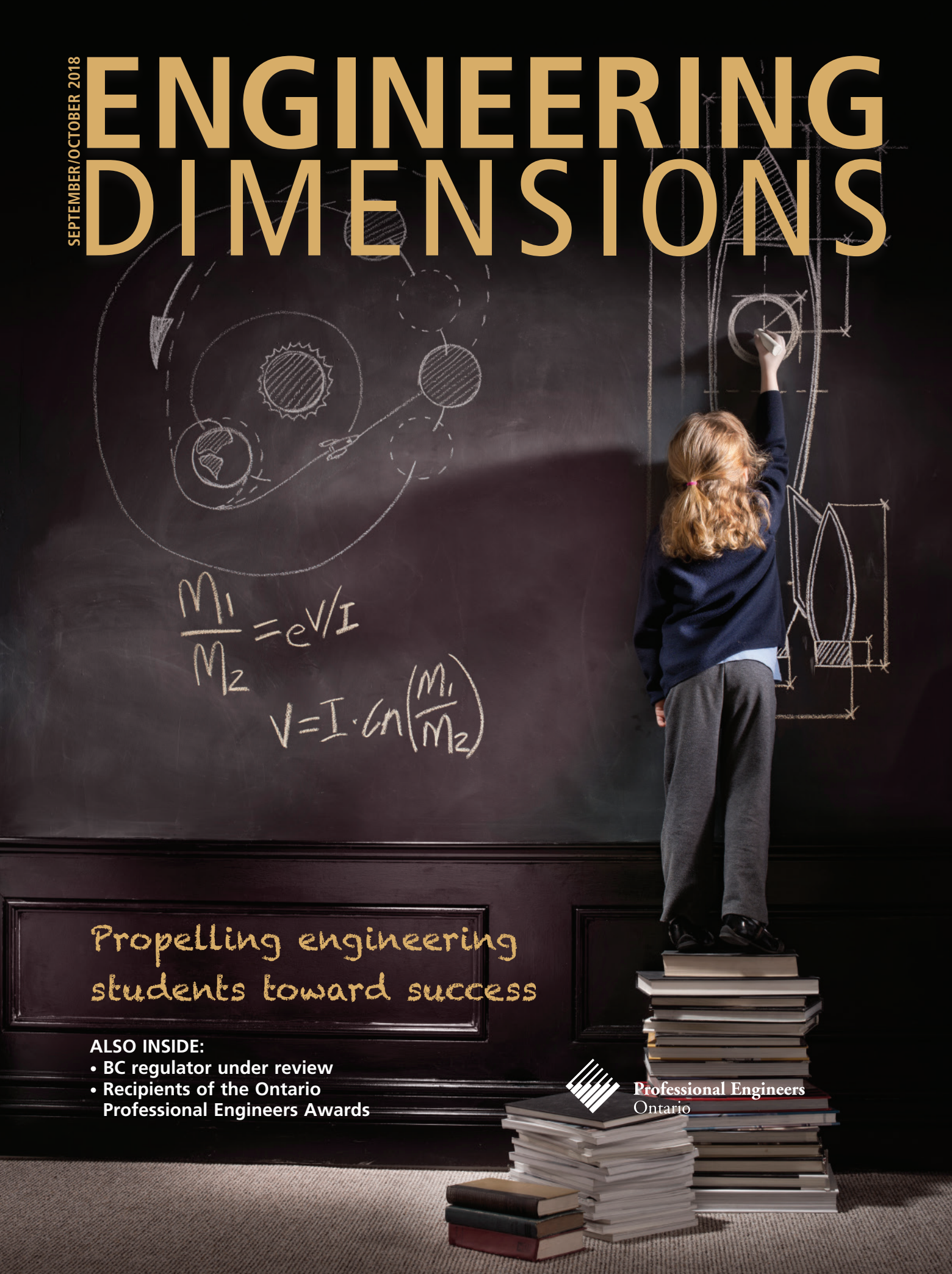
SEPTEMBER/OCTOBER 2018

ENGINEERING DIMENSIONS



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PREPARING STUDENTS FOR THE FUTURE

By Nicole Axworthy

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Hollywood directors are said to be as good as their last film. Maintaining their reputation means continuing to produce high-quality work that reflects the tastes and expectations of the time.

A similar measure applies to engineers. Although they have more than a century's worth of major contributions to wealth, health and quality of life, the next century will require that they innovate at a faster rate. The explosion of technology and use of new materials and processes have dramatically and irreversibly changed the practice of engineering, and the pace of this change is accelerating. But can engineering education—the profession's basic source of training and skill—keep up with growing demands?

Today's engineering students are entering the workforce at a time when almost every industry is being disrupted, meaning they need to acquire many more skills—in broader areas—than their predecessors. As the world becomes more complex, engineers must understand the human dimensions of technology, have a grasp of global issues, be sensitive to cultural diversity and know how to communicate effectively. On page 26, Associate Editor Marika Bigongiari explores the evolution of our education system, which is shaping students into well-rounded and versatile engineers who can take on this ever-changing world, beginning with the infusion of arts into what has been traditionally known as STEM (science, technology, engineering and math). It may seem insignificant in the grand scheme of things, but this subtle shift in curricula enables students to develop creative thinking and essential soft skills by connecting with traditional STEM material through experiential learning and active engagement.

In his debut article for *Engineering Dimensions*, new Associate Editor Adam Sidsworth reflects on why university co-operative education programs are worthwhile for engineering students. Although currently largely optional in Ontario universities, co-op work placements allow students to obtain valuable experience that helps bridge the gap between school, the workplace and the required four years' experience to become a professional engineer ("Bridging the gap," p. 31). Equally important, it helps students develop confidence in their skills and a better sense of what they want to do.

Please also take a moment to read the inspiring biographies of the 11 engineers who will be recognized this year with Ontario Professional Engineers Awards (p. 12). They will be celebrated at a black-tie gala on November 17 in Toronto, Ontario. For more information, visit www.opeawards.ca.

Finally, I'd like to thank everyone who responded to our annual call for ideas. I always enjoy reading your thoughts and feedback. It is very much appreciated. **e**

THIS ISSUE If engineering is at the heart of the Fourth Industrial Revolution, engineering education must move away from the traditional chalk-and-talk approach toward new, innovative approaches. In this issue, we look at the evolution of STEM into STEAM, allowing school-age children to be enrolled in fully integrated and well-rounded science and arts curricula; and we explore universities' use of work placements prior to graduation to help engineering students make connections between their schooling and their prospective engineering careers.

THE VALUE IN REGULATORY PERFORMANCE REVIEWS

By David Brown, P.Eng., BDS, C.E.T., IntPE, MCSCE

In my last column, "Is it time to self-disrupt?" (*Engineering Dimensions*, July/August 2018, p. 6), I suggested PEO undergo an external regulatory performance review to help us determine if we're effectively carrying out our mandate to protect the public as set out in the *Professional Engineers Act*.

Many recent reviews have been carried out by the Professional Standards Authority (PSA)—a body established by the United Kingdom parliament to oversee the country's health and social work regulators. Widely considered the gold standard at assessing regulatory performance, PSA conducts research on evidence-based regulatory best practices and has developed standards covering guidance and standards, education and training, registration and fitness to practise. PSA uses these standards as its benchmarks in conducting regulatory reviews.

Besides its annual reviews of UK health/social work regulators, PSA has conducted reviews of regulators in Australia, New Zealand, Ireland and Canada. Recent Canadian audits involved the Royal College of Dental Surgeons of Ontario and the College of Registered Nurses of British Columbia, examining the setting of standards and provision of guidance for practitioners registration and renewal of practitioners and the investigation and resolution of complaints about practitioners.

In this column, I will examine a review of another Canadian regulator, Engineers and Geoscientists BC (EGBC), and how PEO could similarly benefit.

PSA's REVIEW OF EGBC

This year, PSA undertook a review of EGBC, assessing the association's governance and legislative framework and how it helps—or hinders—its regulatory effectiveness.

PSA released its phase 1 review report in June 2018 and came back with several observations and recommendations. (You can read the full report at https://bit.ly/2OynNp6)

In its governance review, it found the regulator met all but two of its nine regulatory standards—one involving risk management processes and one involving legislative framework.

For the former, the review recognized EGBC was developing risk management processes and would likely meet the standard upon completion.

For the latter—that the regulator has a legislative framework where decisions can be made transparently and in the interests of the public—the review found the requirement in the *Engineers and Geoscientists Act* that members ratify bylaws via referendum was a barrier to meeting the standard.

The review also made several observations and recommendations around EGBC's legislative framework, and I will touch on a few that I believe parallel potential shortcomings at PEO:

Continuing Professional Development (CPD): Related to EGBC's current legislation requiring two-thirds member approval of any new bylaws, the regulator has been unable to introduce a mandatory CPD regime because it couldn't pass the bylaw with members.

Board size and composition: The review found EGBC's current council size of 17 members to be too large to be effective, recommending a council of around eight to 12 members to be "most conducive to effectiveness." Similarly, it found EGBC's practice of electing council members meant the regulator had little control over council composition and an appropriate mix of skills—particularly important given the many regulatory roles councillors are expected to fulfil.

Election cycles: The review found two-year council terms to be problematic because new councillors need time to acclimatize, meaning frequent councillor turnover is inefficient. And being subject to election could influence councillor decision making and make them feel less inclined to support measures that are unpopular with members.

President terms: The review found that EGBC's practice of changing presidents every year could potentially introduce disruption and impact the organization's ability to carry out its three-year strategic plans.

Publicly appointed councillors: EGBC has four government-appointed councillors, going against PSA's advice on parity between member and non-member registrant councillors. PSA says a key value in appointed councillors is the strict selection process, which helps ensure optimum skills and experience. EGBC staff also said they valued the external perspective of appointed councillors.

Complaints/discipline committees: The review recommends that EGBC consider options for increasing the involvement of public members in its investigation and discipline committees, noting that it would be beneficial to have greater involvement of the public in both committees.

EGBC shared this report with other Canadian engineering regulators and noted that with its ongoing work and several act changes currently before government—including increasing agility to make bylaw changes—it would meet PSA standards in short order. It also noted the audit did much to reinforce its effectiveness as a self-regulator.

I believe PEO would do well to do likewise. As engineers, many of us are used to the audit process and use the results to bridge gaps and ensure our practices and organizations are performing effectively. PEO and its regulatory work shouldn't be any different.

Indeed, we owe it to ourselves and the public we protect to measure our effectiveness and make changes as necessary—it can only make us stronger. **e**

QUEBEC REGULATOR ANNOUNCES NEW REGULATION AFFECTING INTERNATIONALLY TRAINED APPLICANTS

By Adam Sidsworth

On June 12, Quebec engineering regulator l'Ordre des ingénieurs du Québec (OIQ) announced a significant and immediate regulatory change affecting some internationally trained professionals (ITPs) applying for engineering licences to work within the province of Quebec.

The change is intended to make ITPs' application process more personal and reflective of each candidate's background and takes into consideration their diplomas earned as well as their relevant work experience and all competencies acquired when their admissions applications are evaluated. Its objective is to ease access to the profession for ITPs while maintaining a rigorous competency validation process that protects the public.

Of the 46 professional orders in Quebec, OIQ has one of the highest rates of ITP applications: In the 2017–2018 period, a quarter of all applicants for an OIQ engineering licence received their education from a university outside Canada; of these internationally trained candidates, 60 per cent of them received their education from countries with no mutual recognition agreement (MRA), which is an international agreement between countries that establishes mutual recognition of academic and/or professional credentials, intended to foster mobility for engineers looking to practice in other jurisdictions.

Under Quebec legislation, ITPs fall into two categories: those who received their training in 20 foreign countries with which OIQ has MRAs—notably France and some Commonwealth countries—and those from all remaining international jurisdictions that don't have any agreements with Quebec.

Historically, this second group of ITPs has had to overcome significant hurdles, says OIQ President Kathy Baig, ing., FEC. "How can we increase the success rate and shorten the process?" Baig asks. "We wanted to find a way for them to get their licences while maintaining our rigorous admission criteria."

Under the old application process, ITPs who obtained their education from jurisdictions without MRAs could have faced up to 11 examinations that, although designed to "test and improve [applicants'] knowledge," were, according to OIQ, "a demanding step." It could also prove lengthy, possibly up to 16 months. According to Baig, only 58 per cent of ITPs under this system were able to successfully navigate this process and get a permit to work in Quebec. "We want to increase the success rate to 75 per cent and lower the process to eight months," Baig adds.

To meet this target, under the new procedure, these candidates are now able to take university courses, work on engineering projects and have interviews to demonstrate their engineering skills meet OIQ's standards. Whatever the path the candidate takes, their skills will be assessed by a panel of OIQ experts and licensed engineers. "There are competencies they will have to prove," Baig reiterates. "But we do think this will be beneficial."

Baig, who, on June 15, was re-elected to her second consecutive term as OIQ president, notes there is a two-tiered treatment of ITPs, stating that ITPs from countries with MRAs have a much easier application process. "With all the [engineering] programs in France," Baig uses as an example, "it's like they graduated in Quebec."

Although this new regulation is designed to lessen the burden on ITPs with training from non-MRA countries, Baig notes there can still be hurdles. As she stated in a June 12 news release: "Their integration also depends on the work and assistance of many other actors, such as immigrant support organizations, universities and various job market–related bodies that must work together to make their path easier."

