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DEPARTMENT MAGAZINE

Issue 22
FALL 2017

#SUSTAINABILITY?

TRENDING HASHTAG OR MOBILIZING QUESTION

Professors discuss driving results beyond the hype

GREEN START-UPS

SAN FRANCISCO TECH

ALUMNI UPDATE

Civil Engineering
UNIVERSITY OF TORONTO

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ISSUE 22
FALL 2017

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MESSAGE FROM THE CHAIR

The topic of sustainability is an evolving subject with wide-sweeping implications. In previous issues of The Civilian we have discussed certain technologies marketed as green alternatives, resource use in megacities and water management practices and research. However, as the environment continues to be a pressing concern, our professors are continually identifying and resolving areas of need and controversy. Moving past the hype, our Department continues to produce fresh thinking and innovative solutions warranting another issue of The Civilian on Sustainability – is it a trending hashtag or mobilizing question?

Perhaps considered by some as a buzzword, there is no denying its current popularity in academic, industry and policy discourse, sustainability can seem to be a nebulous and ambiguous term. Beyond the glamour of 'going green', our department's work demonstrates the impact and responsibility we take seriously to preserve the earth.

At the intersection of good research and exploration, there are champions insisting on forward thinking and challenging the status quo. Our faculty are advancing the dialogue surrounding sustainability and empowering a cleaner future. In this issue, you will read professor insights and opinions on the buzzword-status of 'sustainable'. Developing a definition of 'sustainability', you will learn how the word's powerful nuances shapes and directs research.

Also in this issue, we feature the Grand Prize Winners in the 2017 US Department of Energy's Race to Zero Student Design Competition. A market-ready, design solution for Toronto homeowners and an answer to our city's housing crunch – with net-zero results. Read about alumni who are forging dynamic careers in green start-ups and in the San Francisco tech valley.

In Lassonde Institute of Mining news, I am pleased to congratulate our Department's Professor Lesley Warren on her appointment as Director of the Lassonde Institute of Mining. Along with holding the Claudette MacKay-Lassonde Chair in Mineral Engineering, she is an accomplished researcher and trailblazer. We look forward to seeing the success the Institute will achieve with her vision and leadership.

On a final note, during this auspicious year celebrating Canada's 150th of confederation, this issue contains a special legacy feature. A lecture, delivered in 1977 on the occasion of the University's 150th anniversary, chronicles the first 150 years of Canadian Civil Engineering and provides foundational details of our profession's impact on building the foundations upon which our country literally stands. Special thanks to Professor Brenda McCabe for her comments illuminating the recent updates and advancements of the recent 40 years.

I invite you to provide your thoughts or questions the issue of sustainability might raise to **civ.communications@utoronto.ca**. Or we invite your discussion on our faculty professional platform, **UofTEngineeringConnect.ca**. We love hearing from our alumni and would love to continue to stay CONNECT-ed as you grow in your career and impact in this world.

Professor Brent Sleep

10.52+M Total Research Funding

1st in CANADA

Recently, the Lassonde Mineral Program was ranked top in Canada and 9th globally by the Shanghai Ranking Consultancy

RANKED 9TH IN WORLD

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CIVIL + MINERAL

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11 RESEARCH CHAIRS

7,722 LIVING ALUMNI

NEW
Lassonde Mining Hub Announced

Institute Director Appointed

FEATURES

SECTIONS

LASSONDE INSTITUTE OF MINING

New Director Appointment

DR. LESLEY WARREN

The Lassonde Institute of Mining (LIM) is a world-leading interdisciplinary mining research institute with a focus on sustainability. As a global leader in innovation, the Faculty has appointed cutting-edge researcher Dr. Lesley Warren as the Institute's Director. Warren's appointment will drive deeper industry connections and exploration of pioneering technologies.

Professor Warren joined the Department of Civil Engineering on January 1, 2016 as the Claudette Mackay-Lassonde Chair in Mineral Engineering. She leads a team of students and researchers, the Warren Group, exploring microbially-driven geochemical cycling in mining wastewaters. Internationally recognized for her work in mining water quality management, both in academic and resource-sector based communities, Warren has strong connections with numerous energy and mining industry leaders. Housed on the fourth floor of the Galbraith Building, the new $1.1M lab named The Mining Water and Environment Facility, will serve as the Warren Group's lab to grow and drive new discoveries. For more information on The Warren Group and their new lab, please see page 11.

Warren began as LIM Director in April 2017 and despite her short time in the role, she is spearheading a new initiative for the Institute. The Lassonde Mining Hub (LMH) with shared academic and industry directorship will serve as a Canadian centre for industry-academic partnerships tasked to develop transformative solutions and pivoting the mining discourse. The LMH will coalesce the deep expertise in mineral exploration, mining engineering, computational geomechanics, mineral process engineering, metallurgy and water management across the entire Faculty producing unprecedented results.

The LMH's mandate will serve to connect companies directly with cutting-edge research, faculty and students alike, and will provide structural support to increase the LIM research portfolio. This new initiative will expand capacity and increase opportunities for student engagement, internships, research positions, networking and seminars.

Recently, the Faculty of Applied Science and Engineering (FASE) Dean's Strategic Fund provided financial support for the creation of a nationally unique role, the LMH Industry Associate-Director. An industry veteran intimately involved in the field will fill the position; their primary objective will focus on strengthening LIM's ties with the extractive resources sector, strategically accelerate industry engagement and foster LIM's connections nationally and globally to other mining programs and collaborative projects.

> "Mining is a global enterprise and the industry continues to look for ways to bring the community together to tackle challenges and find solutions," Warren remarks.

As the new Director of the LIM and overseeing the LMH, Professor Warren sees her role as a facilitator, accelerating and supporting excellence in research, teaching and outreach. She seeks to grow an inclusive and vibrant LIM community both inside and outside the university.

"The LIM takes the U of T view on things – we will be the best, we will look to the future rather than resting on the past and we will find innovative ways to make a real difference to our community both here in Canada and around the world"

~ Professor Lesley Warren,

Director of Lassonde Institute of Mining

The LIM has some of the best and brightest minds working on critical challenges facing the industry. Our work is addressing new and emerging areas of critical significance for smarter mining; such as reducing waste and improving environmental stewardship, improving exploration and processing technologies and innovating construction, data management, geotechnical and operational technologies," remarks Warren.

When talking to Professor Warren, her passion for the LIM students, researchers and work is evident. It is from this emboldened position, that the U of T Professor is positioning the LIM to reach new levels of future success and achievement. It is also important to note that LIM success will not only benefit academics but also improve the economic viability of industry partners as well.

Environmental and societal challenges are among the biggest issues facing the mineral extraction industry. The need for smarter mining approaches and new timely technologies increases as the call for substantive attitude shifts towards sustainability. As the demand increases, a void in the market grows. A long-identified fundamental impediment to mining innovation, the LMH seeks to bridge the knowledge gap, connecting industry and academia at a broad scale to inform on real-time issues. The LMH will provide a direct pipeline of enhanced researchers to the concerns of mine managers and through this uniquely positioned national centre, propagating critical advancements and, ultimately, sector disruption.

"LIM's goal is to be the national hub for broad engagement that will connect thought leadership with advanced research expertise to tackle the knowledge gaps limiting development of innovative mining solutions," remarks Warren.

Precipitating from the LIM's award-winning ethos, the LMH will generate transformative research outcomes and continue to train next generation advanced professionals who will serve as industry leaders strengthening the global competitiveness of Canadian mining operations.

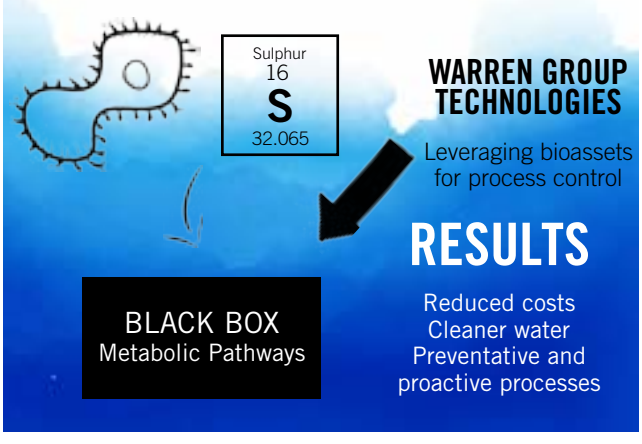
The New World Class MINING WATER AND ENVIRONMENT FACILITY

Completed in June, the first of its kind $1.1M "Mining Water and Environment Facility" will be home to the Warren Group. Addressing mining wastewater, the group is aggressively pursuing the untapped areas of microbe diversity. Naturally-occurring bacteria thrive in these inhospitable conditions of mining wastewater. Some negative side effects of their activity are increases toxicity levels, driving cleaning costs up for industry.

