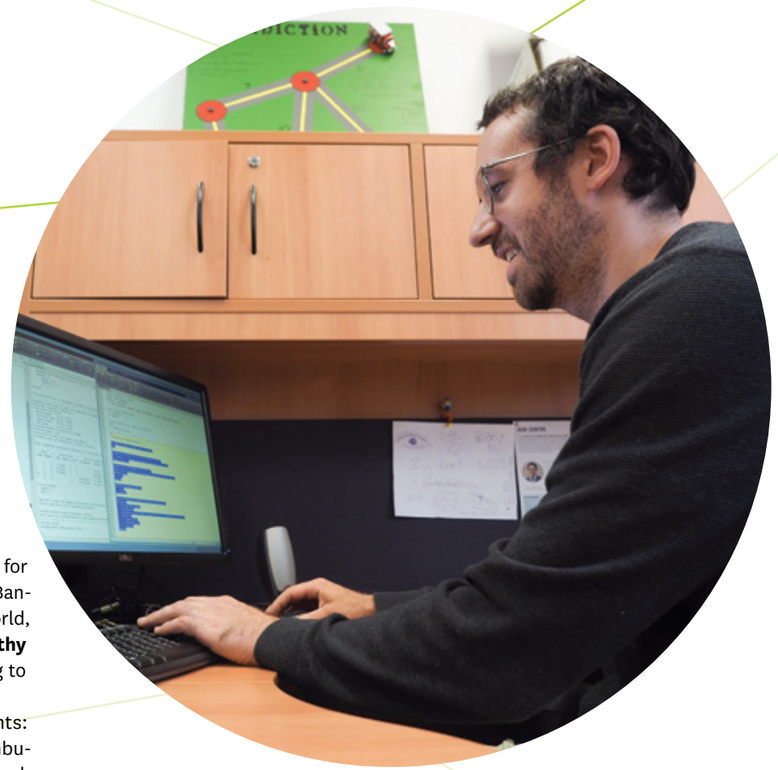
Human bodies elegantly integrate chemical, electrical, materials and mechanical systems — and Andrysek's research is just as multidisciplinary. In addition to colleagues across the University of Toronto and hospital networks, he works directly with prosthetics companies, non-governmental organizations and clinical partners around the globe.

"These collaborations help us define important areas of need, and subsequently help us deliver our solutions to children and adults who stand to benefit from them most," Andrysek said.

"THE AT-KNEE IS DESIGNED TO LOCK AND UNLOCK SMOOTHLY AS YOU WALK, AND MOVE JUST LIKE THE HUMAN KNEE JOINT."

PHOTO/ NEIL TA

"OUR RESEARCH HAS TWO COMPONENTS: FIRST, OPTIMIZING THE LOCATIONS OF AMBULANCES THROUGHOUT THE CITY, AND SECOND, ROUTING THEM TO THE PATIENTS."



Optimizing ambulance distribution and routing

In Toronto, the average response time for ambulances is six minutes. In Dhaka, Bangladesh, the 11th largest city in the world, it's 60 to 80 minutes. Professor **Timothy Chan** (MIE) and his team are working to help close this health-services gap.

"Our research has two components: first, optimizing the locations of ambulances throughout the city, and second, routing them to the patients," said **Justin Boutilier**, pictured above, a PhD candidate in Chan's lab.

In September 2015, Boutilier spent three weeks in Dhaka assessing the current situation. Collaborating with Moinul Hossain, a traffic engineer and professor from the Islamic University of Technology (IUT), Boutilier surveyed patients regarding emergency transportation to hospitals to better understand the current state of the system. He also distributed a GPS-based app to rental car drivers that will track driving speeds and help map traffic patterns in the city.

All this information will be fed into a computer optimization model, which will test out hundreds of possible scenarios before arriving at an ideal distribution of ambulances across the city. The data will also be used to develop an app that provides real-time recommendations to drivers on the fastest route. In a city where it is not the cultural norm to yield to ambulances — and where there is little room to move aside anyway — avoiding busy streets can mean the difference between life and death.

Boutilier and Chan will also evaluate other forms of transportation, such as three-wheeled cabs or rickshaws, in order to address issues with reaching patients in areas without adequate access to ambulance transport, such as slums. They hope their approach can bring significant health benefits for the citizens of developing countries.

"There is a long history of using operations research to improve emergency medical services in North America, but in developing countries many of these ideas are still very new," Chan said. "I think we can make a big impact there."

Reducing the risks of cycling

Cycling and walking are good for your health, right? It's actually a more complicated question: while increased physical activity can improve cardiovascular function, cyclists and pedestrians are also exposed to air pollution, which can do the opposite. Professor and alumna **Marianne Hatzopoulou** (CivE) , pictured below, right, and her team aim to help city dwellers get more of the benefits of physical activity while reducing the risks.

This summer, Hatzopoulou and her team collaborated with Health Canada on a study that aimed to map out how pollution affects human health in different areas of the city. Volunteers walked the streets of Toronto equipped with GPS devices and instruments to monitor their heart rates and blood pressure, as well as the level of noise and air pollution they are exposed to. By correlating location with pollution and physiological data, the team can find the cleanest, safest routes.

Hatzopoulou has already created an online tool that does just that, based on the results of previous studies. The Clean Ride Mapper leverages Google Maps to help cyclists find routes that have lower levels of pollutants like ultra-fine particles or nitrogen oxides.

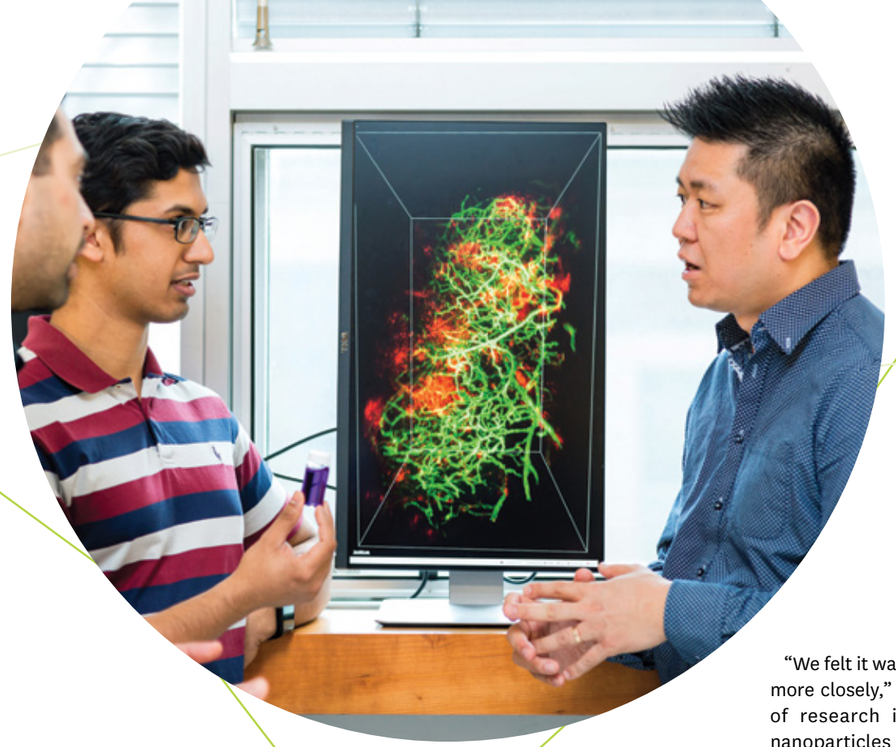
The next step is to determine how cyclists weigh the value of reduced pollution exposure against other factors involved in choosing a route, including separation from traffic, elevation and distance. Hatzopoulou and postdoctoral researcher **Sabreena Anowar** (CivE) are measuring this through an online survey launched this past June.