THE PEO PROCESS

PEO's Acting Deputy Registrar, Licensing and Registration Moody Farag, P.Eng., notes OIQ's new policy is equivalent to the Internationally Educated Engineers Qualification Bridging (IEEQB) Program that Ryerson University offers. The IEEQB program is an individualized study program in lieu of PEO's Confirmatory Examination Program. Farag notes that, upon completion, the applicant will be deemed to have PEO's academic requirements for licensure. However, they must, like all P.Eng. applicants, still pass the professional practice exam and complete 48 months of work experience, of which a minimum 12 months must be in Canada.

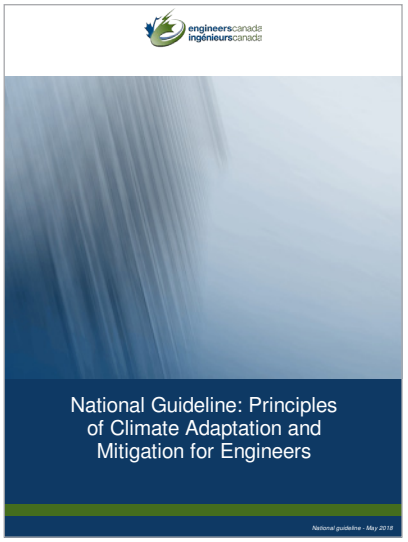
In situations where applicants are trained in another jurisdiction and are applying for a PEO licence, their transcripts are reviewed by the Academic Requirements Committee, which can:

- reject the application;
- exempt the applicant from any further exams; or
- assign the applicant to an examination program.

Timelines on meeting any of the licensure requirements depend on each applicant's circumstances.

ENGINEERS CANADA RELEASES NEW CLIMATE CHANGE GUIDELINE

By Adam Sidsworth



In May, Engineers Canada, the national umbrella organization of Canada's provincial and territorial engineering regulatory bodies, released the new guideline *Principles of Climate Adaptation and Mitigation for Engineers* (engineerscanada.ca/publications/national-model-guide-principles-of-climate-change-adaptation-for-professional-engineers). The document has 11 non-binding principles—enforceable changes lie with the provincial and territorial engineering regulatory bodies—to guide engineers in a world in which, from the viewpoint of Engineers Canada: "The climate is changing…at a rate that is likely accelerated by anthropogenic releases of greenhouse gases. [C]limate change has led to changes in climate extremes, such as heat waves, record high temperatures and, in many regions, heavy precipitation, in the past half century."

Although engineers and their clients must plan for climate change when designing engineered systems, changing public opinion and evolving government policies may hold engineers responsible for systems failures caused by climate impacts. The document states: "It is the engineer's duty to take all reasonable measures that [engineered systems] appropriately anticipate the impact of changing climate conditions." What follows is a brief synopsis of Engineers Canada's 11 guidelines.

1. Integrate climate adaptation and resiliency into practice

Engineers must work with design function professionals to create engineered systems that exceed codes and guidelines. This can be achieved by:

- Maintaining a record of actions that addresses climate change issues; and
- Explaining the solution to the client in economic terms.

2. Integrate climate mitigation into practice

Engineers should create engineered systems that reduce the 30 billion tonnes of carbon released into the atmosphere every year. Engineers should develop:

- Alternative propulsion technologies and fuels;
- Electric propulsion and distribution; and
- Nuclear waste management.

3. Review adequacy of current standards

Engineers should investigate their local design standards to adequately withstand changing climate and weather conditions; they should also advise other engineers and the appropriate governing body.

4. Exercise professional judgment

Engineers must consider the consequences of climate change from an adaptation and mitigation perspective. Engineers should keep in mind:

- The quality and consistency of materials, manufacturing and inspection;
- Reliable analysis and experimental data; and
- Good knowledge of the actual load and the environment.

5. Interpret climate information

Climate and meteorological experts are now engineers' allies. This is especially true now that

historical weather cannot be used to predict future weather trends.

6. Emphasize innovation in mitigation and adaptation
Engineers need to innovate state-of-the-art developments that reduce or eliminate greenhouse gas emissions. This is where engineers can have the biggest impact. A recent example would be the efforts to sequester carbon emissions in oil sands operations.

7. Work with specialists and stakeholders
Just as engineers need to work with climate specialists, they need to work with people in other specialized sciences, such as forestry and ecology, and tap into people with knowledge of previous local climatic events.

8. Use effective language
Engineers already know the importance of effective communication with their clients, especially laypeople who don't necessarily understand the message. Yet the public is aware of climate change, and this influences government policies that may require engineers' expertise.

9. Plan for service life and resilience
Although it's difficult to forecast climate change decades in advance, engineers should take it into consideration when developing a project, and they should use time slotted for periodic refurbishments to incorporate adaptive measures. This planning, although initially costlier, will save money in the long run.

10. Apply risk management principles for uncertainty
Identify and define threats, prioritize risks, implement treatments and monitor the progress of climate change impacts. This may require the help of an outside professional.

11. Monitor legal liabilities
Being held responsible for projects that can risk public health and safety is nothing new; however, in the age of climate change, a reliance of current codes and regulations may not be enough. Therefore, maintain a record of actions taken to address climate change issues and keep documentation of training and consultation.

Following the announcement of the new guideline, Minister of Infrastructure and Communities Amarjeet Sohi announced on June 1 that federally funded infrastructure projects will be assessed for contributing to lowering carbon pollution. Additionally, their locations, designs and planned operations will be assessed for climate change risks. Called the Climate Lens, the assessment process will affect programs seeking funding from the Investing in Canada Infrastructure Program, a plan that helps create long-term economic growth and supports a low-carbon, green economy; the Disaster Mitigation and Adaption Fund, a program designed to help communities better withstand future risks of natural hazards; and the Smart Cities Challenge, which encourages communities across Canada to improve the lives of their residents through innovation, data and connected technology.

Noting that the measurement and calculation of greenhouse gases is complex, Engineers Canada President Annette Bergeron, P.Eng., FEC, stated the organization "is pleased to see the federal government recognize that professional engineers have these skills…Engineers Canada has been encouraging the federal government to require climate change vulnerability assessments for new infrastructure projects…over the past many years."

PROFESSIONAL RELIANCE REVIEW TARGETS BC NATURAL RESOURCE REGULATORS

By Adam Sidsworth

On May 18, the British Columbia Ministry of Environment and Climate Change Strategy released its *Professional Reliance Review in the Natural Resource Sector*. The review was initiated in October 2017 with the goal of examining the current legislation governing qualified professionals in the natural resource sector and the role their professional associations play in upholding the public interest. Engineers and Geoscientists BC (EGBC) was one of five self-regulatory bodies whose procedures and policies were explored, along with regulators of agrology, applied science technology, applied biology and professional forestry.

The 135-page report—prepared by University of Victoria environmental law professor Mark Haddock, who was commissioned by the BC government to review the professional reliance model—makes 121 recommendations. The most notable recommendations affecting EGBC include:

- EGBC and five other regulating bodies would fall under the jurisdiction of the Office of Professional Regulation and Oversight (OPRO), which would regulate most aspects of self-regulation, including investigations, codes of conduct and thresholds of incompetent practice;
- The OPRO should appoint council members, potentially eliminating elections;
- A requirement that 50 per cent of governing bodies and committees of professional regulatory bodies are non-professional members of the public;
- Government regulation should develop a set of practices to ensure accountability of professionals;
- Mandatory continuing professional development of regulated professionals; and
- The government should standardize professional governance by regulating the profession and clarifying regulators' roles to protect the public.

ENGINEERS AND GEOSCIENTISTS BC's CONCERNS

On June 28, EGBC released its response to the report, which included some concerns regarding these key recommendations, notably:

- The inclusion of EGBC under this umbrella legislation would make the administration of the engineering regulator difficult, since 80 per cent of its members don't work in the natural resource sector; and
- The OPRO would add a new level of costly administration that would create an unnecessary distance between professional engineers and the government.

In addition, EGBC has expressed concerns that the OPRO, a body without any technical expertise, would have sweeping powers to overturn and appeal independent decisions by EGBC.

In a subsequent news release dated July 31, EGBC noted that "while the Office [of Professional Regulation and Oversight] would have broad and sweeping powers, its mandate is not defined. Its proposed authority appears to reflect the healthcare oversight model used in BC and the UK… [which] is under review by the minister of health due to concerns about its effectiveness."

EGBC Director of Communications and Stakeholder Engagement Megan Archibald told *Engineering Dimensions*: "We share [the] government's desire to see certain regulatory processes strengthened—and we've been working for a few years now to advance several amendments to our governing legislation, which is nearly 100 years old. However, we feel the regulatory improvements included in the report can be achieved through amendments to the *Engineers and Geoscientists Act*, without creating a new level of potentially costly administration."

Archibald adds: "We also recently undertook an external audit of our own—initiated prior to the professional reliance review—in an effort to identify ways to strengthen the regulatory and governance tools we have, within the current framework." UK-based Professional Standards Authority, which undertook the review, found that EGBC is meeting seven out of nine Standards of Good Regulation and would be fully compliant with just a few amendments (see "The value in regulatory performance reviews," p. 6).

"We were pleased to see several of our recommendations in the [Professional Standards Authority] final report," Archibald says. "Primarily, the report reinforced our request for additional tools for stronger regulation, including the ability to regulate engineering and geoscience companies and the ability to ensure competency of engineers and geoscientists through continuing professional development."

OTHER REGULATORY BODIES

Other regulatory bodies and business associations in BC had equally harsh reactions to the report, particularly to the OPRO, and its implied usurpation of regulatory control. The Business Council of British Columbia asked why "a professional working for government is somehow more skilled and ethical than one in the private sector," adding that the "government's responsibility is to enforce its laws, policies and regulations, not to oversee the maintenance of professional standards…."

The BC Council of Forest Industries noted the forest industry is already highly regulated, adding "it has a good record of compliance." The Mining Association of British Columbia noted the present regulatory system "is comprehensive and clearly articulates the roles and responsibilities of qualified professionals in relation to mine-related approvals," accenting that the Code of BC was significantly strengthened in 2016—in consultation with government and First Nations—resulting in a "world-class regulatory system for mining." And the Association for Mineral Exploration urged the government to focus on changes to "provide both public and investor confidence and allow our members" to develop technology for a low-carbon future. All organizations, including EGBC, agreed that the report goes beyond the government's original intention to strengthen regulatory bodies.

BITS & PIECES

The Rideau Canal, built between 1827 and 1832, is a 202-kilometre-long waterway with 47 locks constructed out of enormous blocks of stone. It's a demonstration of adaptive thinking to address Canadian conditions and lauded as a benchmark in Canadian engineering. An important commercial route before being replaced by the St. Lawrence, it's now a facility for recreational boating in the summer and the world's longest skating rink in winter.

MEET THE 2018 WINNERS OF THE ONTARIO PROFESSIONAL ENGINEERS AWARDS

By Duff McCutcheon

This year marks the 71st anniversary of the Ontario Professional Engineers Awards, a program founded by PEO to recognize engineers for their professional achievements in such categories as engineering excellence, research and development, young engineer, and for their community service. The program also recognizes a team of engineers that has had a significant and positive impact on society, industry and/or engineering with the Award for Engineering Project or Achievement.

Since 2005, the awards have been presented jointly by PEO and the Ontario Society of Professional Engineers. This year, the following 10 awardees and one project will be honoured at a special gala on Saturday, November 17 in Toronto, Ontario. For ticket information, visit www.opeawards.ca.

PROFESSIONAL ENGINEERS GOLD MEDAL

A true polymath, **John Bandler, PhD, P.Eng.,** is a professor, engineer, entrepreneur, innovator, researcher, artist, speaker and playwright. But it's his work in microwave engineering that cemented his professional reputation and helped position Canada as a leader in this game-changing technology.

A professor emeritus at McMaster University, Bandler is the global microwave community's most recognized figure in design optimization, both as an academic and a practitioner who engineered the highest forms of optimization into microwave computer-aided design (CAD) practice. His pioneering research—optimization algorithms, sensitivity analysis, yield-driven design, fault diagnosis, nonlinear optimization and electromagnetic optimization—built microwave CAD's foundations. Through his company, Optimization Systems Associates Inc., acquired in 1997 by Hewlett Packard, Bandler commercialized his research by creating software tools used regularly by microwave designers around the world.

In the early 1990s, he invented a mathematical technique known as "space mapping"—a systematic procedure to project the parameter space of a complex, computer-intensive field-based model into a much faster surrogate model that would drastically accelerate traditional electromagnetics-based analysis without sacrificing modeling accuracy. Space mapping methodology has been implemented by a variety of companies in a broad range of applications, including Philips, Saab and BAE.

Inducted as an Officer of the Order of Canada in 2016, Bandler is active in artistic, literary and theatrical endeavors and has authored fiction and non-fiction, including a screenplay and nine stage plays.

THE ENGINEERING MEDAL—ENGINEERING EXCELLENCE

Known by colleagues as an "engineer's engineer," **Gary J. E. Kramer, P.Eng., PE,** senior vice president and global practice director (tunnels), Hatch, has built an international reputation as one of the world's foremost tunnelling experts. Through his 34-year career, Kramer has managed design and construction for many of North America's signature tunneling projects, including more than 140 kilometres of constructed tunnels for transit, water, wastewater and energy works. His work includes some of North America's highest-profile and technically complex tunnelling jobs, such as the Eglinton Crosstown Light Rail Transit system, Toronto-York Spadina Subway Extension, Niagara Tunnel Facility Project and Los Angeles' Metro Red Line Subway. Under Kramer's leadership, he has assisted in growing Hatch's tunnels practice from 50 to over 200 staff working in more than five countries. Kramer has devoted considerable efforts over the years to sharing his knowledge through numerous technical publications and is a sought-after presenter at the world's most prestigious tunnelling institutions and conferences.