The Mining Water and Environment Facility offers upstream R&D poised to transform a decades-old industry problem: cost-effective and environmentally safe mine water tailings decontamination.

The Warren Group has diverse and multi-disciplinary skills drawing upon geochemical, microbial biology and engineering including chemical, mining and mineral fields. Their integrated efforts aim to crack open the "microbial black box" linking certain metabolic pathway controls with desired outcomes. Harnessing their abilities transforms bacteria into bioassets capable of pollution prevention and mine reclamation.

Global tailings production is estimated at 7.1 million tons per year. The treatment of this waste has created a global market worth $3.6B. Current remedial efforts employ toxic chemicals to mitigate and treat the problem, increasing environmental hazards. Extraction of earth materials has occurred for centuries. Today's mines require deeper depths to access higher-grade ore. Accordingly, producing higher amounts of tailings. These wastewaters are sulphur-rich and provide an energy source for bacteria influencing the water's composition. If industry could control and manipulate the microorganisms' activity, mining managers would be able to exploit these tiny biotechnology creatures for the benefit of industry and environment.



The bio-legacy of mining sites in the future will prove to be a global issue due to our expanding population. Land once dedicated to resource extraction will be required for homes, cities and farms. The lasting environment effects on land-health is something today's policy efforts are looking to address. Increased understanding of the biological make-up and genomic composition of wastewater dwelling organisms will further extend our understanding to better treat and preserve our earth.

2016
2017

Awards & Honours

Faculty

INTERNATIONAL

International Society of Indoor Air Quality & Climate
Fellow Inductee
Jeff Siegel

International Society for Rock Mechanics
Rocha Medal Recipient
Bryan Tatone

Institute of Materials, Minerals and Mining (UK)
Fellow Inductee
Paul Young

American Concrete Institute
Design Award
Evan Bentz, Michael Collins, Giorgio Proestos and Phillip Quach

American Concrete Institute
Joe W. Kelly Award Recipient
Frank Vecchio

Institute of Concrete Technology
Honourary Fellow
Doug Hooton

American Association for the Advancement of Science
Elected Fellow
Jeff Packer

NATIONAL

Canadian Academy of Engineering
Fellow Inductees
Robert C. Andrews and Heather MacLean

Canadian Society for Civil Engineering
Fellow Inductee
Brent Sleep

Canadian Society for Civil Engineering
Albert E. Berry Medal Recipient
Heather MacLean

Canada Research Chair
Seismic Resilience of Infrastructure
Constantin Christopoulos (Renewal)

Canada Research Chair
Transportation and Air Quality
Marianne Hatzopoulou

UNIVERSITY of TORONTO

Technology Enhanced Active Learning (TEAL)
Fellows
Elodie Passeport
Marianne Touchie

Hart Teaching Innovation Professorship
Bryan Karney

Connaught Global Challenge Award
Engineering Education for Sustainable African Cities
Brent Sleep

The Order of Canada Recipient

Congratulations to the Lassonde Institute of Mining Advisory Board Member Bert Wasmund who received the honour in July 2017.

Students

INTERNATIONAL

American Society of Civil Engineers
O.H. Ammann Research Fellowship
Stamatina Chasioti

US Department of Energy
Race to Zero Student Competition
Jason Gray (CivE MASc) and Kevin Qu Almanzar (CivE 1T6)

St. Gallen Symposium (Switzerland)
Leaders of Tomorrow Conference Selectee
Edvard Bruun

US National Electrical Contractors Association (NECA)
Student Passport Initiative 1st Place
Ernesto Diaz Lozano Patiño (CivE 1T5 + PEY, MASc candidate), Sneha Adhikari (Year 3 CivE), Mackenzie de Carle (Year 3 CivE) and Andy Liao (Year 2 CivE) with Professor Brenda McCabe

NATIONAL

Canadian Society for Civil Engineering
Best Paper in the Construction Category: **Yuting Chen** with co-authors **Professor Brenda McCabe**
Best Student Poster: **Junting Li**
2nd Place in the Capstone Competition: **Weije Liu, Angela Hu, Michael DeSanti, Eleano Siow and Johnny Ton**

Ontario Mining Association
MINED Competition | Top 3
Marina Reny, Matthew Hart, Yoko Yanagimura and Justin Simardzic

Ontario Centres of Excellence Discovery Conference Award
Mark Elias (CivE 1T4)

UNIVERSITY of TORONTO

Engineering Varsity Blues
Academic Excellence Award
Corrine Bertoia

Gordon Cressy Student Leadership Award
Sanchit Gupta (Year 4 CivE)

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The S-Word: DEFINING SUSTAINABILITY

Today, people argue, the power of the word **'sustainability'** has been diluted due to overuse. What began as a noble ideal has been reduced to a mere buzzword. We sat down with some of our professors to understand how 'sustainability' is more than hype for them and their research.

PROFESSOR I. DANIEL POSEN

Research Focus:

Providing system-scale environmental sustainability analysis for policy development

Large-scale systems are inherently complex. When holistically evaluating the 'sustainability' of a system a broad range of environmental, societal and economic metrics compound the matter. Naturally, a professor with such a research focus has a complicated relationship with the word 'sustainability'. Riddled with over-hyped products, under-delivering theories and overall 'green-washing', Professor Posen believes the discourse is weak. He particularly notices the current lack of numerical definition.

Posen's research exists at the intersection of engineering, environmental science, economics and public policy. His cross-discipline approach engenders a complete evaluation of all 'sustainability' efforts. It is with this integrated analysis that Professor Posen seeks to inform future system designs yielding greener outcomes.

Success in his quantitative analysis for policy development depends on capturing all factors, inputs and circumstances. The accuracy and availability of data, the consistency of modelling efforts across fields and the incorporation of nascent technologies are some challenges he must address. The variables are numerous, nuanced and involve advanced statistical analysis. Iterations are necessary to provide confidence ranges and uncertainty measurements to help craft policies.

Appropriately, Posen views 'sustainability' through a system-wide lens, considering the triple-bottom line in-

PROFESSOR I. DANIEL POSEN

Continued...

clusive of social, ecological and financial effects. He believes to operationalize 'sustainability' it must be reduced to measurable properties. Developing empirical tools to assess current levels, magnitude changes and confidence levels are all integral points in sustainability's definition. Once these methodologies are in place, it is important to tell the data's story accurately and without bias mobilizing policy makers driving real change.

With recent developments of the pan-Canadian climate framework addressing the country's 2030 emissions reduction targets, Posen's research plays an essential tool for government. Most recently, in conjunction with Professor Heather MacLean and a charitable environmental organization called Pollution Probe, Professor Posen is working on a white paper providing analysis to the Government of Ontario. The paper will provide guidance in provincial emissions from indirect land use change and carbon accounting for biofuels as part of both Ontario Renewable Fuel Standard and Canada's Clean Fuel Standard.

> "Only when we operationalize the term sustainability through quantitative analysis can we begin to mobilize policy makers and drive tangible change," Professor Posen on defining sustainability.

"It is necessary to remember that though governments can shift and mandate new targets, magnitudes of change in one area will have consequences in another," Posen says. These market-rebound and indirect effects are an important consideration in Professor Posen's research.

"It is not as simple as implementing biofuels to reduce green house gases (GHG)," says Posen. According to the professor when addressing GHG mitigation strategies, policy makers need to consider the totality of costs and benefits associated with the proposed protocols. If a food production crop is replaced with a biofuel-bound crop, this change will have implications not only in the energy sector but also for world hunger and food scarcity problems. Once bio-fuel crops are harvested, refining the biomass consumes energy, processing will affect air quality and the infrastructure needed to support distribution efforts requires investment. These are only a sampling of considerations to address when evaluating and selecting among the competing uses for biomass and prioritizing GHG mitigation strategies.