While no route is perfect, Hatzopoulou said that for most people, the benefits of physical activity outweigh the risks.

"If you are a healthy person, you are better off to continue cycling or walking than stop," she said.

Hatzopoulou hopes that her research will help city planners create walking or cycling infrastructure and is both safe and clean, making life in cities that much healthier.

"IF YOU ARE A HEALTHY PERSON, YOU ARE BETTER OFF TO CONTINUE CYCLING OR WALKING THAN STOP."



Target practice on tumors

The side effects of cancer treatment can be painful: hair loss, ulcers and nausea. Cancer drugs cause damage because they destroy fast-growing cells indiscriminately, whether they're cancerous or healthy. Professor **Warren Chan** (IBBME), pictured above, right, has spent the last decade figuring out how to deliver chemotherapy drugs directly into tumours — and nowhere else.

Chan, a pioneer in the field of nanomedicine, brings a holistic view to his research. His group works on engineering more effective nanoparticles for drug delivery, modelling and imaging the behaviour of nanoparticles inside the body, and studying the effectiveness — or ineffectiveness — of nanoparticle treatments. The group published a paper in spring 2016 revealing that less than one per cent of nanomedicines reach their intended tumour targets. Now they're trying to find out why.

"OUR BEST WORK HAPPENS WHEN WE'RE LOOKING AT THE PROBLEM FROM MULTIPLE ANGLES."

"We felt it was time to look at the field more closely," Chan said. "The amount of research into using engineered nanoparticles to deliver cancer drugs directly to tumours has been growing steadily over the last decade, but there are very few formulations used in patients. Our paper illuminated some major limitations we're now working to overcome."

Most of the nanoparticles get stuck in the liver, spleen and kidneys — organs responsible for filtering toxins and waste from blood. Chan's group is now examining how the liver takes up nanoparticles, in partnership with Dr. Ian McGilvray at Toronto General Hospital, Professor Anton Zilman in the Department of Physics, and Professor **Julie Audet** in IBBME.

"Our connections to the rest of the University, as well as the surrounding research hospitals, really help us drive our research forward," Chan said. "Our best work happens when we're looking at the problem from multiple angles."

Lab-grown tissues could help repair damaged hearts

Professor **Milica Radisic** (IBBME, ChemE) and her team create sophisticated, realistic systems for growing human cells outside the body. Their lab-grown tissues are already being used to discover and test new drugs, and could one day replace or repair damaged organs.

The team's latest invention, the AngioChip, is a three-dimensional scaffold complete with tiny channels that act as internal blood vessels. Made of POMaC, a polymer that is both biodegradable and biocompatible, the AngioChip is seeded with heart or liver cells, which attach to the surface and begin growing just like they would in the body.

"Our heart muscle tissue actually beats, and our liver produces urea and metabolizes drugs," said Radisic, pictured below, left.

The team has licensed the technology to a spinoff company, TARA Biosystems, which uses the lab-grown tissues to screen new drug candidate molecules for negative side effects on the heart or liver. This reduces the use of animal testing and can prevent potentially dangerous drugs from reaching the market.

In the future, the tissues could also be used to screen large libraries of molecules for beneficial effects, helping to discover new drugs. But the ultimate goal would be to implant the lab-grown tissues back into patients whose own organs have become damaged through disease or injury.

Radisic and her team have many collaborators, from fellow U of T professors **Michael Sefton** (ChemE, IBBME) and **Aaron Wheeler** (Chemistry, IBBME), to researchers at the University Health Network and her business partners at TARA Biosystems.

"It's all about meeting the right people and making connections," she said. "When you are able to look back and see something you invented in lab turn into something that could really help people, I think that's very motivating."

"OUR HEART MUSCLE TISSUE ACTUALLY BEATS, AND OUR LIVER PRODUCES UREA AND METABOLIZES DRUGS."

PHOTOS/ NEIL TA

Mind reader

Professor **Tom Chau** (IBBME) wants to break down communication barriers. He has devoted his career to applying engineering solutions to clinical settings, with the goal of helping children with disabilities share their opinions and reach their goals with their families and in daily activities of life.

Chau, who is also the vice-president of research at Holland Bloorview Kids Rehabilitation Hospital, is working to find non-invasive ways for children with limited mobility, motor control or loss of speech to communicate and interact with the world around them using technology. One of his latest projects is an intuitive brain-computer interface that uses near-infrared spectroscopy to image blood flow on the surface of the brain, and map that data to thoughts and intentions.

"WE'RE TRYING TO 'TEACH' THE COMPUTER TO RECOGNIZE PATTERNS IN BLOOD FLOW, AND GUESS WHAT THAT PERSON MIGHT BE THINKING."

"We're trying to 'teach' the computer to recognize patterns in blood flow, and guess what that person might be thinking," said Chau, pictured below, left.

Before the computer can read your mind, it needs to be trained to understand how your brain works. Chau and his team have developed a set of training paradigms that ask the subject to perform a mental task, such as singing a song in your head, performing mental arithmetic or thinking of all the words you know that start with a given letter of the alphabet. These tasks induce patterns of blood flow that are generally identifiable and relatively similar across individuals.

The next step is for you to "send" blood to different part of your brain without performing the mental task.

"When people come into our lab, they are always sceptical — they don't believe they can do it," Chau said. "In our studies, we've shown that by the 10th session people can modulate blood flow in their brain without the task. They learn how it feels."

They've also taught the computer to recognize a relaxed, wandering mind — not so simple, it turns out.

"The brain at rest is incredibly noisy," he said.

Chau's team works at the leading edge of both medicine and engineering, and welcomes fresh ideas and approaches from all fields.

"Collaboration is critical in our group," he said. "I've had exceptional grad students from U of T — from IBBME, but also chemical, electrical, aerospace and mechanical. All of them bring such innovative approaches to biomedical challenges."

Machine learning

In the decade since the genome was sequenced in 2003, scientists, engineers and doctors have struggled to answer an all-consuming question: Which DNA mutations cause disease?

Professor **Brendan Frey** (ECE), pictured above, right, and his team aim to revolutionize genomic medicine by applying advanced deep-learning computational techniques to unravel mysteries contained in the three-billion paired DNA molecules that make up the human genome.

In 2015, Frey and his collaborators founded Deep Genomics, the first company to combine the group's decades of world-leading expertise with machine learning and genomic science.

"Our vision is to change the course of genomic medicine," said Frey, the company's president and CEO. "We're inventing a new generation of deep learning technologies that can tell us what will happen within a cell when DNA is altered by natural mutations, therapies or even by deliberate gene editing."

In its first year, Deep Genomics secured $5 million in seed funding and has grown to 17 full-time employees. Its multidisciplinary scientific advisory board includes Yann Lecun, director of artificial intelligence research at Facebook, Stephen Scherer, director of the Centre for Applied Genomics and world-leading expert on autism spectrum disorder, and Anshul Kundaje, a professor of genetics and computer science at Stanford University.