A former consulting engineer in Canada's Arctic for nearly 20 years, **David Lapp, P.Eng., FEC,** is manager, globalization and sustainable development, at Engineers Canada, where he leads a project assessing potential climate change impacts on Canada's public infrastructure, and where his work helped develop an infrastructure climate risk assessment protocol. As secretary to the World Federation of Engineering Organisations' Committee on Engineering and the Environment, he helped apply the protocol for engineers in Costa Rica and Honduras as well as gaining recognition by the United Nations. Lapp also co-chairs the Natural Resources Canada Infrastructure and Buildings Working Group alongside the Institute for Catastrophic Loss Reduction. As a volunteer, Lapp has served as a coach in the Ottawa Special Olympics' bowling and swimming programs. Lapp currently serves as chair of the Building Advisory Committee for the Ottawa Citadel Salvation Army.

ENGINEERING MEDAL—ENTREPRENEURSHIP

David Beckman, P.Eng., president and CEO, Zeton Inc., saw a need in the chemicals and energy industries to design and fabricate small-scale production plants that efficiently take complex process technologies to market. After creating a methodology that sees engineering design and fabrication take place in the same facility, Beckman co-founded Zeton Inc.—a Canadian company that designs and builds lab scale systems and small-scale plants using modular fabrication. Since its founding in 1986, Zeton has completed over 750 projects across many industries and has grown to approximately 250 staff. Since Zeton's inception, Beckman has been responsible for its operations, strategies for company growth and in-house research and development. Beckman also continues to help develop process design

for customers. Currently, Beckman is vice president of the Canadian Society for Chemical Engineering and a member of the board of advisors for the University of Toronto's department of chemical engineering and applied chemistry.

THE ENGINEERING MEDAL—MANAGEMENT

The Greater Toronto Area's York Region has relied on the engineering and management expertise of **Paul May, P.Eng.,** vice president, project implementation, York Region Rapid Transit Corporation, to help guide the region's tremendous growth. A former transportation engineer, May contributed to the seamless planning and implementation of significant infrastructure improvements to manage expansion, including road and transit infrastructure, and water and wastewater programs. He also oversaw the design and construction of the region's $1.75 billion rapid-transit system. A leader who challenges his teams to take initiatives and be innovative, May guided and mentored many technical staffers who have gone on to more senior roles. May and his projects have been recognized with numerous awards over the course of his career, including a 2017 Top 10 Public Works Leader award from the American Public Works Association and *ReNew Canada* magazine's 2016 Top 100 Biggest Infrastructure Projects.

Working nearly 50 years in aviation, **Terrance Nord, P.Eng.,** president, TNCC Global Aviation, began as a Royal Canadian Air Force captain and continued to his role as managing director/CEO, global aviation with DHL Express. As a Greater Toronto Airports Authority board member, Nord guided the development of the Global Mega Hub Strategy—a plan to develop Toronto Pearson International Airport into one of the globe's few "mega hub" airports. Nord played a leadership role in the creation of Canadian Airlines—Canada's first major airline merger. Internationally, he led a team that established a global air cargo network for DHL Express. He also oversaw operations moving freight across an intercontinental air route and managed support infrastructure for engineering, quality control and more. Nord's engineering achievements include the design and implementation of operations and maintenance procedures for a variety of aircrafts and operations programs for the Royal Canadian Air Force and the United States Air Force.

THE ENGINEERING MEDAL—RESEARCH AND DEVELOPMENT

Winnie Ye, PhD, P.Eng., Canada research chair (tier two) and associate professor, Carleton University, is at the forefront of silicon photonics research, an emerging technology with potential to impact the

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next generation communication, sensing for medical and life sciences, and high-performance computing. Ye conducts research on applying silicon photonics to data communications, telecommunications, sensing, medical devices and renewable energy. Examples of her work include developing an effective DNA detection device and improving the efficiency of solar energy applications. Ye has built an impressive research portfolio, securing nearly $2.5 million in research funding from government organizations and industry contributions. She is recognized internationally and made a major impact with her research, including three industry relevant patents. Her work has been recognized with prestigious awards, including the Institute of Electrical and Electronics Engineers Women in Engineering Inspiring Member of the Year Award. Ye also won Carleton's Teaching Award in 2011; and, since 2009, she has directly supervised 89 students.

Ashraf El Damatty, PhD, P.Eng., professor and chair, civil and environmental engineering, Western University, and research director, Wind Engineering, Energy and Environment Research Institute, is a research pioneer in the stability of water structures and the effects of severe wind on power distribution infrastructure. His research helped develop innovative design methodologies for managing hydrostatic and earthquake loads on water tanks, which have been used in Canada and around the world. El Damatty also studies the behaviour of transmission line structures under tornadoes and downbursts, and his research helped create a software package for designing transmission line structures that allows engineers to prepare, upgrade and design transmission lines likely subjected to high-intensity winds. He has published papers in top scientific journals, supervised graduate students, and served as editor-in-chief of the *Journal of Wind and Structures*.

THE ENGINEERING MEDAL—YOUNG ENGINEER

While **Jennifer Drake, PhD, P.Eng.,** assistant professor, civil engineering, University of Toronto (U of T), was finishing up her PhD, her research was already impacting stormwater management across North America. She even received a faculty position at U of T six months before completing her doctorate. In her first year as a professor, she published three papers and obtained funding to continue her research on watershed planning and stormwater systems and management. In 2018, Drake was awarded an Early Researcher Award by the Ontario Ministry of Research and Innovation; and, in 2014, she developed new regional flood equations for the Ontario Ministry of Transportation for ungauged watercourses, replacing then-current methods. Pro-

viding expertise to young graduates, Drake has trained 45 students, who are now working in water resources engineering for a variety of organizations. Currently serving on the Toronto and Region Conservation Authority's board of directors and Regional Watershed Alliance, Drake is committed to increasing the public's knowledge and understanding of issues related to urban flooding and flood prevention.

CITIZENSHIP AWARD

Some of Toronto's best-known hotspots, like the Liberty Grand, came from the vision and drive of engineer and entrepreneur **Nick Di Donato, P.Eng.,** president and CEO, Liberty Entertainment Group. Founded by Di Donato in 1986, Liberty Entertainment Group develops and operates numerous landmark establishments and has been redefining Toronto's restaurant, nightlife and special event experience. Combining his engineering credentials, design and construction experience and a passion for architecture, Di Donato has built his career by breathing new life into historically significant properties, including Toronto's Casa Loma. An active volunteer with the University of Toronto's faculty of applied science and engineering, Di Donato mentors students and speaks at the BizSkule program, which showcases engineering leadership in business. He also serves on several boards, including Sick Kids Hospital, St. Michael's College and Canada's Walk of Fame. He is also founder and co-chair of the annual Caring & Sharing Children's Christmas gala.

AWARD FOR ENGINEERING PROJECT OR ACHIEVEMENT

Improving mobility while protecting the environment in a fast-growing region, **York Region's 2nd Concession Project** connects growing communities and encourages healthy activities such as cycling.

This major north-south arterial corridor located in East Gwillimbury was completed in August 2017, when the local road was widened to a four-lane arterial. The project included road widening, trails, three bridges, retaining walls, active transportation infrastructure, stormwater management, gravity and large force main sanitary sewers, and a watermain.

Positive impacts to the local community are immense. The project increases travel options for all corridor users through greater road capacity and access to York Region's road network, and improved trail connections and sidewalks. It also provides dedicated and illuminated cycling infrastructure. The project's trunk sanitary sewers and watermain provide essential servicing to new residents and allow for future growth. It will have long-lasting and positive social impacts on its surrounding communities, and help bring economic growth to the area.

INTERNATIONAL WOMEN IN ENGINEERING DAY REMINDS US OF WORK STILL AHEAD

By Adam Sidsworth

Cristina Amon, P.Eng., dean of the University of Toronto's faculty of applied science and engineering (centre), with two women engineering students at the Myhal Centre for Engineering and Innovation. Photo: Daniel Ehrenworth

June 23 was International Women in Engineering Day, a worldwide awareness campaign to raise the profile of women in engineering and celebrate the achievements of women engineers throughout the world. The day first launched as National Women in Engineering Day in 2014 by the United Kingdom Women's Engineering Society, and in 2017 it became an international event for the first time due to the interest and enthusiasm of international participants. This year, participants from all over the world hosted events to raise awareness of women engineers, including PEO's York Chapter.

According to Engineers Canada, only 13 per cent of engineers across Canada and 11 per cent in Ontario are women. Other regulated professions, by comparison, have already reached gender parity: The Canadian Medical Association, for example, reported that 42 per cent of doctors across Canada and 41 per cent in Ontario are women.

But there is hope: Engineering schools, as a start, are actively campaigning to attract women students. York University's Lassonde School of Engineering is spending over a million dollars to achieve gender parity, and the University of Toronto's faculty of applied science and engineering has the highest proportion among Ontario universities of female first-year students in its engineering programs. In a statement to *Engineering Dimensions*, Cristina Amon, P.Eng., dean of the University of Toronto's faculty of applied science and engineering, said: "For the past two consecutive years, we have welcomed more than 40 per cent women in our incoming engineering undergraduate class, and we are on track to achieve an even higher percentage in September 2018." Noting that Governor General Julie Payette, ing., is a University of Toronto engineering grad, Amon praised the faculty's effective recruitment and admission processes, stating "gender diversity is our growing strength: it enriches the student experience and deepens the engineering creative process."

It is a sentiment Helen Wojcinski, P.Eng., FEC, chair of PEO's 30 by 30 Task Force, would agree with. "When I was starting off 30 years ago, I felt isolated. When you're the only woman in the room, it can be daunting." The 30 by 30 initiative, led by Engineers Canada, aims to have women make up at least 30 per cent of newly licensed engineers by 2030. "Thirty per cent is a critical mass so women don't feel like an outcast. It is also a widely accepted threshold for self-sustaining change."

Engineers Canada asserts it has support in every province and territory, with most engineering regulators and other stakeholders either adopting the 30 by 30 principles or carrying out plans. "We can no longer rely on a small group of women to address this inequality," Wojcinski says, noting it is not just women who need to participate to affect change. In fact, Wojcinski, notes, it was because of PEO Past President Bob Dony's strong support in his former role as president that PEO Council adopted the 30 by 30 initiative in September 2017. "The entire profession needs to own it, and men have changed [with the times]," Wojcinski notes, stating that the engineering profession is no longer an old boys' club.

Wojcinski, who is also an organizational behavioural expert, will bring her change management expertise to the task force to increase women's numbers in engineering. The task force's action plan will be presented to PEO Council this month and will address organizational changes, including encouraging companies to develop programs to recruit women engineering graduates, facilitate their pathway to licensure and retain them in the profession. "It's the whole engineering profession [that needs to adapt]," she notes. "Are [women] getting their licences? How do we get them to stay in?"

Wojcinski is hopeful, though. Although older, experienced engineers may be leading the way for more women in engineering, it is the up-and-coming generation of engineers that is more embracive of gender representation. "The next generation of women and men want to be mentored to take on a leadership role. People with experience need to pass on the baton."

ESSCO LOOKING TO INCREASE SUPPORT TO UNDERGRADUATE STUDENTS

By Adam Sidsworth

Ontario's student engineering society is focusing on engineers of tomorrow by increasing support to the engineering undergraduate community during the 2018–2019 school year.

At an August 13 planning meeting with PEO's outreach and engagement team, the executive team representatives of the Engineering Student Societies' Council of Ontario (ESSCO) discussed their "engineers of tomorrow" theme and four initiatives for the upcoming school year: high school outreach, tuition, mental health and university curriculum. The PEO-ESSCO Student Conference taking place on November 2 to 4 in Oshawa, Ontario was also discussed. The conference—which is still in its planning stages but quickly taking shape—will give students from the organization's 15 schools a chance to network with each other as well as industry, education and government representatives.

ESSCO is an association of engineering societies from 15 Ontario universities and colleges, and although PEO sponsors ESSCO, the two organizations have a symbiotic relationship, with PEO and ESSCO equally advocating for and promoting each other's organizations.

This year's ESSCO team includes President Ivan Zvonkov, a software engineering student at Western University; Vice President of Communications Julian Faita, a mechanical engineering student at Ryerson University; Vice President of Finance and Administration Santiago Vera, a biotechnology engineering student at McMaster University; Vice President of Services Logan McFadden, an aerospace engineering student at Carleton University; Provincial Counselor Jocelyn Lee, a civil engineering and psychology student at McMaster University; and Conference Chair Gabriel Pizarro, an electrical engineering student at the University of Ontario Institute of Technology. Representing PEO at the August 13 meeting were Manager of Engineering Intern Programs Tracey Caruana, P.Eng., EIT/Student Programs Coordinator Sami Lamrad, EIT, and Manager of Government Liaison Programs Jeanette Chau, P.Eng.

This year, ESSCO's annual student survey will focus on the ability of the engineering student to complete a degree and find work in the engineering field, despite a purported 5 per cent annual hike in tuition. ESSCO plans to outreach

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to Ontario high schools, with engineering students volunteering their time to teach high school students about engineering and the benefits of an engineering degree. The team also plans to create a report on mental health barriers affecting engineering students' education. Networking events planned for the year include sporting and other events, which will allow students to network among each other.