Other examples of sustainability analysis issues include prioritizing certain sectors before others, market price fluctuations and accounting for technologies that currently do not exist. New developments create alternative scenarios. Policy makers forge new directions with each new regulation. Some directions will lead to fruitful and tangible results while others will lead to dead ends. Confounding the issue, attributing the origins of outcomes is difficult to disentangle empirically. Posen is working to identify new, precise measurement modelling to improve path forecasting.

Professor Posen's previous work focused on large-scale systems at global and national levels. He is currently looking to address city-scale systems. As global leaders discuss and stipulate new green targets and frameworks, cities have an important role in implementing and driving their success.

"Often cities do not have an accurate picture of their current emission levels, for example. It proves difficult to identify necessary fundamental policy changes without data to inform the direction," says Posen. "With increased capacity to collect, analyze and disseminate crucial data points, local officials can make substantial changes that benefit both the short and long run sustainability of cities."

Professor Tamer El-Diraby

RESEARCH FOCUS: Construction management for societal and corporate changes

Professor El-Diraby agrees the conversation around 'sustainability' needs to be more than a passing fad. He notes, buzzword or not, 'sustainability' promotes positive results. "It is just a given nowadays," he remarks. "Most governments, businesses and our society as a whole accept and are prioritizing its implications."

El-Diraby notes his school-age children studying sciences are now learning through a lens of 'sustainability'. The generational expectation for sustainable efforts is non-negotiable. Despite its hashtag status, he believes there is a general movement from generic thoughts to actionable policies and programs for energy conservation and climate change. "While we may be bored with its use, caring about these issues is the result of profound belief in 'sustainability'," says El-Diraby. The Professor warns that not all who use the term have noble intentions. Some companies are abusing the term and diluting its operational power.

In construction management, Professor El-Diraby focuses on more than just green technology and number crunching. He is interested in the business case, change management and the sociology of embracing 'sustainability'. The professor is using social network analysis to help discover how communities - both citizens and professionals - view 'sustainability'. Through crowdsourcing, the Professor is sifting through the noise uncovering interesting insights.

A large portion of his research examines how to manage and support implementation efforts for 'sustainability'. Leveraging data analytics to help managers discover new knowledge or patterns of change, El-Diraby develops tools to help coordinate decision-making.

Across the global construction industry, many of the environmental and economic challenges with infrastructure systems are the same. However, the social aspects of 'sustainability' vary with the developmental phase of the city and country. In Canada, with preexisting infrastructure, governing bodies are seeking to change long-standing unsustainable construction practices. In a country like China, which is building new infrastructure, there is an opportunity to incorporate green construction and promote sustainable habits from the beginning. China is seeking to develop while Canada is seeking to optimize its developed systems. The methods are distinct but overall the goals remain the same.

Potential game changers are close, Professor El-Diraby believes for the construction management industry. He is confident the future is poised for many new impacts, which will improve the health and livability of our cities.

To read Professor El-Diraby's postulated gamechangers turn to page 21.

IMAGE by Jannoon028 - Freepik.com

PROFESSOR EVAN BENTZ

RESEARCH FOCUS:

Concrete and structures standing the test of time

"Sustainability is indeed a word that has become less powerful due to repeated use, but still represents an important concept," says Professor Bentz. Speaking as a concrete expert, the term evokes similar feelings to "resilience" – which the Professor notes is also pervasive in the industry. In both cases, Bentz believes these terms are important considerations and afford design engineers a point of reference when talking with building owners.

Bentz laughs when he recalls the reception the term artificial intelligence received during the 1980's. Back then, engineers believed AI was probably impossible and discredited the term quickly. Fast forward to 2017 and AI is now a worthy pursuit many corporate giants are chasing. His bit of trivia elucidates; trending or not, engineers must address 'sustainability' today and ready themselves for the unexpected of tomorrow.

When studying concrete, Bentz uses 'sustainability' to imply longevity and practicality. "As engineers we need to build lasting structures and, given the constraints of the project, use materials as efficiently as possible," says the Professor. "In a sense, it is an attempt to provide an accounting of environmental issues previously neglected by our profession." Improving building codes and creating increasingly efficient structures are just some of the 'sustainability' concepts involved in Bentz's research.

Viewing 'sustainability' from a global perspective, there are only so many construction materials available on this planet. However, despite limited material types, their applications can be vastly different. The surrounding landscape of a building in Toronto is vastly different from a structure in Abu Dhabi. "This is why 'sustainability' issues are not taught as a single set of rules like design code regulations," says Bentz. "Instead they represent more of a way of thinking and that is partly why we teach 'sustainability' in all four years of our program."

What does the Professor think will be important changes in the future?

Firstly, the availability of timber for large structural projects. "The stuff grows on trees," he quips. Another is the potential for large carbon taxes - much larger than current proposals, which could change our concrete mixes. Rather than designing with a small amount of high performance (and high strength) concrete, we might move back towards the older methods of having larger structural elements with a lower carbon footprint per cubic metre.

The most precipitous change for the professor will relate to cement production. Today, cement requires the burning of coal, which is a long-term problem. A cheap and greener method to create concrete would be a game changer for the Professor and industry at large.

Professor Marianne Hatzopoulou

RESEARCH FOCUS: Air quality, transportation and green house gases in cities

Disconcerting but repairable - describes Professor Marianne Hatzopoulou's position on the word 'sustainability'. She believes the term is too widely used and more often than not conveys naught. "I don't think we should stop using it, I actually think we should straighten how it is used," remarks the Professor.

Like Professor Posen, Hatzopoulou thinks of 'sustainability' as the triple bottom line. She does not appreciate the expansions and re-imagining efforts people make corrupting triple bottom line's simplicity. To the Professor, it is a straightforward concept: "We must evaluate the consequences of our decisions on the natural environment, on people and on the economy. Because without a growing economy, I don't believe that we can be creative or sustainable," says Hatzopoulou.

'Sustainability' drives her research where she specifically looks at air pollution, green house gases and transportation. She admits that her work cannot improve an entire system but, when combined with other research, there can be great change. "I don't think any researcher can claim that their work on its own will improve the 'sustainability' of our cities and society but coalescing knowledge is what really matters."

In an increasingly complex world, Hatzopoulou's work on air pollution involves understanding the problem before outlining solutions. Transportation sources create the most air pollution in cities but there is more to the equation. Because air moves, travels, mixes and disperses, assigning responsibility is difficult. The Professor notes the motivation, not just the source of pollutants, is complicated. Those who drive may choose to do so because they do not have access to more "sustainable" forms of transportation. Policy-makers can only affect change within the constraints of their budgets. The automotive industry first and foremost must respond to customer demands. There are many factors to consider and her work looks to account for all.

Though Hatzopoulou may be dismayed by the use of 'sustainability' overall she believes Canadians are particularly well versed on green options. "The problem is not a lack of education, the problem exists at a governmental level where long-term and strategic planning is needed to address our uncertain sustainability in the future," she says.

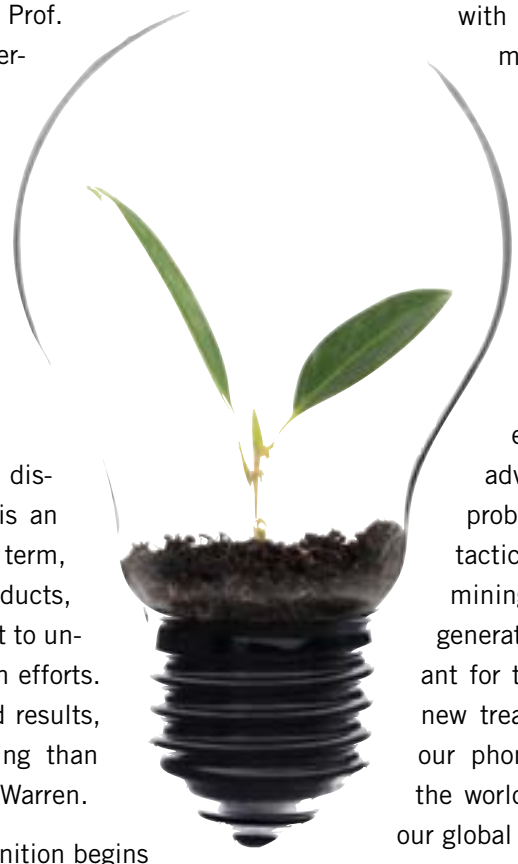
Road transport emissions and urban air quality have obvious implications to the overall health of our planet. The Professor believes one major change in the future will be autonomous vehicles and all other forms of automated transportation systems. Their ramifications on energy consumption, greenhouse gas emissions and air pollution will shape our cities and the lifestyles for all our residents.