"WE'RE INVENTING A NEW GENERATION OF DEEP LEARNING TECHNOLOGIES THAT CAN TELL US WHAT WILL HAPPEN WITHIN A CELL WHEN DNA IS ALTERED BY NATURAL MUTATIONS, THERAPIES OR EVEN BY DELIBERATE GENE EDITING."

Frey feels that collaboration is key to informing the company's direction. The network he and his colleagues are building will see their technology reach across disciplines and industries to benefit real patients, on a global scale.

"At its core, Deep Genomics is a research-driven company," Frey said. "We want to have good relationships with the academic community and we want to provide a computational framework that will help speed up academic discoveries, as well as advances in medicine, including screening, genetic testing, drug targeting, personalized medicine and more effective treatment."

PHOTO/ NEIL TA

A HEALTHY ALLIANCE

U of T Engineering faculty members are leading multidisciplinary collaborative research and educational initiatives that are changing the face of health care.

↑ **Craig Simmons (MIE, IBBME), middle, is one of eight U of T faculty members who are collaborating on research for the Translational Biology and Engineering Program. Simmons is TBEP's scientific director.**

Translational Biology & Engineering Program

Occupying the entire 14th floor of the MaRS Discovery District's West Tower, the new Translational Biology & Engineering Program (TBEP), part of the Ted Rogers Centre for Heart Research (TRCHR), is a unique interdisciplinary research initiative that brings together leading experts in engineering and medicine to advance discoveries and accelerate new treatments for cardiovascular diseases. TBEP combines stem cell technologies with cellular and tissue engineering techniques, cell signaling, experimental platform development and clinical research in heart repair and regeneration. TBEP is one of three components of TRCHR, which also includes The Hospital for Sick Children and University Health Network.

Cardiac regeneration

Professor **Hai-Ling Margaret Cheng** (ECE, IBBME) and her team have discovered a more effective way to monitor cardiac stem cell therapy for treating heart disease. Cheng is developing and testing new contrast agents — chemical compounds that are injected into cells and tracked using MRI technology.

Fruit flies for fundamental research

Approximately 70 to 80 per cent of genes implicated in human diseases are found in fruit flies. Professor **Rodrigo Fernandez-Gonzalez** (IBBME) is researching fruit fly embryos to gain a better understanding of how heart cells develop and how they could be stimulated to repair themselves.

Biomaterials to repair the heart

Professor **Paul Santerre**'s (IBBME, Dentistry) research focuses on developing polymer technologies that reduce inflammation around life-saving devices such as stents and stem cell delivery systems, allowing heart cells to repair themselves and preventing longer-term complications like blood clots and scarring.

PHOTO/ NEIL TA

Centre for Healthcare Engineering

The Centre for Healthcare Engineering (CHE) was established in 2008 to bridge academic research in engineering with health-care practice. CHE is a leader in interdisciplinary research and education in health-care engineering, comprising engineering faculty and students whose research is directly impacting health-care organizations and partners in practice across Canada.

Ambulatory clinic scheduling

Outpatient care is a major component of the Canadian health-care system. Professors **Timothy Chan** (MIE) and **Michael Carter** (MIE), in partnership with Toronto's Women's College Hospital, developed software that generates optimized clinic schedules. The result: an improved use of space and clinic experience in their new hospital.

Systematic interruption management in intensive care

Intensive Care Unit (ICU) nurses receive frequent non-critical interruptions during a shift. In an effort to reduce these interruptions, professors **Birsen Donmez** (MIE), **Anthony Easty** (IBBME) and **Patricia Trbovich** (IBBME) developed a task-severity awareness tool (TAT). Using buttons or a foot pedal inside the room, nurses can activate a "Do Not Disturb" LED display hung above the door to an ICU room. In an observational study at the Toronto General Hospital, TAT was found to significantly reduce non-critical interruptions.

Perioperative decision support

Professor **Michael Carter** (MIE) leads a group of researchers who are developing simulation-based decision tools to help hospitals inform decisions that can lead to improved access, efficiency and quality of surgical processes. The pilot model was developed with Juravinski Hospital (Hamilton Health Sciences), St. Michael's and Mount Sinai Hospitals and has been used by over a dozen hospitals across the country.

"Health-care systems are a lot like giant factories — they involve a large number of people and processes all working together in different stages to meet one goal. At the CHE, we pioneer research that optimizes many of those stages, making health-care delivery more efficient, less costly and quicker."

— **Timothy Chan** (MIE), CHE Director

The future of health-care engineering starts in the classroom

U of T Engineering offers unique educational programs that develop competencies at the intersection of engineering and medicine:

Biomedical Engineering Minor
Specifically designed for undergraduate students interested in applying their engineering knowledge to health-care initiatives.

Biomedical Systems Engineering Major (EngSci)
The first undergraduate program of its kind in Canada. Its interdisciplinary curriculum builds strong foundations in both engineering and the life sciences.

MASc in Biomedical Engineering (IBBME)
Provides a strong academic foundation for students who want to become immersed in the discipline of biomedical engineering.

MEng in Biomedical Engineering (IBBME)
An accelerated, one-year full-time program with a focus on the design and commercialization of biomedical devices.

MEng Certificate in Healthcare Engineering (MIE)
Students learn how to apply industrial engineering methods to clinical problems, focusing their studies on either operations research or human factors.

MHSc in Clinical Engineering (IBBME)
Students learn how to apply and implement medical technologies to optimize modern health-care delivery.

PhD in Biomedical Engineering
With courses and a strong research thesis component, students emerge from this program ready to pursue careers in academia, medicine, industry and government.

PhD in Biomedical Engineering — Clinical Engineering Concentration
Provides the competencies, philosophy and values to enable students to reach the forefront of leadership in biomedical engineering and have a direct impact on health care.

ENGINEERING ON THE FRONT LINES OF CRISIS

Sarah Badiei stands in front of rubble during the Israel-Gaza conflict.

Q & A WITH SARA BADIEI

by KEVIN SOOBRIAN

She began her career in the North American energy sector. In 2011, U of T Engineering alumna **Sara Badiei** (ElecE 0T4) left to turn her talents towards humanitarian work. Since then, she has travelled the world rebuilding infrastructure in war zones, providing relief following natural disasters and helping to treat thousands in areas affected by disease.

Five years ago, you left your role as a power systems engineer at a large Southern California energy company to work for Médecins Sans Frontières, the International Committee of the Red Cross (ICRC) and now the World Bank. What made you decide to change your career from the private sector to humanitarian aid?

It was just perfect timing. I really love travelling and the unknown, and I was at a point where I'd paid off my debts, had a pretty good amount of savings and a nice foundation of experience. I didn't have any obligations and was still young enough that I didn't mind sleeping in tents in the jungle. I was ready to do something a little more exceptional that I didn't think I'd be able to do later if I had kids.

How did the idea come to you?

I had a colleague who had done something similar. He was an accountant, but he mentioned that he had worked with Médecins Sans Frontières. I was confused because I thought that you had to be a doctor to do that kind of thing, but he said that people from many different backgrounds can do this kind of work and, in fact, they're very much needed. I started looking into it more and thought 'Wow I can apply my skills to help people, travel, get paid and build an actual career.' It was like a whole new world opened up to me.

PHOTO/ COURTESY OF SARA BADIEI

Villagers line up for supplies in an effort to rebuild after Typhoon Haiyan devastated parts of the Philippines.

How did your background in engineering help to prepare you for this new challenge?