Throughout the meeting, the PEO team provided the ESSCO executive team with organizational advice and support, while Caruana, Lamrad and Chau, advocating on behalf of PEO, suggested the ESSCO team promote the importance of PEO's Student Membership Program (SMP) and licensure to engineering students.

PEO's SMP (www.engineeringstudents.peo.on.ca) is an ideal way to maintain contact between the regulator and engineering undergraduates in Ontario. The free program allows students to stay attuned to regulatory and licensing issues and maintains a firm connection to the province-wide professional engineering community. Currently, there are nearly 8400 undergraduates signed up with PEO's SMP.

CAROLINE MULRONEY NAMED ONTARIO'S NEW ATTORNEY GENERAL

By Adam Sidsworth

Attorney General and Minister of Francophone Affairs Caroline Mulroney (second from right) at Queen's Park on June 29, shortly after her swearing-in ceremony, pictured with PEO representatives. From left to right: Scarborough GLP Committee member Javeed Ahmed Khan, PhD, P.Eng., PEO Manager of Government Liaison Programs Jeanette Chau, P.Eng., and Government Liaison Committee Vice Chair Gabe Tse, P.Eng.

At a June 29 ceremony at Queen's Park in Toronto, Ontario, Lieutenant Governor Elizabeth Dowdeswell swore in Ontario's newest executive council (cabinet), headed by Progressive Conservative Leader and Ontario Premier Doug Ford. Among the 21-member cabinet is Caroline Mulroney, who, in addition to her role as minister responsible for francophone affairs, is Ontario's newest attorney general.

Members of PEO's Government Liaison Program (GLP), including Manager of Government Liaison Programs Jeannette Chau, P.Eng., had an opportunity to meet Mulroney as she greeted well-wishers on the front steps of the legislature. The team also met with Finance Minister Vic Fedeli and Government House Leader Todd Smith.

PEO President David Brown, P.Eng., BDS, C.E.T., and Interim Registrar Johnny Zuccon, P.Eng., FEC, formally met with Attorney General Mulroney for the first time on August 16.

In a statement to *Engineering Dimensions*, Mulroney said: "As Ontario's new attorney general, I look forward to working with Professional Engineers Ontario and discussing matters related to the engineering profession at the organization's annual Queen's Park Day on October 24."

Although Mulroney boasts a famous last name and solid political connections, her policies and political approaches have yet to become widely known. Until she entered politics, she maintained a relatively quiet profile. She earned her undergraduate degree at Harvard University in the early to mid 1990s, followed by her JD from New York University (NYU)'s law school, and was subsequently called to New York State's bar. As a lawyer, she was an associate at Shearman & Sterling LLP and then associate director of the NYU Center for Law & Business.

Most recently, she served as vice president of Bloomberg-Sen Investment Partners, a Toronto-based investment firm. Prior to that, she spearheaded corporate and regulatory matters related to growth opportunities in Canada and the United States for Wellington Financial LP.

Despite her high-pressure career, Mulroney founded and runs, with her sisters-in-law, the charity Shoebox Project for Shelters, which coordinates and deliver gifts to thousands of women and girls in shelters or facing homelessness.

DUTY TO WARN INVOLVING SAFETY: PERSPECTIVES FROM DIFFERENT JURISDICTIONS

By José Vera, P.Eng., MEPP

Consider this scenario: A family decides to convert their cellar into a living accommodation by increasing its height. The family engages engineering firm ABC to design the structural works, specifically underpinning the outer walls and lowering the floor to create more height. Engineering firm ABC is *not* engaged to supervise and inspect the works, a fact that will prove to be critical in the court case that will follow.

Later, the family hires contractor XYZ to install the underpinning and perform the excavation based on ABC's design. During the project, contractor XYZ engages engineering firm ABC to inspect solely the construction of one of the pins. During the site visit, the engineer for ABC notes the design drawings are not being followed: specifically, there was no reinforcement. Furthermore, the engineer informs contractor XYZ that the pin needs to be replaced and explains the importance of following the design drawings.

Engineering firm ABC does not inform the family that contractor XYZ was not following the design drawings, as at the time, there was no imminent danger or reason to believe contractor XYZ would not follow the drawings after receiving the engineer's advice. Contractor XYZ continues its work without following the drawings, ignoring the advice of the engineer.

Later, the family observes serious cracking on the structure and evacuates the building; subsequently, part of the building collapses. Thereupon, the family brings proceedings against engineering firm ABC and contractor XYZ. However, contractor XYZ is insolvent and plays no part in the proceedings. Nonetheless, the judge determines that it was the breaches of contract on the part of contractor XYZ that caused the collapse and there was no liability on the part of engineering firm ABC.

Key to the ruling is the following statement made by the judge: "The basic standard of care in a case like this involves the exercise of the care to be expected of a reasonably competent engineer." Continuing, the judge notes the scope of services of engineering firm ABC clearly did not cover supervision of the contractor or inspection of the contractor's work.

Therefore, the judge determines professional negligence was not established with regards to whether engineering firm ABC should have warned the family as well. In fact, the judge notes a sizeable number of engineers would have done no more and no less than advise their client—contractor XYZ at this stage—to follow the drawings, since there was no evidence of danger at that moment. Consequently, the family's case against engineering firm ABC is dismissed.

This scenario is based on a court case where the expression "the devil is in the details" clearly applies. For more information, read the full case *Goldswain & Another v Beltec Ltd (t/a BCS Consulting) & Another [2015] EWHC 556, England's Technology and Construction Court* (www.bailii.org/ew/cases/EWHC/TCC/2015/556.html).

DUTY TO WARN INVOLVING PROFESSIONALS IN THE UNITED KINGDOM

In the above-cited case from the United Kingdom, the judge, based on authorities' testimonies, reached the following conclusions in relation to a duty to warn involving professionals:

1. Where the professionals—engineers in this case—are contractually retained, the court must initially determine the scope of the contractual duties and services. It is in this context that the duty to warn and its arising circumstances should be determined.
2. It will, almost invariably, be incumbent upon the professional to exercise reasonable care and skill. This must be looked at in the context of what the professional is engaged to do. The duty to warn is just one aspect a competent professional is to perform with skill and duty.
3. Whether, when and to what extent the duty will arise will depend on all circumstances.
4. The duty to warn will often arise when there is an obvious and significant danger either to life and limb or to property. However, it can arise when a careful professional, having regard to all the facts and circumstances, ought to have known of such danger.
5. The court will be unlikely to find liability because the professional sees merely a possi-

bility of some future danger; likewise, any duty to warn may well not be engaged if there is merely a possibility that the contractor in question may not properly follow procedures in the future.

From the above, it follows that where practitioners are engaged to supervise or inspect construction, there is a clear duty to warn of risks that would be apparent to a reasonable practitioner during the supervision or inspection of construction.

ENGINEER'S DUTY TO WARN OCCUPANTS OF A BUILDING IN CALIFORNIA

The attorney general of California provides opinions on specific questions, particularly when existing laws do not provide clear answers. Several years ago, the following question of interest to engineers, paraphrased here, was presented:

A registered engineer is retained to investigate a building. He or she determines the structural deficiencies are in violation of building standards and there is imminent risk of serious injury to the building's occupants. The building's owner does not intend to disclose the risk to authorities or perform remedial action. The owner then asks the registered engineer to remain silent. Does the registered engineer have a duty to warn the occupants or notify authorities?

Key to the analysis of the attorney general was the following text from *Thompson v. County of Alameda (1980) 27 Cal.3d 741* (https://law.justia.com/cases/california/supreme-court/3d/27/741.html), a case revolving around a public entity's duty to warn of a release of an inmate:

"In those instances in which the released offender poses a predictable threat of harm to a named or readily identifiable victim or group of victims who can be effectively warned of the danger, a releasing agent may well be liable for failure to warn such persons."

Using this scenario as a jumping board, the attorney general noted that if a building poses an imminent risk of serious injury, its occupants similarly constitute a "readily identifiable group of victims" who can be effectively warned of the danger by the engineer who made such determination. The attorney general concluded: "[The] registered engineer has a duty to warn the identifiable occupants or, if not feasible, to notify the local building officials or other appropriate authority of such determinations."

Because this article is only an overview of the duty to warn involving safety, practitioners should read the opinion in its entirety: https://oag.ca.gov/system/files/opinions/pdfs/85-208.pdf.

ENGINEER'S DUTY TO WARN IN ONTARIO AND CANADA

Ontario regulations

The following sections from O. Reg. 941/90 are relevant to an engineer's duty to warn:

72. (1) In this section:

….

"negligence" means an act or an omission in the carrying out of the work of a practitioner that constitutes a failure to maintain the standards that a reasonable and prudent practitioner would maintain in the circumstances.

(2) For the purposes of the act and this regulation, "professional misconduct" means,

…

(c) failure to act to correct or report a situation the practitioner believes may endanger the safety or the welfare of the public,

…

(f) failure of a practitioner to present clearly to the practitioner's employer the consequences to be expected from a deviation proposed in work, if the professional engineering judgment of the practitioner is overruled by non-technical authority in cases where the practitioner is responsible for the technical adequacy of professional engineering work,

Standard of care

Based on the above regulation, an Ontario engineer's duty falls within "the standards that a reasonable and prudent practitioner would maintain in the circumstances." Note its similarity to the UK's standard of care: "The basic standard of care in a case like this involves the exercise of the care to be expected of a reasonably competent engineer."

Scope of services

Because the statutory obligation is to "present clearly to the practitioner's employer…in cases where the practitioner is responsible for the technical adequacy of the professional engineering work," it follows that the work must be part of the practitioner's scope of services for a duty to warn to be established. Again, just like in the UK, the scope of services of the practitioner is quite relevant.

Imminent risk and client inaction

What if the practitioner reports an unsafe situation and, despite clearly articulating its consequences, is asked by his or her client or employer to keep quiet? Although the regulations are silent with respect to situations where there is an imminent danger combined with an unco-operative client or employer, PEO's *Professional Engineering Practice* guideline states:

"Sometimes professional engineers find their advice is not accepted and that the client or employer has no intention of correcting the situation. If the engineer firmly believes that, after exhausting all internal resources, the health and safety of any person is being, or is imminently, endangered, it may be necessary to report these concerns to some external authority, such as a designated regulatory body, a government ministry or ombudsperson…." (For context, it is beneficial to read the entire guideline at www.peo.on.ca/index.php/ci_id/22127/la_id/1.htm.)

Note that this approach happens to mirror the attorney general of California's opinion where an

engineer has a duty to "notify the local building officials or other appropriate authority" in a case of imminent danger combined with an unco-operative building owner.

Duty to warn in Canada

The Supreme Court judgment *Smith v. Jones* (https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/1689/index.do) notes that:

Three factors should be taken into consideration in determining whether public safety outweighs solicitor-client privilege:

1. Is there a clear risk to an identifiable person or group of persons?
2. Is there a risk of serious bodily harm or death?
3. Is the danger imminent?

Although it is not clear how this judgment specifically applies to professional engineers in Ontario, these three factors provide a framework for practitioners to consider when faced with similar situations.

ADDITIONAL INFORMATION

As noted in the previous Professional Practice article "How practitioners can prevent conflicting obligations" (*Engineering Dimensions*, March/April 2018, p. 21), agreements and scopes of services should be consistent with the statutory obligations of practitioners to avoid unnecessary conflicts between their contractual obligations, such as confidentiality, and the practitioner's duty to report unsafe situations.

Finally, PEO's practice advisory team is available by email at practice-standards@peo.on.ca and is happy to help practitioners who are looking for more information on the duty to warn a client, employer or appropriate authority of an unsafe situation related to their scope of services. However, practitioners looking for assistance on resolving legal problems occurring in specific situations should contact their lawyer. **e**

José Vera, P.Eng., MEPP, is PEO's manager of standards and practice.