Professor Lesley Warren

RESEARCH FOCUS: Cleaning dirty water from mineral extraction activity

Sustainability through a southern Ontario lens - is what Professor Lesley Warren calls it. In her research, when discussing the importance of 'sustainability', most people view the issue with an urban bias. This is not a problem exclusive to Ontario – throughout the world, residents of urban areas often have a louder voice as over 60% of the world's population lives in cities.

When thinking of 'sustainability' Prof. Warren explains people often overlook the integral role rural and underdeveloped areas of the country play in the 'sustainability' of our cities. "From the screens you read your emails on, to the fuel used to power commuter traffic, land far from urban centres has a direct impact on city green efforts," Warren says.



The Professor is cautious when discussing 'sustainability' noting it is an ambiguous and at times pejorative term, which many exploit to oversell products, ideas or initiatives. "It is important to understand the deliverables for green efforts. Without full agreement on desired results, the word is more about marketing than driving tangible solutions," states Warren.

An effective 'sustainability' definition begins with experts uniting and coalescing knowledge from across disciplines and contexts. She reiterates the complex nature of the term, noting that the many stakeholders and perspectives influence the term's meaning.

City policies have great impacts on rural communities with close ties to the mineral extraction industry; mining wastewaters produced hundreds of kilometers away from urban environments have lasting impacts on cities' health. Considering the interdependence, our population must come together and consolidate its efforts.

Warren recalls a poignant comment said to her years ago. After mining activity had contaminated the only water supply in a farmer's African town, he remarked, "You can't drink money." This statement has stuck with the Professor driving her efforts to measure 'sustainability' in more than dollar and cents. She regards stewardship, life quality and economic impacts as critical considerations to elicit the best results for the planet.

Collaborating with many mining industry leaders in her research, Warren points to the environmental champions. These advocates not only are reacting to problems, they are adopting proactive tactics. They are minimizing impacts and mining's environmental legacy for future generations. Mineral extraction is important for the medical equipment discovering new treatments, for the microprocessor in our phones connecting loved ones across the world and for fertilizers responsible for our global food supply. And as we continue to meet our resource demands we can do so mitigating our environmental impacts.

An issue Professor Warren looks to address in the importance of sustainability is in water. It is a precious and finite resource and something the mining industry needs in vast quantities. In areas prone to water scarcity there are competing needs to address. Once minerals are extracted, the wastewater produced must

be dealt with safely and securely. Upstream R&D is a focus for Warren. Engaging with industry partners, the Professor and the Lassonde Institute of Mining (LIM) and the new Lassonde Mining Hub (LMH) are pioneering new technologies that will dramatically transform the industry and create proactive solutions. To find out more about the Lassonde Mining Hub please see page 9.

TRENDING HASHTAG OR MOBILIZING QUESTION?

It is clear that the S-word has been reduced to a hashtag moniker for a trending movement. However, the nobility of effort is something to be celebrated. Mobilizing effects are palatable if the repetition does not alienate people first. Regardless of the trend, the word must amount to more than marginal gains and prioritize substantial impacts. Clearly, to do so, definition is important.

The way public discourse uses the word 'sustainable' is undoubtedly unsustainable. Green. Eco. Globally-conscious responsibility. The list can go on. Whatever the word choice, the motivation is there and is important to all engineers.

Evolving eco-conscious lexicons aside, our professors move past the hype and define 'sustainability' for impact and solutions. Here's a recap:

- Professor Posen wants more numbers.
- Professor El-Diraby wants to move past generic ideas to thoughtful examination.
- Professor Bentz wants to ignore the over-use and see the term for that which it inspires.
- Professor Hatzopoulou wants the term straightened-out.
- Professor Warren wants a dual-lens from both urban and rural perspectives.

IMAGE by Jannoon028 - Freepik.com

Continued from page 17...

Potential game changers are close, Professor El-Diraby believes for the construction management industry. He is confident the future is poised for many new impacts, which will improve the health and livability of our cities.

Automation | 3D printing and robotics are increasingly used. These technologies provide significant productivity improvements and elevate our capacity to examine complex problems.

Digitization | New technology called Building Information Modeling (BIM) is allowing sophisticated analysis and enhanced cross-border collaboration. The supply chain for construction design, finance and production is globalizing and yielding great benefits.

Net-generation | New construction customers are perceptive. They are acutely aware of sustainable energy options. These new players will force the industry to surpass green regulations and adapt to serve consumer demands.

Modern cities | There is a need for installing and re-configuring our infrastructure to accommodate new urban technologies such as driverless cars.

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Bilal Yusuf
MEngCEM Practicum 2016

"The work I've done for Yukon Highways and Public Works ties directly into key CEM program concepts: real-life modelling, budget allocation to achieve maximum efficiency and ITS planning to improve effectiveness of road networks."

Sarah Dominie
MEngCEM Practicum 2016

Transportation, utilities, housing and waste management are systems that every city needs to function efficiently or they can hinder the life of the city. The elite MEngCEM (Master of Engineering in Cities Engineering & Management) program gives students a unique combination of technical expertise in infrastructure and a fundamental understanding of the cross-disciplinary issues facing cities.

The program admits a small number of students, who all have at least one year of professional experience. By hiring a student for a four month placement, your organization is getting more than a summer intern, you will be getting a student who can contribute in a meaningful way from day one. Hiring organizations can also benefit from a tax credit.

If you think there might be a role for an MEngCEM student with your organization, please contact **civ.gradprograms@utoronto.ca** for more details.

From a green start-up to Silicon Valley, our alumni provide some insights into their professional journey and life after CivE

GREEN STARTUP
CAROLYN HICKS

U of T Engineering set me on the right track towards entrepreneurship. The skills I developed within and beyond the classroom have been very helpful along the way. In particular, the ability to tackle any sort of problem - breaking it down and building it back up has been essential to figuring out how to start a new company.

Back in first year at U of T, I met my now-husband and business partner, Damien Frost (Eng Sci OT7). Ten years later at the University of Oxford we teamed up with two PhD students to build a new battery technology creating our green start-up, Brill Power. I had never expected to be an entrepreneur, but when the opportunity came up I just had to dive in.

Brill Power is about making energy storage smarter. Our vision is that smarter batteries will drive better product performance, lower costs, reduce battery waste, and enable renewable energy technologies.

The technology we have developed enable battery packs to last up to 60% longer and they will have better life spans. Our technology overcomes a number of existing issues with battery systems. Our technology is a software-embedded hardware solution that allows battery packs to better utilize the capacity of each cell within a pack. It will be integrated into the design of batteries to extend life, increase system reliability, and reduce maintenance costs. We are currently targeting grid-scale energy storage and electric vehicles, both applications where there is a big gain to be made from smarter systems.

More efficient energy storage is also critical. The elements that we use to create battery cells (such as Lithium) are only available in limited quantity. Current battery packs can waste up to half of their lithium-ion cells because of they way battery packs are designed. We need smarter battery systems to stop wasting the resources we have.

More intelligent battery systems will help create more reliable energy systems in cities. While it is not yet economical in most places for homes to generate and store solar energy, this will be the reality in the near future. By making home energy storage more intelligent, individual systems can start to work together to create a network of energy storage. Instead of creating energy in one place and using it somewhere else, you can start to decentralize the system and run it as a network of connected infrastructure.

We want to see the expected success of electric vehicles (EV) become a reality. In order for that to happen, EVs need to perform just as well as combustion engine vehicles for their entire lifetime. As EVs age, their battery degrades and where you used to be able to drive 200km on one charge, perhaps you can now only drive 150km. Smarter batteries fix this problem, keep the range next to new for many more years.