I think U of T graduates are somewhat overachievers and kind of thirsty for knowledge. They need challenge. I definitely see that in myself, and people I graduated with. And engineers in general, I think we need to see new dimensions and find new avenues to explore. The unknown is really exciting — and if the unknown is exciting, we have to be really good at solving problems fast.

Every mission I've gone on, it's a completely different location, set of people and skills, and an entirely different domain of work. And you have maybe three months to a year to not only figure it out, but also to be productive, contribute and try to actually make a difference. On one mission, I'll be working on supply chain management, next it's water sanitation, then energy, then pure people management. The thing about engineering is that it teaches you to learn pretty fast and be really adaptable. I would have to say that it's probably the best undergrad you can do, in my humble opinion. And, if you can, as an engineer, apply your skills to problems on a global scale, why not?

Do you think of your transition to humanitarian work as a career change or a progression in your engineering career?

At the time, I really thought of it as a complete change. What I realize now is that it's more like building a house: at one point you're going to work on the pillar in the southeast corner, at another point, the northwest corner. But eventually, it comes to together and you build something to put on top.

I worked for five years in the energy sector in North America, and then I thought I had completely changed gears and moved over to the humanitarian sector. But those things are merging into one job, now that I'm an energy specialist at the World Bank. I don't look at it necessarily as a career change. I look at it as a progression toward that niche area that defines me, that's made up of different things that I really like and get excited about. I don't think about it like it's a job, it just feels like it's what I love doing.

How would you describe the work that you do? Is there such thing as a typical day for you?

Not really — and that's what's really nice about it. We just get thrown so much stuff that we learn to thrive in constantly changing environments and challenges.

During my first mission with Médecins Sans Frontières Holland (MSFH), I was the manager of supply chain operations in Chad and it was so different from anything I'd done before. For the next mission with Médecins Sans Frontières France (MSFF), I was in the middle of Congo's jungles doing water and sanitation. Then, I was in the Philippines with MSFH after a typhoon doing emergency response work. For my first mission with the ICRC, I was sent to Gaza during the longest and most intense war ever experienced in a small enclave. As the head of the engineering department, which was the largest department in the sub-delegation, I was overseeing endless repairs to critical infrastructure damaged by the war. Next, the ICRC sent me to Afghanistan where I worked in Kandahar, Kabul and Herat to design wastewater treatment plants for provincial prisons.

Now, I'm living in Jerusalem and working for the World Bank on energy policy, institutional reform, regional integration, renewable technologies and more. So the days are different, people are different. Everything is different all the time. Which is really, really nice, but at some point it can get tiring. At some point, you want to have a home, so that's the flip side.

PHOTOS/ COURTESY OF SARA BADIEI

Administering a vaccine to Pygmy children in the jungles of northern Congo.

What is the impact or role that engineering plays in disaster relief and, more broadly, humanitarian work?

Next to doctors, engineers are — I would argue — the best people you can send to the field. If you need somebody to manage your program, to get the funding, to handle the water and sanitation, build your building, build your infrastructure — send engineers. They can do all of it. They can do anything.

What advice do you have for engineering students and alumni who might be interested in a career in humanitarian work?

The number one piece of advice I have is to not be afraid. It's totally possible and it's really worth it. It's a pretty cool career. I had a bug inside of me that wouldn't be quiet and just kept saying 'go, go, go.' It was just calling me, and I know some other people have it. If you have it, listen to it. You have to go. Even if it's for just one year, you have to do it.

Sara Badiei has experienced both the best and worst of the human condition over the past five years. Visit **uoft.me/badiei** to read about three of her cherished memories.

CGEN: Engineering in a global environment

The Centre for Global Engineering (CGEN), led by professor and director **Yu-Ling Cheng** (ChemE), encourages U of T Engineering researchers and students to think creatively about some of the world's most pressing challenges. Since its establishment in 2009, CGEN has tackled a wide range of issues — from reinventing the toilet to solutions for breastfeeding in developing countries. Here are three examples of recent projects:

Managing micronutrients

The diets of people in the developing world often lack essential micronutrients such as folic acid, thiamine, iron and zinc. Professor **Levente Diosady** (ChemE) and his team have worked out a way to create tiny edible particles — basically indistinguishable from salt grains — that are rich in iron. The particles are mixed with traditional iodized salt to create double fortified salt (DFS). Diosady has teamed up with Venkatesh Mannar of the Micronutrient Initiative to distribute DFS to more than five million children a day in India's Tamil Nadu province, and will expand into the province of Uttar Pradesh, where it will be distributed to between 10 million and 20 million people.

Improving aquaculture

Fish is a key source of protein worldwide, but fish farming is not always easy to sustain in developing nations. Oxygenating the water isn't easy — electricity is not always reliable, and the high cost of buying equipment is a barrier. Professor **Amy Bilton** (MIE) and her team have taken up this challenge by installing a passive aeration device in test ponds in Vietnam and Bangladesh. The device increases the level of dissolved oxygen in the water without the need for electricity, increasing fish production. Aquaculture is big business in South-East Asia and accounts for over five per cent of gross domestic product in Bangladesh and Vietnam. Bilton's next phase of the project involves field trials with 100 fish farmers in Bangladesh with support from the Powering Agriculture Program.

Smarter soils

Food production depends largely on the quality of the soil that sustains it. Professor **Arun Ramchandran** (ChemE) and his team aim to design a kind of chemical probe that could be impregnated into a small-scale substrate such as a piece of fabric or paper. When placed into a mixture of soil and water, the chemical probe would react with the target nutrient to create a colour change, similar to a litmus test, indicating whether supplements such as fertilizers need to be added. Because only tiny amounts of the probe are needed, the kits could be created for mere pennies apiece.

Visit **uoft.me/centreforglobalengineering** to read more about CGEN's full scope of research.

DEPARTMENT OF CHEMICAL ENGINEERING & APPLIED CHEMISTRY

chem-eng.utoronto.ca

Pei-Yu Kuo, a PhD candidate in Forestry, and Rana Sodhi, senior research associate and adjunct professor (ChemE), work on the new secondary ion mass spectrometer at the Ontario Centre for the Characterisation of Advanced Materials (OCCAM).

OCCAM to advance world-leading research

The Ontario Centre for the Characterisation of Advanced Materials (OCCAM) — a $20-million analytical laboratory co-led by Professors **Charles Mims** (ChemE) and **Doug Perovic** (MSE) — officially opened in May 2016. The facility contains leading-edge equipment for imaging, analyzing and manipulating materials with nanometre-scale precision that helps researchers understand the natural world and design better devices for a number of different sectors, including health care.

Professor **Chris Yip** (ChemE, IBBME) and his team are some of the many researchers who use the Centre.

"How biomolecules interact with each other is pivotal to all biological and cellular processes — from controlling our mood and brain function to our metabolism and senses," says Yip. "When these interactions are disrupted — whether through genetic mutations, disease or other factors — we get sick."

Yip and his team study how proteins self-assemble and interact, which in turn could lead to new strategies to treat disease and improve human health.

The team makes extensive use of an OCCAM tool called nanoIR to image protein molecules. In a two-step process, a tiny needle tracks over the surface of individual molecules, mapping their shape and organization in 3D. The needle also measures how these molecules interact with infrared light, which may yield new insights into the local chemical structure, organization and bonding. These insights are critical to learning how proteins might assemble or mis-assemble. The nanoIR will help identify structural and chemical details of how antibodies bind to proteins and protein aggregates, which may herald new approaches to treating diseases such as Alzheimer's.