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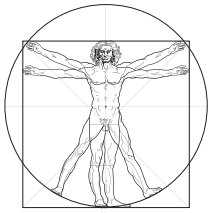

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2018 Canadian Healthcare Engineering Society National Conference,
St. John's, NL
ches.org/2018-ches-national-conference

SEPTEMBER 16–19
Canadian Society of Safety Engineering Professional Development Conference,
Niagara Falls, ON
csse.org/site/events/conference

SEPTEMBER 18–21
Western Canada Water Conference,
Winnipeg, MB
wcw18.wcwwa.ca

SEPTEMBER 19–20
Build Expo,
Seattle, WA
buildexpousa.com

SEPTEMBER 19–21
Canadian Steel Conference,
Halifax, NS
canadiansteelconference.ca

SEPTEMBER 23–26
Canadian Geotechnical Conference,
Edmonton, AB
geoedmonton2018.ca

SEPTEMBER 24–28
International Pipeline Conference,
Calgary, AB
asme.org/events/ipc

SEPTEMBER 28
Steel Day,
across Canada
steelday.ca

SEPTEMBER 30–OCTOBER 3
Transportation Association of Canada Conference & Exhibition,
Saskatoon, SK
tac-atc.ca/en/conference

October 2018

OCTOBER 3–5
CONSTRUCT Trade Show & Conference,
Long Beach, CA
constructshow.com

OCTOBER 10
Design Engineering Expo,
Kitchener, ON
dexexpo.com

OCTOBER 10
It's Time WE Act: Claudette MacKay-Lassonde Fall Forum,
Ottawa, ON
ospe.on.ca/events#1163

OCTOBER 11
Green Building Festival,
Toronto, ON
sbcanada.org/conferences/green-building-festival-2018

OCTOBER 11–12
Ontario Climate Symposium,
Toronto, ON
climateconnections.ca

OCTOBER 10–11
IEEE Electrical Power and Energy Conference,
Toronto, ON
epec2018.ieee.ca

OCTOBER 18
Design for Manufacturing Summit,
Toronto, ON
dfmsummit.com

OCTOBER 14–16
Construction Management Association of America National Conference & Trade Show,
Las Vegas, NV
cmaanet.org/conferences

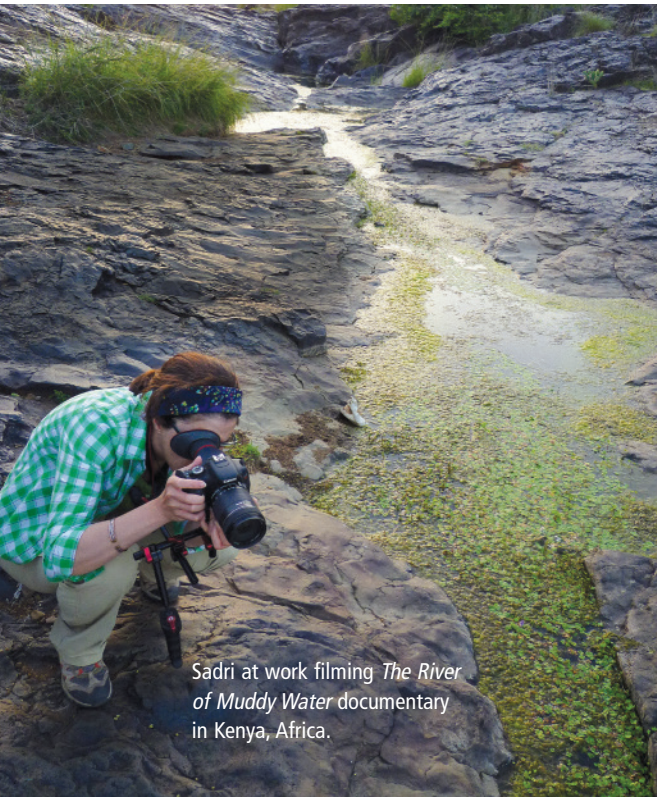
OCTOBER 24
PEO Queen's Park Day Reception,
Toronto, ON
www.peo.on.ca

ENVIRONMENTAL ENGINEER'S PASSION FOR WATER RUNS DEEP

Sara Sadri, PhD, P.Eng., a newly licensed professional engineer, is a dedicated scientist and truth-seeker with a dizzying resumé.

By Marika Bigongiari

When Sara Sadri, PhD, P.Eng., isn't making films in Kenya, rubbing shoulders with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and braving crocodile-infested waters doing research or working with Princeton University and the University of California, Los Angeles (UCLA) on NASA-funded projects, she's winning at chess and going on blog tours to educate people about small-operation coffee roasters. Scientist, photographer, filmmaker: her wide-ranging interests epitomize the spirit of the modern engineer.



Sadri at work filming *The River of Muddy Water* documentary in Kenya, Africa.

AN ENGINEER IS BORN

Sadri's work ethic, passion for engineering and activist spirit were sparked at an early age. Born in Tehran, Iran, much of Sadri's childhood was spent on her grandfather's farm, escaping city life, chasing chickens and climbing fig trees. There, she built a treehouse with her brother and learned about farming, gardening and the challenges that come with not having enough water in the developing world. Her ensuing passion for the environment, which touches all aspects of her work, drove her to become a professional engineer. "Every time we study the environment, we find something new we didn't know before," she enthusiastically exclaims.

Sadri came to the engineering profession through a combination of family influence, environment and conviction. Because her mother was a pharmacist, her father a physician and her brother a mathematics Olympian, she felt getting a higher education was a no-brainer. She struggled at first to find a niche for herself but excelled at math—geometry in particular—and physics. "I chose engineering because of good grades in these subjects, but I was amazed by how understanding mathematics and physics—the foundations of engineering—opened doors to other possibilities, such as the arts," she says.

Sadri, whose ambition saw her determined to become a licensed P.Eng., strongly believes in the value of being an engineer: "Understanding facts, logic and algorithms helps us understand how the physical world around us works and how we can connect the dots and variables in the world and make realistic predictions. The more we understand the physical world, the more peaceful life can become—and engineering is the umbrella that makes it all possible."

SCIENCE DYNAMO

Her environmental focus was set early in her academic career. After moving to Canada in 2003 to earn a master's in biosystems engineering at the University of Manitoba, Sadri went on to earn a PhD in civil and environmental engineering from the University of Waterloo. She also holds a bachelor's degree in agricultural, irrigation and drainage engineering from the University of Tehran. Sadri loves travelling, enjoys working with different people and sees herself as a "world citizen," an identity, she says, makes her fit right in.

After earning her PhD, Sadri began postdoctoral work at Princeton University, where she conducted research for the African Drought Monitoring Programme. There, she also befriended the owners of a local coffee shop. Her curious mind soon led her to a behind-the-scenes tour, where she learned all about the coffee-roasting process. She made a short film about it and, soon after, the budding filmmaker was at it again while conducting research in Kenya, Africa, this time making a film about water gauges, drought and floods in collaboration with UNESCO's water division.

The film, *The River of Muddy Water*, was shown at several indie and small festivals in Europe, played at NewFilmmakers New York, was featured during the UNESCO Youth Workshop and appeared at Green Market Toronto, Ghent University, Princeton University and at the American Geophysical Union Cinema. Sadri sees filmmaking as another form of scientific enquiry. She recognizes its value as a tool for reaching a larger audience and as a medium that serves her goal to help people understand experimental design, algorithms and critical thinking. "Making films in my field brings scientists, stakeholders, policy-makers and NGOs together, breaks the ice and helps them communicate their ideas better," she explains. "I'm fascinated by the art of filmmaking and storytelling. As a scientist, I wonder if better films with scientific undertones could get the world more excited about science."

Sadri, who was also a consultant for the United Nations World Meteorological Organization, is presently engaged in postdoctoral research at UCLA. She's in the process of transferring to a senior research specialist position at the department of civil and environmental engineering at Princeton University and will also be a visiting scientist at NASA's Jet Propulsion Laboratory, a federally funded research and development center for robotic exploration of the solar system.

ENVIRONMENT WARRIOR

Sadri's focus on studying climate change and addressing its far-reaching effects has led her to undertake frequency and risk analysis of droughts and floods all over the world, including Canada, Denmark and the United States, in addition to her research in Africa. Sadri says water conservation continues to be an important part of her work: "Our freshwater resources are under pressure globally to meet our future demands, due to both population growth and climate change. Between 2000 and 2050, water demand is projected to increase by 55 per cent. Agriculture is the major consumer of 70 per cent of freshwater, and food production will need to grow by 69 per cent by 2035. This means we'll be facing one big freshwater drain after the next."

Although Sadri worked on several different projects at Princeton, her focus was on statistical hydrology using various methods to monitor low flows in the eastern US. "The analysis of low flow patterns provides scientists with a better understanding of climate change impact, which helps them in decision making regarding allowable withdrawals and other studies," Sadri says.

Her NASA-Princeton project is about understanding the risks associated with extreme hydrologic conditions, which are crucial for effective water management. She's also building a national and international soil moisture monitoring system to assess drought risk for NASA's Soil Moisture Active Passive mission and has developed an online drought index map that updates every 24 hours. "My goal is to develop this into the first global near-real-time soil moisture drought index system," she explains. "It's unique because it's based directly on remotely sensed data and not common land surface models forced mostly by precipitation. We need to monitor extreme events in near real-time and real-time before we can predict them."

Sadri points out that because population and temperatures are constantly rising, the limited freshwater we have is under severe strain. She describes an alarming global trend and cautions against the folly of thinking fresh water is an inexhaustible resource: "The water table is dropping all over the world—there's no such thing as an infinite supply of water."

Musing on the irony of looming water shortages on a planet that's 70 per cent water, she's quick to point out 97.5 per cent of it is sea water, requiring significant processing to be fit for human consumption. Technology, Sadri says, is making progress: Sea water can be desalinated, and drills might be able to go deep into the ground to access depth freshwater, "but we need to keep in mind that under such scenarios, water will not be free—it will cost a lot to provide water in that way," she cautions. "It's not unimaginable people might fight over water in the future. Since we don't want that to happen, we must conserve what we have."

Sadri thinks of climate change as an umbrella concept encompassing many different spatial and temporal aspects of environmental change, including temperature, rainfall, snowfall and seasonality. As such, and because it's an abstract term, "it opens doors to conspiracy theories or denial," Sadri says. "It's true that climate has always been changing but it's not true, when compared with different spatial and temporal scales, that it's been changing at the same pace. It's important to understand that when we talk about climate change, we mean changes in water, temperature, landscape, groundwater, land development, flood, drought and the numbers and statistics under population growth."

Sadri and other climatologists and hydrologists work to pursue answers on how these changes occurred, discern what role humans played and determine whether changes should be addressed through policy-making. "Essentially, under the terminology of climate change, we're raising awareness on whether we'll have enough resources—water, air, land—to leave for future generations and how our actions and decisions contribute to rising temperatures, sea level rises, increased flooding and droughts and consequently food and water security in the future. These are important questions," Sadri explains.

Sadri finds satisfaction in the study of the environment, and she's asking big questions she believes it can ultimately solve. Environmental study, she maintains, demonstrates how the world is more connected than disconnected. "We've barely scratched the surface of understanding what's going on with our environment, and that's a huge challenge for mankind," she says. "Understanding our environment requires an understanding of physics, statistics, geography and computers. It's also fun, involving fieldwork and travel to parts of the world one would never have imagined existed. We hear a lot about going to Mars, but we barely know anything about our own planet. Much has been done, but much has been left to explore. What resources do the deep sea and deep groundwater have for us? What alternative sources of energy and design can be used to maximize harvesting solar and wind powers? And what agricultural alternatives can be used to eradicate poverty in the world? We don't have those answers. They remain underexplored areas in environmental engineering we must keep exploring." **e**

WITH A NEW GOVERNMENT COMES NEW OPPORTUNITY

By Howard Brown

Without a doubt, engineers are leading change in our society, and PEO has an important role to play.

The day-to-day lives of people in Ontario and around the world are continuously reshaped by technological advancements that would not be possible without the leading-edge skills of engineers.

The engineering community wields transformative power every day.

Being at the forefront of the Fourth Industrial Revolution means engineers are inventing new work that was unimaginable in the past—and that has major implications for self-regulation of the profession.

PEO President David Brown, P.Eng., BDS, C.E.T., talked about this change at PEO's annual general meeting earlier this year: "Engineering, as it is defined under our act, is being carried out all around us and will continue to expand. Yet we are almost powerless to put a rope around it and regulate it."

To stay relevant in a time of disruption, many believe PEO must adapt. "The status quo is no longer acceptable for a regulator," Brown said, "and for us to stick our collective heads in the sand and hope for the best is far from a prudent course of action."

One challenge Brown sees for PEO Council is to ensure its high professional standards apply to a rapidly expanding array of people applying their engineering skills. "I believe we are at a crossroads where we need to decide if we want to disrupt ourselves from within, while we still have that opportunity, or be disrupted externally, without having a choice," he said. "The evidence shows this is happening around us and in this province."

An important partner for PEO in this rapidly changing environment is the new class of Members of Provincial Parliament (MPPs), who were elected in June.

Although PEO and its Government Liaison Program (GLP) have consistently worked hard to build relationships with MPPs for over a decade, turnover in the legislature means efforts need to be renewed after each election. There are over 70 first-time MPPs serving at Queen's Park. Now is the time for PEO to reach out to these important elected officials because many may not be aware of the engineering profession's self-regulating mandate.

PEO's GLP has three very clear goals, which have been in place since 2005:

1. To facilitate strong, ongoing relationships between chapter members and their local MPPs;
2. To actively monitor and take action on policy proposals and upcoming legislation that could affect PEO and the *Professional Engineers Act*; and
3. To provide communications and policy support to express PEO policy positions to government policy-makers.

Of the three engineers who ran for legislature in this past provincial election, only one engineer—Progressive Conservative MPP Jim McDonell, P.Eng., MPP (Stormont-Dundas-South Glengarry)—was successful. The legislature is short of people who understand the engineering profession and share its analytical mindset, which is needed more than ever given the greater technological issues we face and on which the government must make decisions.

Ontario's new premier and leader of the Progressive Conservative Party, Doug Ford. Photo: Justin Tang, Canadian Press

This puts more pressure on PEO to deliver a clear message to MPPs about the value professional engineers bring to our province under a regime of self-regulation in the public interest.