SAN FRANCISCO TECH
MARK SANDORI

My professional journey consisted of many interconnected steps, any one of which could have led me to a different outcome. After graduating from U of T with a Master degree in Civil Engineering, I tried my hand at environmental engineering, which involved cleaning up contaminated sites. However, I was always more interested in the software and modelling side than field work. After a few years, with the boom in the internet, I switched fulltime to working on software and never looked back. I initially worked for a start-up that was acquired by an American company in Seattle and that was the first path to California. Along the way, I have been very fortunate to work for some truly amazing companies — Amazon, Apple, Netflix, and now LinkedIn. I was always looking to learn, take on new challenges, and explore new fields. I didn't know where those choices would lead me, but if they were interesting and challenging, then the outcome didn't matter.

CivE is a great mix of mathematical theory and practical application. It taught me to think logically and break a problem down into manageable steps. The best solution also tends to be the simplest and most cost effective. I still use those same skills today in my tech career when confronted with a new problem. Building a complex piece of software is no different than designing a building or a bridge. The technique is different, but the same skills are needed to be successful and my studies at U of T equipped me for that.

As an engineering manager at LinkedIn, leading a team that often has to solve complex problems, I always have to keep in mind the big picture, from both business and technical perspectives. With my background, staying connected to the technical aspects is fairly easy, but I find the best approach is to not go too deep into any one aspect. A manager's goal should be to hire the smartest people he or she can find and allow them to take care of the fine details while making sure the end goal is being met. Most people with a technical background that are newly promoted to management struggle with this and it is something I coach them on. They are used to being the most knowledgeable and don't know how to let go and allow someone else to take over.

My advice to new grads and seasoned professionals wishing to join a tech company giant is simple. Improving your technical skills is essential, but not enough. Your skills get you through an interview and allow you to perform your job once you land it, however, assume everyone else applying for the job has comparable skills. Standing out is about making connections and being involved in something that will get you noticed. Every job I have landed was through a close connection at that company. Start building your network on LinkedIn and use it heavily. It is never too early to start. Build your connections at every opportunity through internships, jobs, volunteer work, friends, classmates and job fairs.

Any advice for current students?

Most importantly, follow your passions and never be afraid to take on new challenges — if you are worried about being able to perform on a job, then that job is probably the right choice for you. And always be building your professional network.

Creating homes in the forgotten Toronto back laneways, LaneZero's design offers stylish living while achieving sustainable development.

GRAND PRIZE WINNING DESIGN
US DEPT OF ENERGY'S RACE TO ZERO COMPETITION

The team beat out over 50 submissions from four countries during this eight-month competition. The project focuses on building sciences, green energy initiatives and sustainable city development

Downtown location with loft-style, open-concept living featuring a bright kitchen, second-floor balcony and no energy bills for life.

This net-zero listing is a surprising addition to the rear garages and often neglected buildings dotting Toronto back alleys; but for a city facing a housing crunch this design contest winner might be the sustainable solution needed.

Recently, Jason Gray (CivE MASc student) and U of T alum Kevin Wu Almanzar (CivE 1T6) teamed up with students from Ryerson to take home the grand prize in the 2017 U.S. Department of Energy (DOE) Race to Zero competition. Tackling green energy and building science challenges, the team addressed some unique problems plaguing Toronto with their market-ready design concept entitled, LaneZero.

LaneZero is a commercially viable design providing current homeowners the ability to transform pre-existing vehicle storage units to net-zero, single-family dwellings. Common garages are an untapped potential, which could transform our city. With City Hall actively pursuing sustainable transportation alternatives, current forecasts suggest the need for garages will dramatically decrease.

Standing out from its competition, LaneZero responds to property owners' needs today. The design offers a modern living space, affordable construction and great returns on initial investment given the net-zero mechanical performance.

"LaneZero shows that there is a viable option to help mitigate Toronto's housing crisis. The fact that it can be competitively built while being net-zero, is in itself a large achievement. We expect LaneZero will encourage and help inform future Toronto by-law changes, which have been slow to develop and evolve," Wu Almanzar notes.

Working within existing city landscape and infrastructure, the team used the laneways of Christie Pits as inspiration, and set out to identify a net-zero energy solution for the neighbourhood.

Prospective LaneZero sites are small and forced the team to reevaluate traditional green building strat-

LaneZero's winning architectural rendering of their market-ready Toronto laneway design.

egies. In typical low-energy homes, the necessary insulation needed in the building envelop to minimize thermal bridging requires walls up to three times larger than conventional building methods. The LaneZero design balanced the home's footprint with wall thickness for optimal living through energy modelling and parametric analysis.

"Our design serves to activate the laneways of Toronto and foster a community in the spaces that were historically underused," said Gray. "The laneway concept gives homeowners the opportunity to establish income properties on their existing lots and provides housing alternatives in the Toronto market. For those that don't want to go the condo route - this is a great housing option."

With 15 team members from a variety of fields like architecture, building science and mechanical engineering the students collaborated on every decision and development phase. From competing design needs requiring compromise to conflicting construction requirements, the team harnessed the complex, iterative process to spark ingenuity and innovation.

After weeks of comparisons and adjustments, the team obtained net-zero energy unlike other submissions who failed to meet the energy target. Using modelling software to determine an optimal design, the team considered the quantity of daylight penetration year-round, environmental impact and overall building costs.

Gray and Wu Almanzar spearheaded the envelope system design to minimize heat loss, protect the structure from damage, and help ensure year-round comfort. They worked alongside the architecture, mechanical, and indoor environmental quality teams to ensure comprehensive and fully integrated systems.

One creative and interesting consideration the team addressed was the limited roof space on laneway homes for solar panels. They employed passive solar and mechanical design concepts to take advantage of free energy and technological enhancements.

"For example, LaneZero leveraged the low-angle sun in the winter time with large south facing windows to maximize free heat gains while offsetting the heating demand. Appropriate shading for the summertime limited the amount of direct solar radiation entering the building and lowered the cooling demand," explains Gray. "On the mechanical side, using an innovative heat pump design, the heating, cooling, and domestic hot water were all provided in a highly energy efficient manner. Other strategies, such as a large amount of insulation for the envelope assemblies, continuous thermal layers, and energy efficient appliance selection contributed to achieving the net-zero goal."

The design lauded for its architectural finesse, comprehensive building science analysis and a unique vision for the future of sustainable cities, won in the Attached Housing category and the grand prize across all categories. The team is investigating future expansions and potential opportunities for project applications.

Past Student Competition Winners Update

The 2015 Canadian Electrical Contractors Association's University of Toronto Student Chapter entered and placed fourth in the Green Energy Challenge. With the help of local associations, contractors and suppliers the team's design took a year and a half to retrofit a Toronto homeless shelter costing about $42,000.

From LED lights and motion sensors to the next phase including solar panels and a backup generator, the team has reduced the shelter's energy bills by 40% per month.

In an increasingly interconnected and interdisciplinary world, the Department of Civil Engineering is pleased to introduce our new faculty members joining in 2017

Professor Shoshanna Saxe

Could you explain the focus and (potential) impact of your research in the next coming year and in the future?

The focus of my research for the coming year is to work on the question "what does it mean to build and operate sustainable infrastructure?" Are we just interested in the materials and energy that go into the physical infrastructure or also the behaviour it inspires in people (e.g. travel behaviour, land use, consumption patterns). I will also be working on quantifying the various impacts this question relates to. The impact of the work will ideally be to nudge the government and engineers to think more holistically about the impacts of our infrastructure systems and design/build accordingly.

Could you tell us more about some of the designs and construction of Canadian metro stations, tunnels and bridges that you were involved in before coming to U of T?

While a consulting engineer I worked on the design of Vaughan Metropolitan Station (which will be the new terminus of the Spadina Subway line). York University Station, Keele Station and Caledonia Station (on Eglinton Crosstown). I mainly worked on designing for the excavation that makes the hole the station goes in. This involved designing a lot of secant pile and soldier pile walls and thinking about construction staging. For the Billy Bishop Airport Tunnel I worked on the early design thinking about how to compensate for rock squeeze in the shale that underlies Toronto (make a hole in it and the rock expands). In all of these projects I was part of a much bigger team working on overall design. This experience continues to be critical to my research as it gave me a grounding in how things get designed and built in practice.

What do you hope to accomplish here at U of T Engineering?

I want to change how we conceive of, design, operate maintain and use infrastructure to be more holistic.