"The nanoIR serves an important role not only in my area of research, but in our overall understanding of nano-scale material structure, composition and conformation," Yip said.

LAB-GROWN HUMAN CELLS AND TISSUE

An allied research program led by Professor **Milica Radisic** (ChemE, IBBME) received a Collaborative Research and Training Experience grant from the Natural Sciences and Engineering Research Council worth $1.65 million over six years. Through this grant, Radisic and her team, which includes professors **Alison McGuigan** (ChemE, IBBME) and **Arun Ramchandran** (ChemE), will help train a new generation of experts in developing leading-edge treatments for disease based on lab-grown human tissues.

Late last year, McGuigan and Professor **Radhakrishnan Mahadevan** (ChemE, IBBME) developed a way to grow cancer cells in the form of a rolled-up sheet that mimics the 3D environment of a tumour. The innovation will enhance the study of cancer by moving away from the traditional petri dish, which only provides a 2D perspective. Their findings were published in the prestigious science journal *Nature Materials* in November 2015.

PHOTO/ NEIL TA

DEPARTMENT OF CIVIL ENGINEERING

civil.engineering.utoronto.ca

Alumnus leaves stunning legacy gift of $20 million

A historic $20-million bequest from the estate of alumnus **Erwin Edward Hart** (CivE 4T0) will drive engineering forward by supporting emerging research and education at the Faculty of Applied Science & Engineering and providing enhanced opportunities for graduate students.

"Investments in early-career faculty will accelerate research and innovation," Dean **Cristina Amon** said. "This gift will support generations of professors and deepen our Faculty's culture of research and teaching excellence. It will also strengthen the Faculty's ability to recruit brilliant early-career educators and researchers from around the world. Our students will benefit from faculty who are committed to mentoring the next generation of innovators."

The income from the Hart Trust funds the Percy Edward Hart and Erwin Edward Hart Professorships. In September 2016, seven U of T Engineering faculty members received the inaugural award — three-year funding of $75,000 per year — for research and graduate student support. The seven professors are: 1. **Natalie Enright Jerger** (ECE), 2. **Tobin Filleter** (MIE), 3. **Philippe Lavoie** (UTIAS), 4. **Alison McGuigan** (ChemE), 5. **Daman Panesar** (CivE), 6. **Jonathan Rocheleau** (IBBME) and 7. **Chandra Veer Singh** (MSE). Visit **uoft.me/hart** to learn more about each recipient.

Alumnus Erwin Edward Hart's landmark gift will support the Percy Edward Hart and Erwin Edward Hart Professorships to bolster early-career research and graduate student mentorship.

←

Erwin Edward Hart, was a long-time employee of Massey-Ferguson Ltd. and served as the company's chief welding engineer. The professorships are named in honour of Hart and his late father, Percy Edward Hart.

This bequest contributes to U of T Engineering's $200-million fundraising goal as part of Boundless: The Campaign for the University of Toronto. To date, the Faculty has raised more than $180 million.

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ILLUSTRATION/ ANDREA M. LISTRO

RESEARCHERS AIM TO PREVENT LEAD-CONTAMINATED DRINKING WATER

The Drinking Water Research Group (DWRG) — a collaboration between professors **Robert Andrews** (CivE), **Susan Andrews** (CivE) and **Ron Hofmann** (CivE) — is studying the science of corrosion inhibitors. Using various additives, the researchers are learning the optimal combination of chemicals to limit and inhibit lead contamination of drinking water from aging pipe infrastructure.

In light of the recent state of emergency in Flint, Mich., understanding what corrosion inhibitors need to be used with Lake Ontario water can help to prevent a similar crisis of lead-contaminated drinking water in Canada. U of T Engineering is a global leader in water sustainability, treatment and management. In 2013, alumus **Henry Wu** (EngSci 7T5, ChemE MASc 7T9) generously gave $3.5 million, in part to support lab space for the Institute for Water Innovation — a key collaborator with the DWRG — in the forthcoming Centre for Engineering Innovation & Entrepreneurship.

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Leader in action: Six career tips from alumnus Rami Rahim

Rami Rahim (ElecE 9T4), CEO of Juniper Networks, stepped to the podium as the guest speaker for Convocation 2016 and confessed something surprising about his career.

"I've never had a 10-year plan; I've never had a five-year plan; I've never even had a one-year plan," Rahim said. "At each stage of my career, the next was never obvious to me."

His lack of planning worked to his advantage. As one of Juniper's original employees — the 32nd, to be exact — Rahim focussed on his first breakthrough product, the revolutionary M40 internet router. He then spent the next 20 years progressing through a series of technical and leadership roles to become the company's CEO and a member of its Board of Directors. Rahim was recently ranked 24th in the U.S. on Glassdoor's 2016 Highest Rated CEOs list with a 94 per cent employee approval rating.

Rahim punctuated his speech with six of the most important lessons he's learned throughout his career:

1. Do not dwell too much on the next career step: "Do a great job in your current role, stand out and thrive."
2. Finish what you start: "You can either let the pressure destroy you or motivate you to work even harder ... Pressure can truly create diamonds with the right attitude."
3. Push yourself outside of your comfort zone: "Never let fear, uncertainty or self-doubt slow you down or prevent you from taking that next step."
4. Work with wicked-smart people: "If the initial idea is flawed a great team will almost always figure out a course correct."
5. Be kind: "Everybody has a role to play in the success of a company."
6. Work hard: "You need to find a mission that motivates you in your career and your life."

Rahim holds 17 U.S. patents in networking technologies and is a member of the Institute of Electrical and Electronics Engineers (IEEE).

← "You are engineers — nothing is impossible." Rami Rahim spoke to the graduating ECE and MSE classes on June 9, 2016.

Professor Jonathan Rose.

WITH MOBILITY COMES GREAT CREATIVITY

An expert in field-programmable gate arrays, Professor **Jonathan Rose** (ECE) never thought he would count pediatricians, speech pathologists and physiotherapists among his students — but mobile devices and their many applications have a way of bringing people together.

ECE 1778 Creative Applications for Mobile Devices is a project-based course open to all graduate students from across the University of Toronto. ECE and Computer Science students with graduate-level programming skills are matched with specialists from other fields to create new interdisciplinary applications for mobile devices that aim to solve an open problem in the specialists' fields.

Past projects include CardiACT, an app that helps bystanders respond quickly and effectively if someone goes into cardiac arrest; Snap'N'Dose, an app that helps parents deliver the correct dosage of medication based on their children's age and size; and, an addiction-support app that inspired a research project in collaboration with the Centre for Addiction and Mental Health to create a smoking cessation app.

PHOTO/ SARA COLLATON

DIVISION OF ENGINEERING SCIENCE

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Thomas Looi holds a piece of the KidsArm, an image-guided robotic surgical arm for pediatric surgery.

From outer space to inner space — a robot revolution in paediatric surgery

Operating on children often requires suturing together tiny vessels, challenging the limits of a surgeon's manual dexterity. At Toronto's Hospital for Sick Children, **Thomas Looi** (EngSci 0T0, UTIAS MASc 0T2, IBBME PhD Candidate) is using space technology from Canada's most famous robot, the Canadarm, to automate this process and make it up to 10 times faster and more accurate.