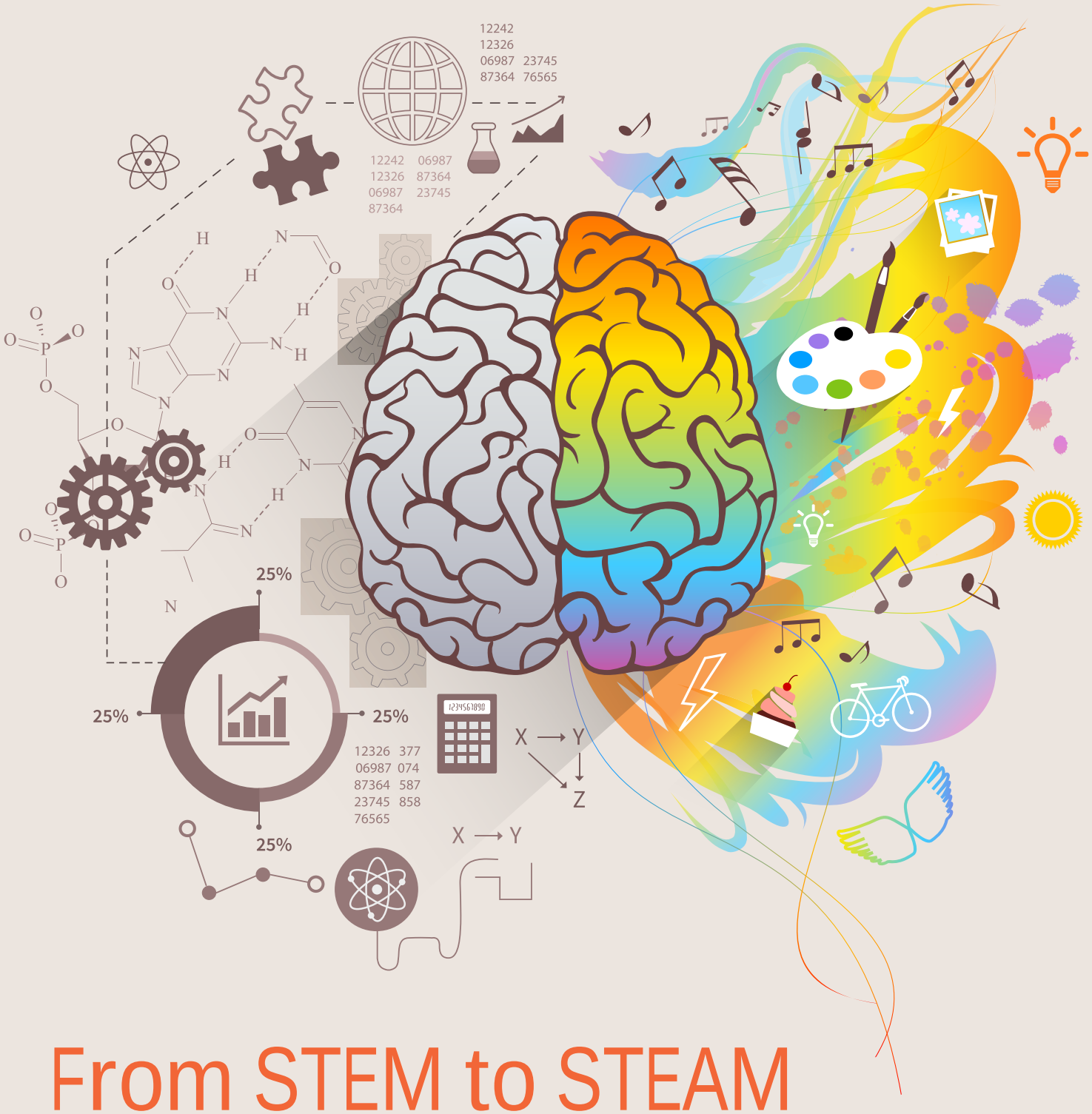
For PEO to be successful, this must be done systematically, riding by riding. Every MPP, regardless of party, has a role that can be used to influence both public opinion and decision making.

PEO, with its robust 36-chapter structure and a Council that includes lieutenant-governor appointees, is well positioned to make the case for the profession with all legislators at Queen's Park and, more importantly, right at home in their communities.

"This new government provides PEO with a new opportunity to demonstrate how they can help the government protect the public interest," says PEO Manager of Government Liaison Programs Jeannette Chau, P.Eng. "If we ever had a chance to show our role as a robust regulator and a partner of the government and have our voice heard, now is the time."

For more information on the PEO's GLP, contact Jeannette Chau, P.Eng., at jchau@peo.on.ca. e

Howard Brown is president of Brown & Cohen Communications & Public Affairs and PEO's government relations consultant.



From STEM to STEAM

The evolution of the engineering student

The Fourth Industrial Revolution is upon us, and it demands evolution. New engineers must be equipped to step into this rapidly changing arena, and their educators are getting creative to ensure they're up to the task. By Marika Bigongiari

Where previous revolutions were characterized by a single technology such as steam or digital, the Fourth Industrial Revolution is characterized by an array of exponentially expanding technologies. With web connectivity and the Internet of Things, smart everything, robotics, autonomous vehicles and artificial intelligence, most jobs—if not all—will change. As technology explodes around us at breakneck speed, today's students are entering the workforce at a time when almost every industry is being disrupted. Engineers will need to be well versed in multiple areas of expertise, and their curricula must be motivating and engaging, with real-world applications.

PUTTING THE 'A' IN STEM

A shift is quietly taking place in engineering education with potentially far-reaching effects: the subtle adding of the letter "a" to what is traditionally known as STEM (science, technology, engineering and math). STEAM adds "arts" and brings the creative spirit to the mix—something that's so important to a field as inherently creative as engineering. STEAM aims to help students achieve deeper learning, keep them engaged and give them better tools to learn the skills of tomorrow. Just as engineers work to solve problems using creative thinking, students must also engage their problem-solving skills using creative processes.

There's a misconception that the integration of arts means dropping an isolated art course into the core STEM curriculum, but where the concept of STEAM shines is the seamless integration of arts embedded into course content. STEAM curricula better reflect how students learn naturally and allow them to express their creativity and develop creative thinking—essential skills to have when they enter the workforce. STEAM finds where creativity fits naturally and gets students to connect with traditional STEM material through experiential learning and active engagement. Anyone familiar with the evidence-based Montessori Method, developed decades ago by Italian physician and educator Maria Montessori, will recognize the similarity to the STEAM philosophy, whose proponents recognize motivation and engagement as critical for keeping students involved with traditional STEM subjects over the long-term.

CREATIVITY AND EXPERIENTIAL LEARNING

Matt Minnick, PhD, P.Eng., assistant professor at McMaster University's faculty of engineering and vice chair of PEO's Hamilton-Burlington Chapter, weighs in on creativity in STEM education: "Creativity is very important for science and very important for engineering. There's so much creativity in everything engineering related people do. If you're thinking about how you should design something, engineering itself involves practising a lot of creativity. If the goal of STEAM is to increase creativity, that's a useful goal."

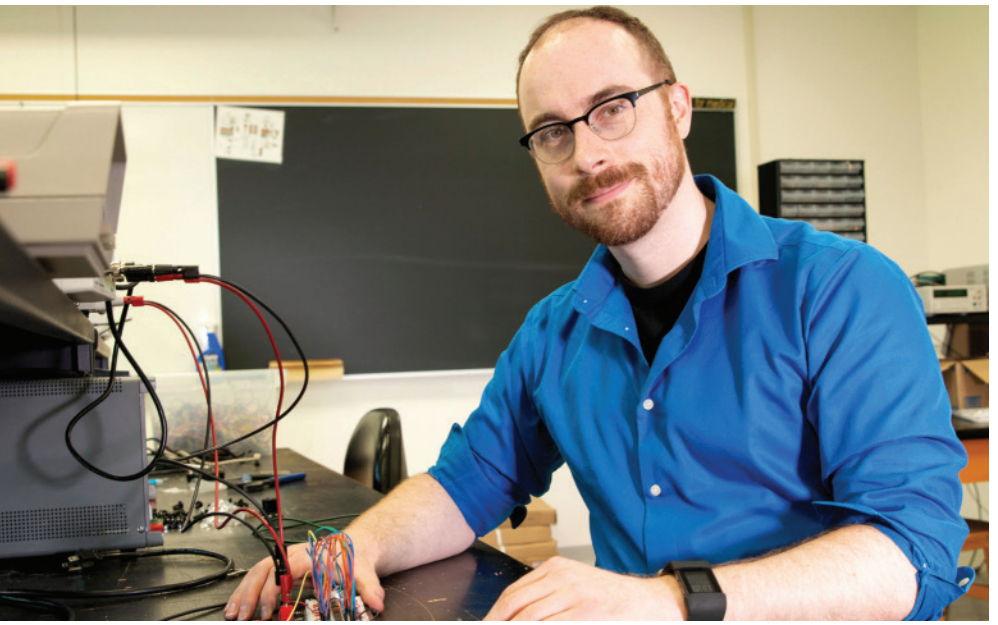
Minnick, who delivered the Ontario Society of Professional Engineers exam skills program and is the co-founder of ExPs.org, a company that specializes in helping applicants prepare for the professional practice exam for engineering licensing in Ontario, points out that students today have more creative input. "There's a definite shift towards creativity and experiential learning," he says. "There are more courses that involve design projects, and design projects inherently involve a lot of creativity. There's less of what you'd call 'chalk and talk courses'—the classic thing where the teacher goes and writes stuff on the board and talks about it, writes a bit, then talks about it some more—as opposed to what we have now, which is more active learning." This type of hands-on learning is critical, says Minnick. "What we're finding, and this applies to engineering too, is students put into co-op, into work experience and problem-based learning scenarios, not only get practical experience but are much more available to the theory when it comes up," he says (see "Bridging the gap," p. 31).

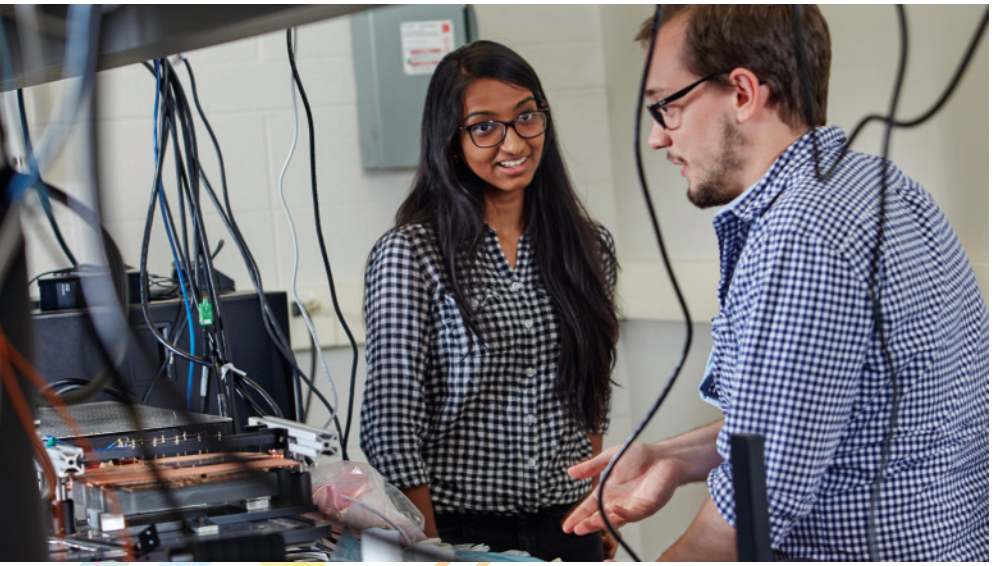
McMaster University was recently awarded the prestigious Global Teaching Excellence Award based on the strength of their experiential learning opportunities. Hands-on learning breeds engagement, which feeds motivation, something Minnick believes is critical for academic success. "Motivation is such a key factor for everybody," he says. "As an instructor, you must recognize that motivation of students is an important thing to consider, and students must find the material interesting, because then they're going to get further with the stuff." This is especially important in a world where students carry the Internet in their pocket and holding their attention is a challenge. While Minnick thinks the curriculum is keeping up, and he's optimistic that educators are winning the battle, "it's a bit of an arms race for students' attention," he points out.

AN EDUCATION REVOLUTION

Chris Meyer, president of the Ontario Association of Physics Teachers and a hybrid teacher-coach with the Toronto District School Board (TDSB), is deeply involved with physics education research. Meyer developed a Grade 11 and 12 physics program that's regarded as a leading example in Ontario of active-learning, inquiry-based education. He believes a key factor for supporting good learning is having students talk to one another about their scientific ideas under expert supervision and showing them why an expert would care about what it is they're learning. "Traditional science instruction encourages students to memorize disconnected facts or apply knowledge in cookie-cutter problems and laboratory activities," Meyer says. "These students never have an opportunity to learn or use scientific knowledge in ways like expert practitioners. They never get to answer the questions 'Why? Why are we learning this?' Students never experience science as a living, breathing process."

Meyer says people who observe the reformed chemistry and physics classes in his school are surprised by what they see: "They observe a hive of activity as students work in collaborative teams on tasks carefully designed by their teachers to help them discover new scientific ideas. In this learning environment, students are asking and answering questions that model the thinking process of experts." The advantage of this approach is that students are much more encouraged to find "aha" moments, compared with traditional instruction. "Students are highly engaged in their work and take ownership of





Top: Matt Minnick, P.Eng., showing off a student digital logic design project in a second-year undergraduate electronics lab in McMaster University's engineering department.

Bottom: Engineering students confer at McMaster University.

the ideas they discover," Meyer says. "They're constantly talking and writing about scientific ideas in their own words—and, most importantly, they're having fun, all while achieving a higher level of skill development than students in traditional classes."

This helps combat what Meyer calls the Einstein effect—that you must be an Einstein to succeed at physics—a widely reinforced belief in popular culture. "This is wrong," Meyer explains. "There are many average people who succeed in STEM fields due to their highly trained skills and willingness to tackle challenging problems. The modern science of learning strongly supports the idea that the average person can achieve this elevated level of skill development if they're taught well and are not discouraged during the long training process." In his Grade 11 introductory physics classes, Meyer confronts the common perceptions of who can be a scientist, engineer or physicist and reflects on the importance of helping students experience success early on. "Diversity initiatives will fail if students from underrepresented groups arrive in class and quickly decide, 'I can't do this.' Research shows that inquiry-based learning prevents the gap between high- and low-performing students from widening, as it does with traditional instruction. These changes in teaching are a critical component of opening up career prospects in the STEM disciplines to new students."