ADVICE FOR STUDENTS

UNDERGRADS: The goal is learning not grades. It is too easy to conflate the two, don't.

GRADUATES: Find a question that excites you; you are most likely to do great work if the motivation is intrinsic.

Professor I. Daniel Posen

Could you explain the focus and (potential) impact of your research?

I usually describe my research as 'system-scale environmental sustainability analysis,' which basically means that I'm trying to understand the big picture when it comes to how both public and private decisions impact the environment. A key goal of this work is to help government and industry tailor their policies and investment decisions to improve environmental outcomes. Much of my work focuses on prioritizing green house gas reduction strategies, especially when choosing among competing uses for biomass (energy/materials derived from plants), and within the urban environment. I also plan to incorporate a broader range of environmental metrics (e.g., related to air & water quality or resource use) to provide a holistic evaluation of these systems, and others.

Your academic background is unique, can you explain why your interests have varied from chemistry to economics to public policy to engineering?

There is actually a common theme linking my degrees together: sustainability. The research I do is inherently interdisciplinary, using tools from natural sciences, engineering, economics and policy analysis. There is a lot of important work being done in each of these disciplines, and one of the biggest challenges is about how to link these different areas together to design systems with the best social and environmental outcomes. This is a key goal of my work, so it has been a real asset to have a background in these different fields.

Why did you choose U of T?

I'm originally from Toronto, and am passionate about doing research that benefits both Canada and the world. U of T is a top university in Canada, which has both a rich set of colleagues with whom I can collaborate, and allows me to work with some of the best students. The city of Toronto is also a great place to live and is an excellent environment for researching urban-scale sustainability.

ADVICE FOR STUDENTS

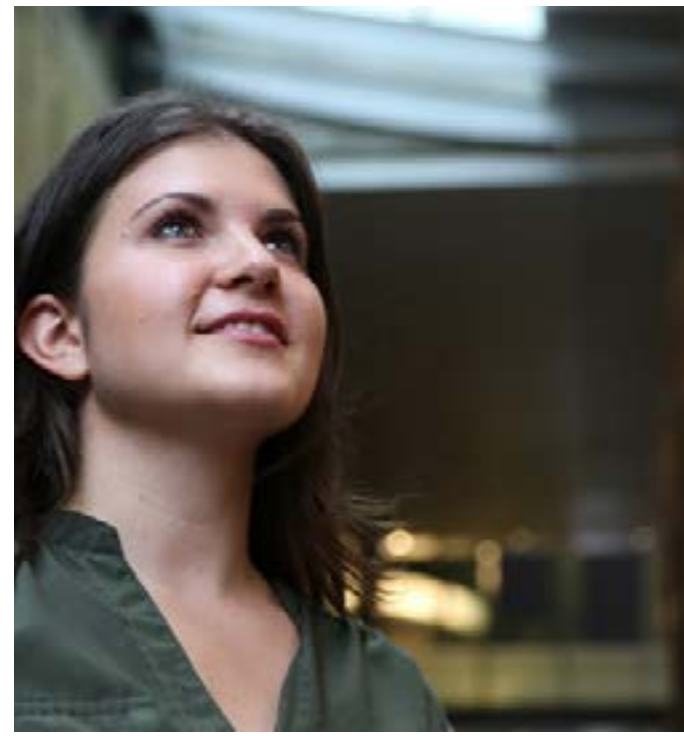
UNDERGRADS: Focus on key foundational skills in engineering, math, statistics and the like, but don't neglect the broader picture – take advantage of your elective courses and make sure to step outside your field once in a while.

GRADUATES: Start thinking early on about what skills you want to develop, and put in place a plan to develop them. At the same time, don't fall into the temptation of only using those skills – make sure the tools you're using fit the problem you want to answer.

#myPEY

Professional Experience Year

It's more than an internship program.



HIRE TOMORROW'S GLOBAL ENGINEERING LEADERS

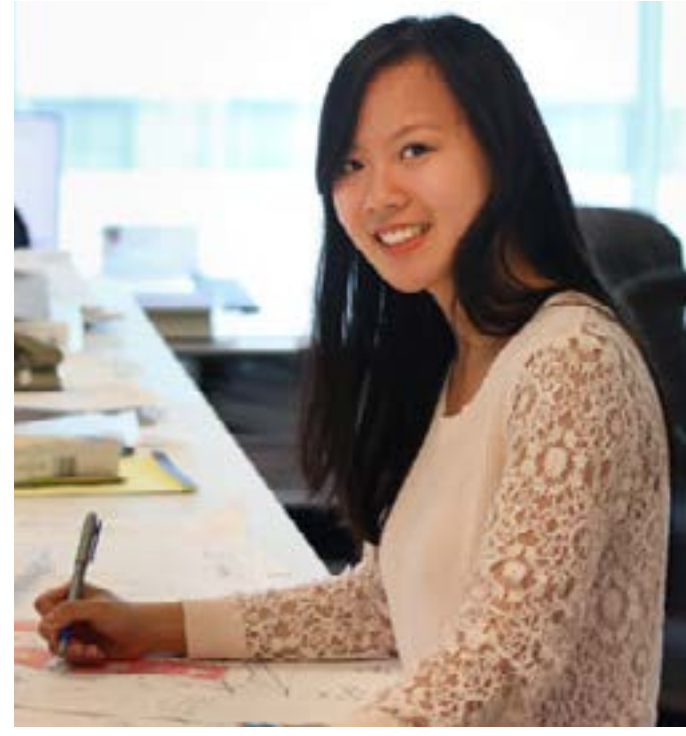
U of T Engineering's Professional Experience Year (PEY) internship program is the most highly regarded paid internship program in Canada. 3rd and 4th year students are placed for 12 to 16 month - an excellent way for your company to access and recruit some of the world's brightest future engineering leaders.

uoft.me/hire-pey

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

GRADS TO WATCH

Embodying the spirit of U of T Engineering, these students demonstrate the engineering values of creativity, innovation and global impact.



ANGELA HU
(CivE 1T7)

"Being at U of T for the last four years has allowed me to participate in an eclectic collection of activities," says Hu. "I love the fact that this school is not just a world class academic institution but also a place filled with so many inspiring and energetic students."

Many of Hu's projects have an international focus. In 2015 she organized a bridge-building competition for the U of T chapter of Bridges to Prosperity, an organization that assists students to design and construct footbridges for remote communities in developing nations. During an internship with consulting engineering firm Arup, Hu became involved in a project to design an elementary school in the village of Timo in Haiti, in partnership with the Haiti Health Initiative, which she will continue to work on after graduation.

Hu conducted undergraduate research with Professor Frank Vecchio on fibre-reinforced concrete, work that will be incorporated into the upcoming revision of the Canadian Highway Bridge Design Code (CSA S6). She was also an active member of the You're Next Career Network. In the fall, Hu will begin a Master of Science degree in structural engineering, mechanics and materials at the University of California, Berkeley.

"Having an engineering degree means that I am now able to play a more active role in initiating change," she says. "I want to employ new technologies and advances in materials research to make our buildings more resilient to large scale events such as earthquakes. In addition, I want to continue my involvement with various projects in developing nations."

Photo | Alex Flash

Matthew Hart
(MinE 1T6 + PEY)

"Most people can find problems," says Hart. "The people you need are ones that can find solutions and want to constantly improve. U of T and my PEY experience helped me develop the solution-driven mindset I have today."

While at U of T Engineering, Hart pursued a rich variety of co-curricular activities. He played Varsity water polo for four years and was part of the team that won the 2016 Ontario University Athletics championships. Hart is also a member of the 2017 senior men's water polo national champions, the Toronto Golden Jets. He served as Vice-president, Finance for the Mineral Engineering club and along with his teammates placed second at the 2017 Canadian Mining Games. "I found the activities outside the classroom to be the most influential in developing the emotional intelligence that is needed to be successful," he says.

Hart completed his PEY internship at Imperial Oil, working at the Kearl Oil Sands Project as part of the short-range mine planning team. The experience prepared him for the job he will take up upon graduation, in the Toronto office of Barrick Gold.

Photo | Water Polo Canada

NEW Experiential Learning City

2017 partnership establishes a Canadian teaching city for U of T engineering students

Medical doctors learn in immersive teaching hospitals — and now U of T Engineering students will have their own immersive learning opportunities within a real-life teaching city. Later this year, the City of Oshawa will become Canada's first-ever living laboratory for urban research, allowing students to probe complex municipal issues and test practical solutions for the future.