Looi is the program director for the team behind KidsArm, the world's first image-guided robotic surgical arm specifically for paediatric surgery. Its control algorithm is based on the same systems theory used on the shuttle and space station's Canadarm, and uses targets developed for satellite tracking to accurately trace the surgical tool's tip. KidsArm can autonomously suture surface tissue and small vessels, and adapts conventional surgical tools to automate for a range of procedures including cardiac, neurological and general surgery. One of the key challenges is tracking tissue movement to accurately guide the robot's instruments as a patient breathes or the heart beats.

"The goal now is to make smaller, smarter tools, while mimicking the dexterity of a human hand," Looi said. "This would make surgeries much less invasive and shorten time on the operating table."

Looi developed his technical expertise working on space robotics for MacDonald, Dettwiler and Associates Ltd., the company behind the Canadarm that is also a partner in the KidsArm. When given the opportunity to take the technology into the surgical arena, he jumped at the chance.

"Robotics interest has skyrocketed in all areas from medicine to cars," he said. "It's a very exciting time!"

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Vicki Komisar stands in front of the Toronto Rehab Hospital's "lab on a platform."

GETTING A HANDLE ON SAFETY FOR SENIORS

Falls are the leading cause of injury, disability and death in seniors, sending nearly 80,000 Canadian seniors to hospital each year. "

Surprisingly, building codes for stairs and railings are not always based on data of how we walk and fall," said **Vicki Komisar** (EngSci 0T9, IBBME PhD candidate). "It's a lost opportunity for injury prevention."

Komisar uses the Challenging Environments Assessment Laboratory — a tilting, shaking "lab on a platform" at the Toronto Rehab Hospital — to study the biomechanics of balance loss and recovery. She has helped improve Canadian regulations for stairs, and shown that current handrail standards are insufficient.

"Using engineering to address serious public health issues is very rewarding," she said.

PHOTO/ ALANNA KOMISAR

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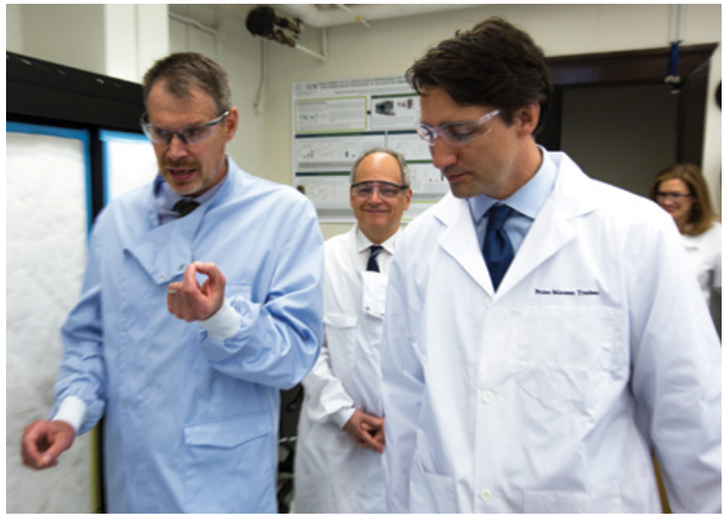

IBBME professor Peter Zandstra (left) leads a tour of regenerative medicine research facilities in U of T's Banting Institute for Prime Minister Justin Trudeau during his visit on Jan. 13, 2016 to announce a $20-million grant to establish a new Centre for Advanced Therapeutic Cell Technologies.

Prime minister backs regenerative medicine research at U of T and partners

Regenerative medicine is the way of the future for Canadian health care, Prime Minister Justin Trudeau said, and the federal government will help strengthen collaborations between U of T and its partners in stem cell research and manufacturing.

In January 2016, Trudeau announced a $20-million grant for the Centre for Commercialization of Regenerative Medicine (CCRM) to establish and operate the Centre for Advanced Therapeutic Cell Technologies in the MaRS Discovery District.

The CCRM is the commercialization arm of U of T's Medicine by Design (MbD) initiative, a program led by Professor **Peter Zandstra** (IBBME) with a mandate to undertake transformative research and clinical translation in regenerative medicine. Supported by the largest federal government grant in U of T's history, MbD will use its $114-million funding to bring together more than 90 researchers across the University and its health-care partners to develop next-generation treatments for serious injuries and diseases.

"Stem cells offer avenues to treat — and perhaps cure — devastating and costly illnesses such as cardiovascular disease, diabetes, blindness, lung disease, neurodegenerative disorders, and diseases of the blood and musculoskeletal system," Zandstra said. "This program will allow us to take regenerative medicine to the next level — we'll be able to design cells, tissues, and organs from the ground up, hopefully with benefit to patients and benefit to the Canadian economy."

The federal government's support for the new centre at MaRS is matched by a $20-million investment from GE Healthcare.

Q-AND-A WITH ALUMNUS AMIR MANBACHI

A faculty position at a prestigious institute is a coveted career path for many PhD graduates. Alumnus **Amir Manbachi** (EngSci 0T8, IBBME PhD 1T5), a recent appointee in the Department of Biomedical Engineering at Johns Hopkins University, shares some insights on his journey.

Can you tell us about your role?
As the director of innovations at the Carnegie Center for Surgical Innovation I will be working closely with researchers in the Johns Hopkins Neurosurgery Spine Program on medical imaging modalities for image-guided neuro-interventions and spine applications, as well as 3D printing for surgical use.

How did you gain exposure to 3D printing technology?
My primary exposure to this technology happened during my postdoctoral appointment at Harvard-MIT's Division of Health Sciences & Technology. My supervisor, Professor **Ali Khademhosseini** (ChemE 9T9, MASc 0T1), is a world-renowned expert in micro- and nano-scale biomedical engineering, and one of the projects I worked with him on involved the use of 3D printing for tissue engineering.

How did your PhD from U of T prepare you for this position?
In three ways: 1) my exposure to hospital surgical observerships in my PhD clinical engineering concentration program, 2) my stellar research supervisor, Professor Emeritus **Richard Cobbald** (ECE, IBBME) and his guidance for my thesis on image-guidance technology for spine surgeries, and 3) the knowledge and experience I gained when I founded Spinesonics Medical Inc., a startup based on my research.

Read the full Q-and-A at **uoft.me/amirmanbachiiinterview**.

PHOTO/ JOHNNY GUATTO

DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING

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The Hykso device, shown above, connects instantly to a companion smartphone app via Bluetooth.

Olympic boxers strike hard with the help of engineering alumnus

The Canadian and American boxing teams had the upper hand going into the 2016 Summer Olympics.

Leading up to the Games, both teams trained using a wearable sensor — created by MIE alumnus **Khalil Zahar** (MechE 1T4) and his company Hykso — that tracked each punch, measuring its speed and intensity.

The small sensor is strapped onto a boxer's wrists to track their hand movements 1,000 times per second. Combining motion tracking and machine-learning technology, the device then calculates, in real-time, the speed of the punch, and even recognizes the type of punch thrown.

Zahar says the University of Toronto's Impact Centre, as well as his engineering background, helped pave the way for his successful startup.

"My engineering background helped me in a lot of ways," he said. "To create this device, I had to explore and validate my hypothesis, and iterate my assumptions, just as I would in research — it's very scientific, actually. I didn't think I would become an entrepreneur, because I really enjoyed research. I thought I could have an impact that way."

His impact will now be felt in the sport of boxing (and in the ring). Boxing coaches traditionally use clickers to measure the number of punches thrown. But Zahar said that method is subject to human error — plus, it doesn't allow you to log additional data.