If the aim is to cultivate multi-disciplinary, out-of-the-box thinkers capable of navigating our rapidly changing world, educators need to get with the times, Meyer warns: "Our education system is barely coping with the social upheaval resulting from the shift away from a manufacturing economy to a knowledge economy. The evidence is right in front of us: Too many students leave school with a genuine dislike for science, and learning in general. When the revolution of cognitive machines hits and many modest thinking tasks are automated, the mismatch between our educational system and the work world will be even greater. In that future world, we will always need to develop our core understanding of math, science and language to maintain our intuitive ability to understand whether something seems right, but we'll also need to nurture deep wells of curiosity, creativity and empathy in our students—attributes that are traditionally considered innate but are actually teachable."

THE IMPORTANCE OF ENGAGEMENT

Another creativity champion, Jennifer Arp, TDSB trustee for Ward 8, Eglinton-Lawrence, and TDSB vice chair, sees STEAM as a natural reflection of the world students live in. She believes hands-on, collaborative education sets students up for success in fields that are all about collaborative work. At John Polanyi Collegiate Institute, a high school in Arp's ward, STEAM is being embedded into all aspects of school life, keeping students engaged with a curriculum that's more flexible and less rigid. "The STEAM curriculum is encouraging creativity in kids, and it's encouraging creativity that reflects the world they're living in today," Arp says. "I see STEAM, with the art component embedded into STEM, allowing kids to explore science and math and engineering in whatever way they would

Left: Dorothy Byers, chair of FIRST Robotics Canada, speaks at a competition at Ryerson University. Photo: Eddy Gunawan

Below: Students in Chris Meyer's physics class confer at York Mills Collegiate Institute.

like to. STEAM education is important because it's about meeting kids where they're at in their learning. The job market is changing so rapidly that we don't necessarily know what the jobs are going to look like and what they're going to be. Often, work in STEM areas isn't individual work: it's group work. It's preparing kids to enter post-secondary [education] and be successful."

The highly successful science, math and robotics program at John Polanyi boasts a fluid, dynamic curriculum, and it's the only one of its kind. "There are other science-technology programs, but this is the only one where it's not about the highest grades to get in," Arp says. "It uses an equitable lens for admissions and identifies the kids who have a real genuine interest. If you walked into that school, into the learning environment, you'd think you were in a university." While there are options to specialize, there's also an option to not specialize and take the courses in the program that are of interest. "It's not like every child in that program is taking the same set of courses for the entire four years," Arp explains. "If a student has an interest in medical technology, there are courses available for them to explore that. If they have an interest in making documentaries, they can pursue that." Arp is concerned with the current political climate and recent push to get "back to basics" in education, and she wonders: "What does that mean?" She sees the decline in math scores not as a failure of the student but a failure of educators to keep up, adding, "Are we providing them with the rich, interdisciplinary learning opportunities that reflect the world they live in?"

As chair of the board of directors of FIRST Robotics Canada, Dorothy Byers knows all about the role creativity plays in learning. The mission of FIRST is to inspire young people to pursue studies and careers in STEM through robotics competitions for school-age students from elementary through high school. Byers, who holds a master's degree in education and was a teacher before moving into administration, explains how important it is for kids to work with professionals and real-life role models through FIRST, and says it's a prime example of the engineering design element in practice

and a demonstration of how creativity and real-world collaboration breed success. "Kids who have been involved in FIRST are 90 per cent more likely to pursue STEM," Byers says. "Kids need to aspire to learn and look at pathways they haven't necessarily thought of for themselves." At FIRST, she explains, creativity and hands-on learning, along with a spirit of equity, diversity and inclusion (EDI), reflects the world we live in, breeds confidence and lays a solid foundation for kids to pursue STEM subjects. "It's important to promote EDI so kids, no matter who they are, see there's a future for themselves. When we have all voices at the table in a profession, you're going to come up with the best solutions and the best ideas."

Another crucial lesson for students is learning the value of failure, something that can only happen through doing.

Student teams look on as their robots compete at a FIRST Robotics event at Ryerson University. Photo: Eddy Gunawan

"There's lots of opportunity for failure and learning from failure, and that's important in any line of work but particularly in engineering," Byers says. "That's a profound lesson. When the mentors work with teams, it's not just about winning; it's about learning how to use the engineering process and design to come up with a solution, in this case a robot that has a strategy to play a game. Think of any line of engineering. It's all about the strategy, the problem, the process and the solution. It's about how we can be innovative and creative to solve this, to look at it from all sides and improve upon it."

FUTURE-PROOFING OUR KIDS

Because students will be entering a workforce in which most of the jobs don't yet exist, it's important to look to the future. "For me, education is not about today; it's about thinking strategically about what we need to equip students with so that, with the education they're receiving today, no matter what level they're at, we're looking at what we as a province and as a country are going to need to have when our kids are older so we can keep innovation alive and be competitive on the world stage," Byers asserts. "When we look at STEM fields, students must be equipped with all the needed skills, including soft skills: problem-solving, teamwork, creative and critical thinking, looking at the value of failure as a learning opportunity, learning how to be collaborative, how to be good communicators, all of that is critical to STEM learning. It's not just the technical stuff."

While STEAM's spirit of creativity is being fostered by educators, some institutions are taking it a step further by weaving art into the STEM curriculum and taking advantage of the multitude of talent students bring to engineering. Willy Wong, PhD, LEL, is an associate professor at the University of Toronto's department of electrical and computer engineering and director of the new engineering performance minor program. The combination of engineering and music is not a new concept, and there are countless examples of individuals who excel at both, including some of the experts in this article: alongside their STEM pursuits, Matt Minnick, Chris Meyer and Willy Wong are all accomplished musicians. Wong explains: "There are challenges to combining an arts-based education with a program like engineering: How do you capture the best of both worlds? Students can find inspiration through studying a variety of courses in different disciplines."

Wong notes engineering education has changed for the better in recent years: "There is much more embracing of non-classical, non-traditional aspects of engineering. In the past, engineering stayed close to its roots. Electrical engineers worked exclusively in electrical engineering, mechanicals with mechanical engineering, etc. But now we're more actively promoting cross-disciplinary areas within the undergraduate curriculum. It's important for students to remember there is a wide world out there when they graduate. They can't be myopic when pursuing their studies and must be prepared to learn long after leaving school. We don't know where the next revolution will be. We need to keep an open mind." **e**

BRIDGING THE GAP

University co-operative education programs offer engineering students valuable hands-on experience in their chosen field, a crucial component to help bridge the gap between school, the workplace and the required 48 months' experience to become a professional engineer. We reflect on why optional pre-graduation work placements are worthwhile.

BY ADAM SIDSWORTH

Picture this: You're 15 or 16 years old. Your best marks in high school are in math and science classes, and your physics teacher suggests you pursue engineering in university because you're so good at it. You apply to a few engineering programs, and you're accepted to all of them. You choose your favourite school, and four years later you've earned your undergraduate degree. Perhaps you're 21 or 22.

You're ready to start applying for jobs so you can make money and bank those mandatory 48 months' experience to get your P.Eng.—except you have no clue how to apply for an engineering job.

Although you learned a lot through the university engineering program, the professors didn't necessarily teach you how to write a cover letter or a resumé or the steps to getting a job in the real world, especially without relevant experience.

Does this sound familiar? It's the same daunting challenge facing today's engineering graduates as they prepare to leave school and head straight into the workforce, albeit with the challenges of LinkedIn and instant communication. If only they had had some engineering-related work experience prior to graduation, along with guidance around the so-called "soft skills" necessary for their careers.

Engineers Canada President Annette Bergeron, P.Eng., FEC, refers to "escaping the bubble of the classroom": the ability to get hands-on professional experience prior to finishing your engineering degree. It's a subject Bergeron feels passionate about: Earlier this year, she provided testimony on behalf of Engineers Canada to the House of Commons Standing Committee on Human Resources, Skills and Social Development and the Status of Persons with Disabilities. In her testimony, Bergeron advocated for "mandatory and paid post-secondary engineering co-op placements in institutions where they do not currently exist." According to Bergeron, only five out of the 24 Canadian engineering programs have mandatory co-operative education programs—although it should be noted that many engineering programs offer optional co-op streams.

Bergeron believes placements help guide students to choose their specialty. *The 2015 Engineers Canada Labour Market Study* reported that because many baby boomer–aged engineers will retire over the next five years, "universities are granting an increasing number of engineering degrees to Canadian and international students…." Certain engineering sectors—civil and computer engineering, for example—have greater need for new engineers.

Bergeron also recommended the federal government provide subsidies to encourage employers to host engineering co-ops, extend co-ops to international students and create an up-to-date database of engineering co-ops. Co-ops and internships, Bergeron told the committee, "are crucial in developing an engineering student's professional network while simultaneously providing opportunities to gain relevant work experiences."

Bergeron told *Engineering Dimensions* that paid co-ops and internships help students lower their student debt and gain valuable work skills that aren't learned in the vacuum of school. "The most important asset is self-confidence," she notes, adding that time management and communication are different in the workforce than school."And the organizational skills are different than studying for exams and writing lab reports." When asked if an engineering student's work co-op should be like medical students' residences or law students' articling, Bergeron gave considerable insight: "[Those] placements are after graduation, so it's different. For engineers, we want it to be integrated, because afterwards, we already have the four-year work requirement for licensure. If they're having trouble, the benefit of a co-op is that you get the skills while you're still in the bubble."

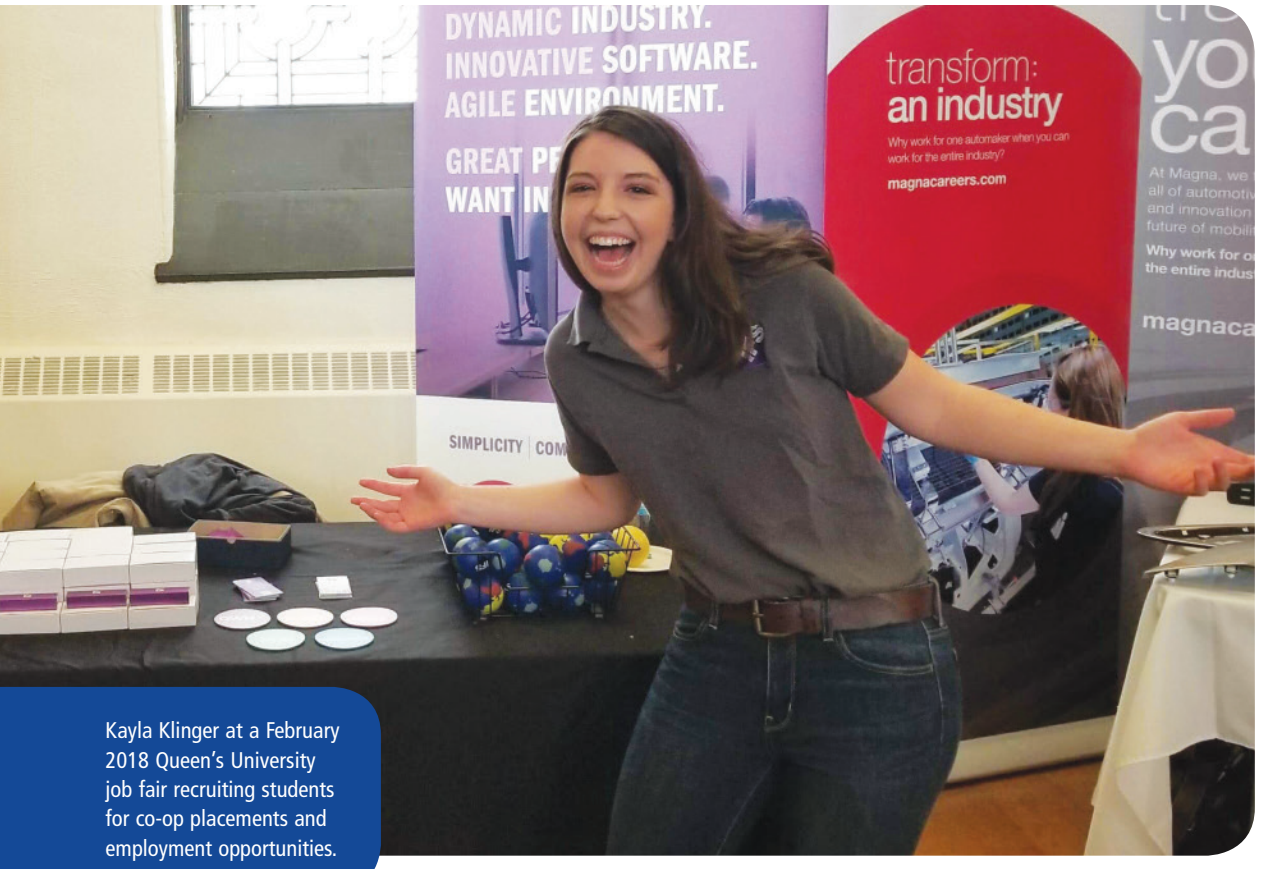
THE IMPORTANCE OF CO-OP PLACEMENTS

What does an engineering graduate look like today, compared to when PEO's veteran engineers graduated? Engineers Canada's *Final Year Engineering Students 2017 Survey–National Results* shares select demographics, hopes and fears of students graduating with undergraduate degrees in engineering across the country and comparable results of the two previous years. Among the highlights:

- 57 per cent don't have a job offer upon graduation;
- 26 per cent said finding a job was the biggest barrier to entering the engineering workforce;
- 31 per cent of grads who feel very or somewhat prepared to enter the engineering workforce said it is because of their co-op, work term or internship;
- 60 per cent used on-campus resources to find a job; and
- 52 per cent used a mentor, usually from a co-op, to find a job.