The University of Toronto's Faculty of Applied Science & Engineering is teaming up with the Canadian Urban Institute, the University of Ontario Institute of Technology, Durham College and the City of Oshawa to realize this first-of-its-kind partnership. As a 'teaching municipality,' Oshawa will connect engineering students with city staff, testing new technologies and methods on the ground and in real time. To find out more visit: civil.engineering.utoronto.ca.

Hill's research was closely tied to industry from the start, including an NSERC industry scholarship with Flynn Canada supporting much of her PhD. Between 2012-2016, she led many field excursions and experiments on the types of 'soil' found on green roofs. Jen developed recommendations on how to maximize the stormwater benefits provided by green roofs, working in a cross-disciplinary team with the John H. Daniels Faculty of Architecture, Landscape and Design.

Realising that the impact of technical advances is limited without dissemination and adoption, she turned her attention to local regulatory agencies. She advised on the development of standards and policy across southern Ontario, and provided expertise for the Sustainable by Design program.

"Regularly meeting engineers and other professionals really helped to keep my research focused and relevant."

After defending her thesis, she joined the Sustainable Technologies Evaluation Program, with Toronto Region Conservation Authority as a Research Scientist. There she advises on urban stormwater policies for municipalities, including the City of Toronto. She also helps reduce the potential impacts of flooding in a changing climate by writing guidance documents and training professional engineers to design better stormwater systems.

Hill's fond memories include Survey Camp and the people she worked with during her time at U of T; Prof. Jenn Drake, Prof. Brent Sleep, Prof. Bryan Karney and all the staff of the department who make it happen.

JENNY HILL
(CivE PHD 1T7)

Photo | Courtesy of Jenny Hill

2017 CANADIAN MINING GAMES

LASSONDE MINERAL ENGINEERING PROGRAM PLAYS NATIONAL HOST TO INDUSTRY & STUDENTS

An annual student competition not only fans school rivalries, it is an opportunity for professional development and creative application of skills beyond the classroom.

For three days in February, 160 students from across Canada's mining engineering programs converged on the St. George campus to compete in the 2017 Canadian Mining Games

Discovery Channel's Daily Planet even came out to film and showcase the competition including the jackleg drilling event.

2017 LASSONDE MINING STUDENTS

35 mining companies sent representatives to judge each of the events. This industry-facing competition provided a great networking opportunity for the students.

Highlights of the 25 events include the Mine Design Challenge, Mine to Mill Innovation, Mine Rescue and Jackleg Drilling.

Congratulations to our U of T Lassonde Mineral Engineering students for placing 2nd overall in the competition. U of T has hosted the games twice previously but this was their best performance home turf. The team members included:

Marina Reny, Justin Samardzic, Matt Hart, Jack Lindsay, Marko Lopac, Yoko Yanagimura, Paige Clarke, Joana Azubalis, Zichen Li, Ice Peerawattuk, William Phillips, Colin Playle, Mark Umanec, Conrad Hopp, Dalton Veintimilla and Denis Lantsov.

CANADA 150

LEGACY LECTURE
THE FIRST HUNDRED AND FIFTY YEARS OF CIVIL ENGINEERING IN CANADA

As Canada celebrates 150 years, we reprint an abridged lecture given by Robert F. Legget in 1977—in honour of the University of Toronto's 150th anniversary—with commentary provided by Professor Brenda McCabe in 2017.

Back in 1827 – the same year as the founding of the University of Toronto – travel was mainly by water but a network of simple roads did exist between the main settlements, often impassable but when in good repair sound enough to permit of the operation of simple horse-drawn wagons.

Although it was possible to travel by stage coach from Montreal to York, when the road was not impassable, the more usual way of making this long journey was by stage coach. Starting the nine miles on the road to Lachine; by boat across Lake St. Louis to Cascades; then a coach again to Coteau du Lac; on board another vessel for the journey to Cornwall; on shore again for a drive to Prescott; and then finally the long sail out by steamboat to the safe harbour of York on Lake Ontario.

North of the lake, once the shoreline settlements were left far behind, one found oneself among the great trees of virgin forests. Beyond the forests was still the land of the Indigenous peoples, penetrated only by intrepid voyageurs in their hunt for furs. In the fledgling settlements, lighting was still by oil or candles. All power was man- or horse-power, apart only from that available from the first water- and wind-mills. Fuel was from the nearby forests.

Surveying had started and the first land subdivisions had been made. Construction was underway on building homes and wharves, simple and imperfect roads, the small timber bridges and there were significant starts on canals, the Welland Canal. What changes the intervening 150 years have seen!

Consider briefly what has happened to the face of Canada in the space of just two generations. Despite its size all of Canada has now been seen from the air and photographed. Our northern regions have been surveyed and measured, to a scale of 1:250,000, and the southern part of the country at 1:50,000. Well over half a million miles of roads and streets now serve the entire southern part of the country. A splendid Trans-Canada Highway runs from coast to coast. A network of over 44,000 miles of railways still serves vital transport needs. The Intercolonial Railway and the Canadian Pacific Railway span the country uniting the early separated colonies in an almost mystical way. Two railways reach the shores of Hudson Bay. One line goes north of the 60th parallel; and in the Yukon, the White Pass Route still gives Whitehorse its link with the sea. Magnificent bridges, some of them world famous, serve both railways and roads.

Telegraph lines parallel road and rail across the land, linked with overseas cables beneath Atlantic and Pacific, their service now supplemented by familiar and frequent steel microwave towers. Almost 20,000 miles of gas and oil pipelines, hidden from view but providing vital media for fuel supplies. Airports throughout the land, of special significance in northern regions where the Inuvik runway continues to give splendid service to the largest planes even though founded on the worst of permafrost and muskeg. The airfields served by a variety of terminal buildings, large and small.

Twenty-five fine deep-water ports on Atlantic and Pacific coasts, as well as up the St. Lawrence, are vital links to worldwide trade. A great dredged channel enables large ships to sail up the St. Lawrence Seaway. This allows ocean-going vessels to penetrate the heartland of North America. In the west, irrigation systems assist in the progress of agriculture. Dams provide reservoirs for irrigation, for water supply and flood control, and above all for power generation. All these facilities are to serve the more than 23 million Canadians, of whom almost 80 per cent live in cities. All cities and towns now have public supplies of clean water for all citizens. All but the smallest inland towns now have sewer systems; many but by no means all, have treatment plants for processing wastewater before returning to natural waterways. Large cities have other underground services such as telephone circuits, high-pressure water for fire fighting, and gas mains. Networks of tunnels beneath city streets for mass transit and above ground we have great and beautiful buildings, some vast, some tall including the tallest building in the Commonwealth, and, in splendid, but puzzling isolation the CN Tower.

In more recent years, the mechanical engineer made great contributions especially in the steady development

of power supply and transportation; mining engineers have been responsible for the development of mines; electrical engineers for the many applications of electricity for practical use; chemical engineers now playing their special role in the process and chemical industries. Civil engineers form part of a well-integrated team.

In earlier days, there were no divisions of engineering; there was military engineering and there was civilian engineering. Since then, it has been the civil engineer who has still been responsible for "changing the face of the land", working with his fellow engineers in the equipping of his structures and associated with architects in the design of buildings.

I think first of the hundreds, rather the thousands of civil engineers who served loyally their better known Chiefs - the surveyors, the resident engineers, the construction superintendents, often working in relative isolation, often in danger in earlier days, usually far removed from the conveniences of urban living, but carrying great responsibilities.

The record of civil engineering in Canada is not an unbroken success story. Mistakes were made, some serious ones. The failure of the Transcona Elevator when first it was filled with grain, tilting almost 40° before it came to rest, was one of the most spectacular building failures that the world has ever seen but restoring it to a vertical position showed the world also the skill of Canadian civil engineering contractors.

Then there are those who equate civil engineering with ugly structures. Admittedly, there are some structures that fail to blend with the landscape and add no beauty to it. In my opinion, these constitute a small minority. On the other hand, one thinks rather of elegant and graceful bridges. Many powerhouses, through the combined work of civil engineers and architects, are truly noble buildings. And some were greatly impressed with the beauty in the West, of the grain elevators, with their white domes and towers, which carry the eye from the immense prairie levels to the blue prairie sky.