"Adding this device means you can differentiate each punch, you can dig deeper into the data so that you can improve as a boxer, and you can measure endurance in real-time in order to change your regimen as you go," he said. "It can even help in pinpointing an injury."

Since launching Hykso in 2013, the company is now based in Orange County, Calif., and has generated $360,000 in sales. Zahar also hopes to keep expanding the use of his device into other sports, as well as sports broadcasting — and even high-intensity workouts like crossfit.

"I want to change the way people train in sports," he said.

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Professor Kamran Behdinan.

MIE RESEARCHER LOOKS TO DESIGN THE NEXT GENERATION OF AIRCRAFT LANDING GEAR

Every time a plane touches the ground — whether taking off, landing or taxiing on the runway — the pivotal piece of equipment that ensures the aircraft's safety, and the safety of its passengers, is the landing gear.

The landing gear relies on many complex and interdependent mechanical components: the retraction-extension mechanism, locking system, tires and 'shimmy damper' that controls the lateral vibration on landing all work together to prevent failure on landing.

Professor **Kamran Behdinan** (MIE) hopes to improve the design. He was recently awarded a $900,000, three-year NSERC Collaborative Research and Development grant to make it happen.

Behdinan and his research group will work alongside SPP Canada Aircraft Inc. and its parent company Sumitomo Precision Products Co. in Japan to develop an integrated computational methodology for the design, testing and development of the next generation of landing gear.

"This is a very unique collaborative research and development project," said Behdinan, Director of the University of Toronto Institute for Multidisciplinary Design & Innovation and the University of Toronto Advanced Research Facility in Lightweight Multifunctional Structures. "The Greater Toronto Area is actually the hub of landing-gear development in the world."

PHOTO/ COURTESY OF HYKSO

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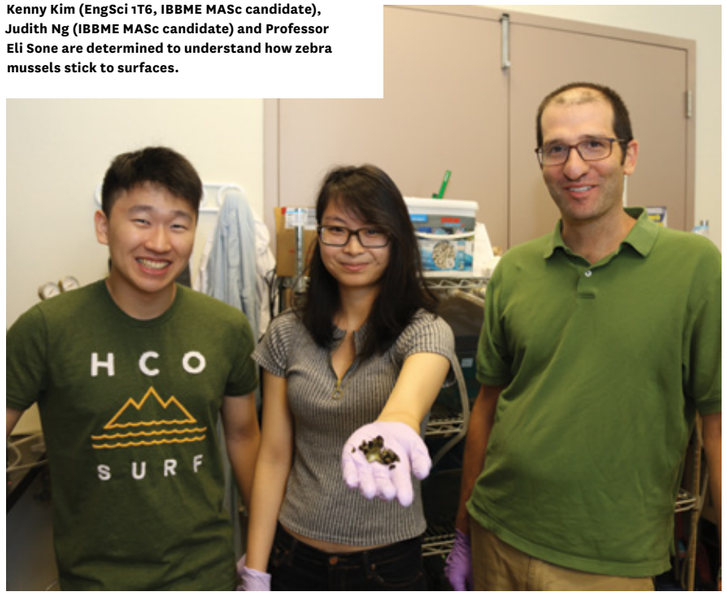

Kenny Kim (EngSci 1T6, IBBME MASc candidate), Judith Ng (IBBME MASc candidate) and Professor Eli Sone are determined to understand how zebra mussels stick to surfaces.

Zebra mussels could inspire better medical adhesives

An invasive species, zebra mussels arrived in the Great Lakes from Russia in the late 1980s. They are best known for clogging water pipes and causing headaches for many industries in the region, but for Professor **Eli Sone** (MSE, IBBME) and his team, zebra mussels could hold the key to a new generation of better medical adhesives.

"Zebra mussel glues have properties very similar to what we need for biomedical or dental glues," says Sone. "They stick to just about any kind of surface in wet conditions and are non-toxic, which is something we can't get with most synthetic glues."

Sone and his team have studied the substances that make up zebra mussel glue using both structural and biochemical techniques. Over the past several years, they have discovered nearly a dozen new proteins that give the glue its unique properties. They recently presented their work at the World Biomaterials Congress, held in Montreal last May.

Understanding how zebra mussels stick to surfaces could enable Sone and his collaborators to design synthetic materials that mimic the proteins, creating safe, strong adhesives for dentistry or surgery.

At the same time, Sone is working with Professor **Ben Hatton** (MSE) to make surfaces that mussels have a hard time sticking to. These surfaces would be more environmentally friendly than current options, and could potentially save industries millions in costly removal operations.

"It's a fascinating problem," says Sone. "The best part is discovering proteins that no-one has ever seen before and trying to figure out how they work. For me, that's really exciting."

University Professor Emerita Ursula Franklin passed away on July 22, 2016. The Faculty held a memorial service on Sept. 28.

REMEMBERING UNIVERSITY PROFESSOR EMERITA URSULA FRANKLIN

The world is mourning University Professor Emerita **Ursula Franklin** (MSE), one of Canada's most accomplished scientists and educators and one of its most renowned feminists and peace activists.

Franklin, who died at the age of 94, was born in Germany and educated in Berlin. After surviving the Holocaust, she came to the University of Toronto as a postdoctoral student in 1949. Following 15 years as a senior scientist with the Ontario Research Foundation – where her research on strontium-90 in baby teeth was instrumental in achieving a moratorium on atmospheric nuclear weapons testing – she joined U of T Engineering in 1967 as the first female professor of what is now known as the Department of Materials Science and Engineering.

Franklin pioneered the field of archaeometry, applying modern materials science to the dating of archaeological artefacts. In 1984, Franklin became the first woman to receive the title of University Professor, the highest academic rank at U of T. She delivered the Massey Lectures in 1989 and holds more than 40 honorary doctorates. In recognition of her humanitarian work, Franklin received the United Nations Association's Pearson Peace Medal in 2002.

PHOTO/ MARK NEIL BALSON

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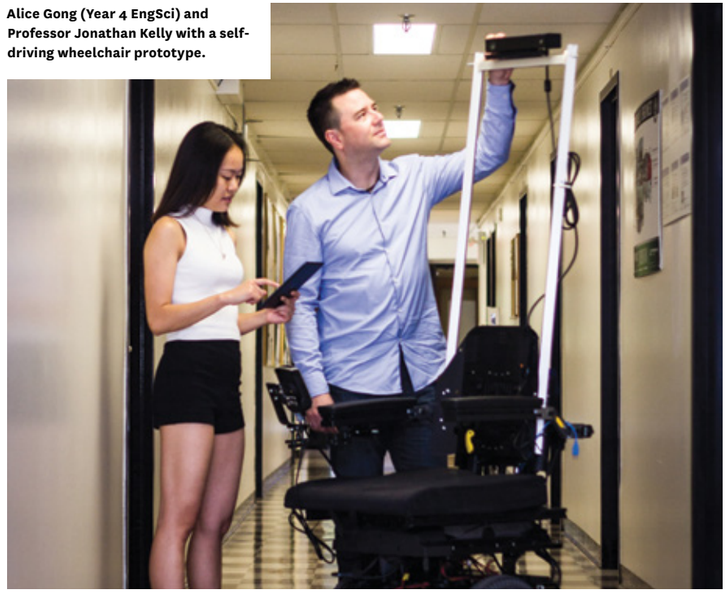

Alice Gong (Year 4 EngSci) and Professor Jonathan Kelly with a self-driving wheelchair prototype.

UTIAS professors marry disparate areas of research for health-care innovation

Three UTIAS researchers are collaborating with experts at the University and beyond on potentially lifesaving technologies.

Professor **Peter Grant** (UTIAS), an internationally recognized expert in vehicle simulation, contributed his expertise to the development of a human-in-the-loop wheelchair simulation in collaboration with Dr. Geoff Fernie at the Toronto Rehabilitation Institute. Their aim is to improve both the design and accessibility of wheelchairs based on human response to the environment. This research could ultimately lead to rethinking the design of all our environments — improving accessibility in ways that we have not yet imagined.

A research focus that enables robots to operate safely over long periods of time and in challenging environments makes Professor **Jonathan Kelly** (UTIAS) particularly well suited for his new collaboration with Cyberworks Robotics and the University of Sherbrooke. Kelly and his team are developing a self-driving wheelchair for people who cannot use the traditional joystick control. The goal is to design a reliable wheelchair that will autonomously map its environment, determine what path to take and how to react to obstacles it encounters.

Professor **Angela Schoellig** (UTIAS), known for her research in robotics, controls and machine learning, leant her unpiloted aerial vehicle (UAV) expertise to a collaboration with Professor **Timothy Chan** (MIE) and U of T's RescuNet. Using data collected over the past 10 years that showed response times to heart attack calls could determine survival rates, the group examined the possibility of delivering defibrillators with UAVs. They found that, in theory, using UAVs could lower response times.

PHOTO/ YANI MACUTE

LEADING EXPERTS GATHER FOR RENOWNED UTIAS WORKSHOP

UTIAS hosted its fifth International Workshop on Aviation and Climate Change in May 2016. Held biennially, the workshop brings together some of the world's leading experts in order to exchange ideas, establish research priorities and identify opportunities for collaboration.

"Every two years we have to ask whether we are advancing quickly enough to achieve the aviation sector's ambitious emissions-reduction targets," said Professor **David Zingg** (UTIAS), the workshop's organizer. "This year's workshop provided cause for optimism, as a wide array of promising technologies are under development. Governments around the world are making significant investments, but continued investment remains urgent."

START@UTIAS SHOWS NO SIGNS OF STOPPING

The inaugural year for Start@UTIAS was a tremendous success. With donor and UTIAS alumnus **Francis Shen** (UTIAS MASc 8T3) personally mentoring the students along with **David Zingg** (UTIAS), 14 teams received funding to explore their ideas. Ultimately, six teams pitched at an investor day and all garnered interest from investors.

Subsequently competing at The Entrepreneurship Hatchery's Demo Day, Start@UTIAS teams took three of the top four spots and won a combined $120,000 in funding. One of these teams, Kepler Communications, announced in August that they had raised $5 million in seed funding to develop their in-space telecommunications network. And teaBOT, co-founded by **Rehman Merali** (UTIAS PhD candidate), recently began expanding its robot-blended, customized cups of loose-leaf tea across North America.

Honour Roll

The collective generosity of U of T Engineering's vibrant community of alumni, faculty, students and friends is nothing short of outstanding. We offer our deep thanks for your tremendous support and dedication.

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The following donors have made new gifts and pledges to the Faculty of $25,000 or more between May 1, 2015 and April 30, 2016.

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Frank and Barbara Milligan (front row, middle), celebrated with fellowship recipients from IBBME and MIE at a luncheon on Dec. 2, 2015.

The **Barbara and Frank Milligan Fellowships** have been foundational in launching the careers of many MIE and IBBME graduate students.

"I love to invent, and I am even more interested in helping people live longer and healthier lives. My future goal is to start a biomedical engineering firm for the development of devices to assist people, and the Milligans' generous support is helping to make this dream become a reality."

— **Ali Anwer** (MechE 1T5, MASc candidate)

Legacy Gifts

Planned gifts help fund the work of our students, scholars and researchers through bequests, insurance gifts, trust agreements and charitable annuities. As of April 30, 2016, the following alumni and friends have thoughtfully made a provision for the University in their estate plans or as Annual Fund gifts.

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The Faculty of Applied Science & Engineering is grateful to the following members of the Skule™ Society for their generous and ongoing support. Their annual gifts of $1,000 to $24,999 (or of $250 and above for current students and young alumni who have graduated in the last decade) enhance the experiences of our students, contribute to Faculty excellence and improve our labs and classrooms. Donors listed below have made leadership gifts or pledges to the Faculty between May 1, 2015 and April 30, 2016.

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Kathleen and **Bill Troost** (ChemE 6T7) continued their support for leadership education at U of T Engineering in 2015–2016 with a $1-million gift for the Institute for Leadership Education in Engineering (ILead) to enhance co-curricular leadership training and $125,000 for the Department of Chemical Engineering & Applied Chemistry's Leaders of Tomorrow Program. With these new gifts, the Troost family has contributed more than $7 million to the Faculty, including a $2 million gift to create new space for ILead in the Centre for Engineering Innovation & Entrepreneurship.

Giving Opportunities

For fundraising and major gift inquiries, please contact **Gillian Sneddon**, Executive Director of Advancement, at **416-946-3449** or **gillian@ecf.utoronto.ca**.

Back to Skule™
A natural connection

by JAMIE HUNTER

Elaine Campbell (ChemE 8T0) spent some of her best years at U of T Engineering — and has been a familiar face at the Faculty ever since. She met her husband during her undergraduate studies. Their three children all graduated from U of T.

"Staying connected to the University just felt very natural," Campbell said.

Campbell, the interim president at Innovative Medicines Canada, currently sits on the Board of Advisors for the Department of Chemical Engineering & Applied Chemistry (ChemE), a position she's held since 2012.

A number of factors influenced her to volunteer for ChemE's Board of Advisors, but it was the department's connections to the biomedical world — including its close collaboration with the Institute of Biomaterials & Biomedical Engineering, its world-leading bioengineering research centre, BioZone, and its close proximity to the network of hospitals along Toronto's University Avenue — that really inspired her.

"The idea of medicine, engineering and pharmacy having a nexus is really appealing," she said. "I'm proud of what the Faculty has done there. There are unique investment opportunities both for global corporations and entrepreneurs and the world needs to be aware of this."

She brings a wealth of pharmaceutical industry expertise to the ChemE board. Over the past 25 years, Campbell has held leadership positions at both DuPont Pharmaceuticals and AstraZeneca — including president and CEO of the latter's Canadian operation.

While studying at Skule™, Campbell was driven to improve the quality of life and health of others, and was intent on a career in the biochemical engineering sector. After a brief stint working as an engineer in DuPont's polymers division, she quickly found her way into the pharmaceutical side of the company's business.

"I like to say that life is just chemistry in motion," she said. "All living things are based on chemistry, so the pharmaceutical industry was a natural fit for me ... I found my way back to my first love — the biomedical and biochemical part the discipline."

Campbell also represents U of T on the MaRS Discovery District's Board of Directors and has participated in U of T Engineering's Alumni Mentorship Program.

Her suggestion for getting and staying involved?

"It all looks very consolidated," she said of her volunteer work. "Define what's important to both your personal and professional life and make the time."

Volunteer Leadership

The Faculty of Applied Science & Engineering is grateful for the support and counsel of dedicated volunteers. These leaders give generously of their time and remarkable expertise to enhance advancement activities across the Faculty, including alumni relations and development. Visit **uoft.me/volunteer-leadership** for a complete list of individuals who have donated their time and service to Skule™.

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