There are also strongly voiced criticisms of civil engineers for "spoiling the environment" with strange implications that it is the civil engineers who are somehow responsible for the pollution of waterways with sewage, to take but one example. Engineers have long known how to purify all liquid wastes but they can only apply that knowledge if those responsible, in industry and in government, so direct and are willing to pay the cost. The city of London, England, demonstrated what can be done by civil engineers, if the leadership is there, by the cleaning up of the River Thames. Canada has still far to go, in cleaning up the

"Civil engineering is the art of directing the great forces of power in nature for the use and convenience of man; being that practical application of the most important principles of natural philosophy which has, to a considerable degree changed the aspect and state of affairs in the whole world...".

Opening section of the classical definition of civil engineering of the Council of the Institution of Civil Engineers (established in 1818) by Thomas Tredgold.

Great Lakes and the Ottawa River to give just a couple examples.

Interest in the protection of the environment is welcome but public concerns must be well informed and based on fact rather than emotions. Some public comments on our waterways, would suggest that civil engineers have done nothing about flood protection and are blamed for not "doing something" long ago. Have those critics heard of the Quebec Streams Commission, world renowned in the 1920s-1930s as a pioneer water conservation agency or the River Valley Conservation Authorities of Ontario whose work has been in both the design and construction of water control projects.

The future has inevitably come up for mention; how could it be otherwise? Almost all the works of civil engineers are planned and designed with future needs always in view. Their prime objective is to provide those physical services for people that are essential for modern living. In all civil engineering anticipating the needs, number and distribution of future people.

The turn of the century is less than twenty three years away. Why do I suggest so limiting our future thinking? Because we can today anticipate some disconcerting developments which will almost certainly be here by 2000 if not before. It now seems certain that the ·population of the world will be about seven billion by the end of the century, double that of 1970. Some experts predict that world starvation will limit total growth beyond this; some say this could occur even before the close of the century.

But that there will be a substantially larger population in Canada by the end of the century is certain, with well over eighty-five per cent living in urban areas. Linked with such changes is the prediction that electric load is expected to double by 1983, and may redouble by 1993. Quadrupling of power supply well before the end of the century raises another set of questions, especially when it is realized that the United States "uses more energy for air conditioning alone than 800

million Chinese use for all purposes (and) Canada is part of this same syndrome". The use and supply of materials, non-renewable natural resources, further illustrate the profligate society in which we are living.

The world of 2000 will be very different from today. The vast problems that can be seen ahead will be overcome but the profligacy of our present society must be curbed. There are limits to growth and the sooner we realize this the better. Here is where we must distinguish between our duty as privileged and informed citizens with corresponding special responsibilities, and as civil engineers. In this article we are concerned with the contributions of civil engineering to Canada.

Remembering this, let us consider just the needs of Canada itself. Civil engineers will continue to be responsible for the construction of urgently needed power plants and of the means of handling fossil fuels, improved railways and waterways for coal and pipelines for gas and oil. More mundane but equally important is the many treatment plants, supplementing new water supply systems, so that our waterways may be conserved for all time while being well used. Other urban services will call for improvement and extension, always with due regard for the amenity of "city-scapes", all possible services being placed underground. Engineers will have special responsibility for protecting the fragile environment of the far North of our country, something that Canada must ensure without question.

These are challenging prospects. Many involve underground work. Remember also that every structure depends for its safety and stability upon the ground on which it rests and thus the importance of geology in all work will be evident. No two foundation problems are ever the same. Judgment is required in every case for the final decision as to the suitability of the ground to serve as foundation bed, as a material of construction, or for excavation. And no computer ever exercised judgment.

Civil engineering must, therefore, continue to depend for its excellence upon well-trained men and women who are willing to gain experience the hard way, on the job, that experience upon which alone sound judgment can be based. This requires, the very best training by experienced instructors , who can introduce their students to a new techniques, new methods, new approaches to old problems. And who can inspire an appreciation of their high calling, of the heritage of their profession.

As we face the unknown of tomorrow, we would do well to look backward, as this anniversary gives us pause to do, to be inspired by the examples of our profession's past; to make every possible use of the accumulated experience of all who have gone before; to realize that every step forward is a small part in the long tradition of civil engineering and to improving this wonderful land of Canada.

Read Robert Leggett's complete lecture: uoft.me/CIV150

CANADA 150

A 2017 perspective by Professor Brenda McCabe

One can only be impressed by the history of Civil Engineering in Canada. Mr. Leggett's story warms the hearts of us all. During Canada 150, I hope you can take a detour to visit some of the country's iconic Civil Engineering sites. Having had the opportunity to travel the length of the Rideau and Trent-Severn Canals, I can attest to the ingenuity and longevity of those incredible water highways. Even today, some of the valves, lock doors and swing bridges along the canals are operated manually. It serves as a reminder of how clever engineering can last longer than a lifetime.

The world is a different place than it was when Leggett gave his insightful lecture 40 years ago. While we are still constructing important transportation, energy, water, and building infrastructure systems, those projects seem bigger and more complex today. New technologies are being introduced at a pace unseen before. Our perspective and responsibilities are growing as we engage more stakeholders in critical decision making, including First Nations. Our goal is not just to build, but to ensure that future generations may also benefit from living in a country of extraordinary people, opportunities, and natural resources.

The civil and mineral engineering classrooms are also changing. Enrollment of women in first year has reached 40 per cent two years in a row! The fundamental tenets of theory and practice remain. Engineering is an applied science and experiential learning is key to the making of a great engineer. For nearly 100 years, Survey Camp has provided civil and mining/mineral students with immersive, hands-on learning about measurement, teamwork, and engineering sensibility. In addition to the array of technical courses, students are learning about social responsibility, leadership, and entrepreneurship.

It would be interesting indeed to read a history of our next 150 years as Canada continues to develop and take leadership roles on the world stage. Hopefully, it would be just as exciting, and celebrate more engineers with the skills and motivation to champion and lead our great country.

UT-SIM
INTERNATIONAL WORKSHOP
Multi-Platform Hybrid Simulation

The University of Toronto has a long-standing tradition of developing cutting edge advanced numerical models for reinforced concrete structures, carrying large-scale experiments, and developing new high-performance resilient structural systems. It is now one of the leading hubs on advanced hybrid simulation methods. The UT-SIM group is now trying to integrate all of these capabilities to develop a next generation simulation platform that will achieve new levels of accuracy and reliability for the modelling of complex structural systems. This will contribute to the worldwide research effort of not only better understanding the expected response of critical infrastructure under extreme loading conditions for better disaster planning or disaster mitigation but also to form the basis for accelerating the development and implementation of more resilient structural systems that will better protect our infrastructure.

It is an open concept that is available to the entire research community in order to foster collaboration between institutions towards developing the next generation of numerical and hybrid numerical-physical simulation strategies. The UT-SIM framework is not a single software which can solve all problems; rather it is a framework for a seamless integration of diverse physical/numerical models through standardized communication protocols and data exchange format.

To facilitate the implementation of this approach, the communication library and source code is released to the public domain such that any institution can easily integrate their own software or laboratory to an integrated simulation. Furthermore, the group has also developed the Network Interface for Console Application (NICA) and the Network Interface for Controllers (NICON) which are used to integrate various software and actuator controllers.

The open-source approach for integration of diverse numerical models and experimental specimens will greatly improve partnerships among institutions in Canada and abroad.

On April 10-11th, 2017 the UT-SIM Group hosted an international workshop on multi-platform hybrid simulation using UT-SIM framework. The workshop's goal was to provide hands-on training for PsD hybrid simulations to researchers looking to develop such simulation capabilities using the UT-SIM framework. Hybrid simulation methods have been actively investigated in the past two decades. Yet, implementation of a hybrid simulation method in a testing facility without any prior experience is still a daunting task as it requires understanding on various aspects of structural testing and numerical modelling. The training very positive results from the participants.

To get involved or have more technical questions please visit, ut-sim.ca or email Professors Oh-Sung Kwon (os.kwon@utoronto.ca) and Constantin Christopoulos (c.christopoulos@utoronto.ca).

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We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

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