PEO has long recognized that co-op placements can play a vital role in an engineering student's development. In fact, of the 48 months' experience licence applicants require to become a P.Eng., up to 12 months can come from co-op work experiences related to their area of study and practice and completed prior to graduation. PEO's EIT and student programs coordinator, Sami Lamrad, EIT, says co-op students' experiences are assessed the same as post-graduation work experience but PEO takes into consideration that "at this stage of their development it's all about getting exposure to acceptable engineering experience." And PEO encourages students to carry over their experiences to the EIT program: If you apply within six months of graduation through the Financial Credit Program, PEO may waive your licence application fee and the annual EIT registration fee for the first year.

Because a large majority of engineering students rely on assistance from their university's campus resources to find work, there is perhaps merit to Bergeron's claim that "engineering co-ops provide opportunities to gain relevant work experiences."



Kayla Klinger at a February 2018 Queen's University job fair recruiting students for co-op placements and employment opportunities.

Engineering Dimensions spoke with Ontario university co-op representatives who work closely with engineering students to gauge how they help these young future engineers to gain work experience and, perhaps more importantly, the crucial communication and networking skills needed to gain employment within the industry. We also interviewed a co-op host about the benefits of working with students, and we highlight the accomplishments of students who participated in paid co-op placements.

SELECT UNIVERSITY PROGRAMS

The University of Guelph has an active co-op program through its co-operative education and career services office. Approximately half of engineering students participate in the program, which includes one four-month and two eight-month-long work terms that begin after the students' second year.

Before their work terms begin, students complete an introductory co-op course that highlights cover letter and resumé writing, job searches, social media and interview skills. "They're very driven; they're very project driven," Sheila Hollidge, a co-op coordinator for the bachelor of engineering programs, says about Guelph's engineering students, noting the co-op program is well developed. During the students' job search, Hollidge and the co-op team send out job postings from employers and coach students on their networking and interviewing skills. The coordinators also work closely with current and new employers on securing valuable work experiences for the students—most placements are within a one-hour drive of the university, although students have gone as far as Nunavut, the United States and Africa.

Hollidge points out one of the many strengths of the engineering co-op student is their ability to communicate effectively: "With an emphasis on project design, our students are team players," she says. "This translates naturally into the workplace where collaboration is the key to success."

As part of their co-op requirements, students complete a work term report detailing engineering skills and attributes they've applied during their four- and eight-month work terms. "This report provides the opportunity for students to consider their experience in some depth and is a worthwhile approach to enhance learning and career planning," Hollidge says. "In addition, the content of the report can be used by students when they complete the PEO pre-graduation experience record."

In response to the significance of co-op, Hollidge says: "The objective of the co-op experience is to provide students the opportunity to explore

Katie Gwozdecky with her team at UTAT Space Systems at the David Florida labs in Ottawa, testing a satellite for launch vibration. Pictured clockwise from top left: Keenan Burnett, Karen Morenz, Katie Gwozdecky and Sam Murray.

a variety of work environments with engineering employers. We are fortunate to work with a wide range of co-op employers who help mentor our students during their work term and hire them after they've graduated."

At Queen's University in Kingston, Ontario, all students learn team skills in their design courses and approximately half the students take advantage of the university's professional development programs, with a quarter of engineering students choosing to participate in paid internships. Queen's works closely with over 400 organizations that host students, although "students are encouraged to gain experience networking; this can translate to great success finding their own hosts," says Brian Frank, PhD, P.Eng., associate dean, teaching and learning, at Queen's faculty of engineering and applied science. "[Internships] give students an excellent opportunity to experience a full year of engineering projects; it gives them an excellent view of what their career can look like after they graduate…[they] come back to class with a new perspective on how their classroom learning applies to the workplace."

According to Chelsea Elliot, P.Eng., director of corporate relations, faculty of engineering and applied science at Queen's, students don't necessarily know how to write an engineering resumé. With very little engineering-related work experience, Queen's students are encouraged to write resumés that include descriptions of design projects at school and extra-curricular activities. They're helped to write a cover letter and coached through the interview process. And when they're on-site, they're coached on work etiquette and how to work with people. "I have a goal to change the word 'soft skills' to 'professional skills.' It's a lifelong skill set," Elliot says.

A HOST'S PERSPECTIVE

Tej Gidda, PhD, P.Eng., vice president of GHD, a consulting company with a focus on resource recovery and waste solutions, is an enthusiastic supporter of hosting engineering co-op students. "We've done it for years, and it's a benefit because you get to test the students, and the students get to test you. They like what they're doing, you like what they bring to the table. And quite a few of them come back for multiple co-ops. We've hired a whole pile of them."

Gidda is quick to point out that a repeat co-op or an employment offer isn't a given: Some students don't work out, saying four- and eight-month placements allow him the opportunity to assess students' comfort at GHD.

"It's the enthusiasm more than anything else," Gidda says about his expectations of students' work experiences in engineering. "We do non-traditional consulting work in areas where we wouldn't count on co-op students to have a lot of experience or schooling. But if they're willing to jump right in and learn it, they do quite well and can come back full-time."

Nevertheless, even though co-op students may not have vast professional engineering experience, the soft skills still matter to Gidda. "Most of the schools I see do training on cover letters and stuff," Gidda says. "Every once in a while, you see one that's so poorly written you know you're not going to hire them. But that's rare now. Most people have a reasonable one. We want somebody with particular knowledge in what they're applying for and not just wanting a job. You can pick that up right away. Research the company: that's the easy thing to do. If they're applying for a particular position and [they've put effort into looking up that job], it shows. That's not something everybody does."

INSIGHTS FROM STUDENTS

A student in the electrical and electronics engineering stream at Queen's University, Shayla Klinger's bachelor of applied science will be her second undergraduate degree. She previously earned a combined honours science degree with a major in neuroscience, where she graduated with high distinction. Klinger, who is seemingly never at a loss for words, sounds like a glutton for punishment for enrolling in two programs that most people would find demanding. But there's a reason for the switch: "I was planning on working with deaf people and working with ear implants, and I needed to get an engineering background to work on implants," she explains. "I realized I liked to work with customers to provide solutions." Her 16-month paid internship, which is just wrapping up, is at Aviation and Defense IFS (AnD IFS), a software company that specializes in financial systems, maintenance and supply. Klinger is a solutions analyst, meaning she is involved in helping to develop solutions for the software that allow aviation maintenance departments to communicate throughout the inspection process of a plane. The goal is to reduce ground time and increase the safety, reliability and efficiency of airplane maintenance checks. "For an airplane to be released, you have to do a walkaround," Klinger says. "We make sure the materials are there." It's a complex system to design, she says, because engineers, planners and mechanics are all doing work and need to be able to communicate with each other. And customers want their plane to leave on time. Although the placement sounds unrelated to her neuroscience background, Klinger states the co-op "led me to realize the focus [of my studies]."

Klinger notes she was proactive in finding her own internship when the opportunity presented itself: Queen's internships normally start after the third year, but she began after her second year. She introduced herself to the AnD IFS contact, who was impressed with Klinger's medical internship, so they created a position for her. But it wasn't a guaranteed position, and Klinger notes, "I have Chelsea [Elliott] to thank for where I'm at." Elliott and Queen's University career services taught Klinger key job-seeking skills, including saying your name at a job fair, having your resumé ready and interview tips. "I cannot express how much I've enjoyed it," she says. "They've helped me realize I want to focus on the business and solutions side. They have the mentality of 'Let's see what you can do.'" She's grateful she has been treated like any other employee, not just in responsibility but in pay, for she has benefits and a travel bonus. "Before [the internship], you don't know what you want. Before, I thought, 'Finish school; get a job.' Now I know how to work." But most of all, Klinger is grateful she was able to work on a project from nearly the beginning to almost its fruition. "Even when I'm gone, I'll know I made an impact…I was fortunate enough to work with people high enough in the company who know I'm competent. You need a lot of acknowledgement. The internship let me know."

Katie Gwozdecky, a recent graduate of the University of Toronto's mechanical engineering program, has a single-minded determination to work in space, and it shows in her work and schooling. This past May, she won a Rising Star Award from Northern Lights Aero Foundation (see p. 41), no doubt in part because of her role as director of the University of Toronto Aerospace Team's (UTAT's) space systems division, a student-led group that, among other things, builds sounding rockets and components for small satellites. While there, she actively rallied for a student levy that raised almost half-a-million dollars to launch their amateur satellite, HERON MKII, which is scheduled to be launched into space next year by the Indian Space Research Organization to conduct microbiology experiments.

Her year-long internship, done during her third year, was at Synaptive Medical, where she worked on the development of a neurosurgical system. And although she was primarily responsible for the design of the power distribution system and the customer-facing connector panel, "it wasn't exactly the area I was interested in, but it taught me a lot. I felt like I was part of a team. It taught me what matters in a job, and I developed new skills," Gwozdecky says. Throughout the internship, she devoted her free time to aerospace. However, it was her other placement, which she completed in 2015 after her second year, where Gwozdecky found her calling. At MDA (Maxar) in Brampton, she relished the opportunity working on medical robotics, testing and building prototypes for flight-bound hardware. "Working at MDA, [I] had to learn a lot. Plus, I learned to work with people of different age groups and skill sets. Work is a lot more creative [than school]. I was accomplishing to-do lists."

Gwozdecky spent this past summer at Sinclair Interplanetary and returned to the University of Toronto this fall to complete her master's degree. For her master's, she'll be doing her work at Space Flight Laboratory, a University of Toronto laboratory that launches satellites for customers. "From my inclination, school can help you approach problems, but work gets you out of your comfort zone," Gwozdecky says. "Things you learn in school don't always get you into the workforce." And that may explain Gwozdecky's strong record in extracurricular activities, for she rose through the ranks at UTAT, where she was also

Linda Chigbo graduated with a degree in electrical engineering from York University's Lassonde School of Engineering and was almost immediately hired by Alectra, an electrical distribution company that is supporting her P.Eng. licence application process.

a business development officer and thermal lead. And it may also explain why she pursued her private pilot's licence in the summer of 2016. She flies low-performance, single-engine aircraft—mainly the Cessna 150 and Cessna 172—although she aspires to be able to pilot float planes or aerobatic vehicles. "I was home for the summer and able to fully pursue it," Gwozdecky says. "It has certainly given me a better appreciation of aviation, considering I was interested in space vehicles and exploration. Now I understand how flight works and [its engineering]. [It] was the cherry on top after my year-long co-op."

Linda Chigbo graduated this year from York University's Lassonde School of Engineering, where she earned her bachelor's degree in electrical engineering. It seems that electricity and power has been a life-long focus for Chigbo. Born and raised in Nigeria, she says: "I grew up in a country with poor energy and utility infrastructure. I wanted to help make a difference. Living in Canada now, I feel very privileged. I turn on the switch and the light comes on. The same cannot be said for people living in developing countries."

Chigbo has a single-minded determination to succeed in the electrical engineering field. She was the founding chair of the York University branch of the Institute of Electrical and Electronics Engineers and volunteered with the Ontario Network of Women in Engineering. "Every opportunity I get to pass info to younger girls, especially if they're just starting out, I do it," she says. "When I started at York, I was one of a few young girls. When you partner with a guy for a lab assignment, you have to convince him you know what you're talking about. [And] people think that electrical engineering is about climbing poles…anyone can do it."

Chigbo's two co-op placements were at Hydro One. Her first placement, a year-long internship, was as a protection and control engineering intern at Hydro One's head office. She had learned about electrical circuits in school, and Hydro One gave her an opportunity to learn about the transmission system and see the engineering drawings. "It made a good connection between what I learned in school and what I saw in the real world," Chigbo explains. "This is where I realized that my passion is in power. I knew I wanted to target protection and control." Chigbo was fortunate, because of her networking skills, to be offered a second placement at Hydro One, a four-month field placement in Barrie, ON. Chigbo says in the field, "your actions have to be calculated and exact because you see the changes happening in front of you."

Chigbo was employed almost immediately after graduation by Alectra, an electrical distribution company, where she is employed as an operations engineer-in-training, tending to the maintenance and reliability of the distribution systems infrastructure; she also schedules and plans key operation initiatives. "I don't think I would have done well in my interview if I hadn't had the co-op experiences," she says, adding that she was able to assure herself through the hiring process: "I know what I've accomplished; I know what I'm talking about; I've seen what it's like in the field; I'm a better candidate."

Chigbo says Alectra is fully supportive in her P.Eng. licence application process and enrolment in the EIT program. "My EIT development includes a plan to meet PEO's criteria for acceptable engineering experience. The application process is straightforward: I'm a new grad, so my application fee is covered under PEO's Financial Credit Program." Chigbo appears to be on a track to become part of PEO's next generation of engineers. **e**

IS CANADIAN ENGINEERING ACCREDITATION A GOLD STANDARD?

By Graham Reader, PhD, P.Eng.

Anyone associated with the Engineers Canada (EC) accreditation system, the Canadian Engineering Accreditation Board (CEAB), which accredits undergraduate engineering programs at Canadian colleges and universities, will hear repeatedly that our engineering accreditation system is the global gold standard that others would like to have. In 2007, PEO's Licensing Process Task Force's final report to Council stated: "Canada's engineering accreditation system is the envy of the rest of the world. Many other countries are now in the process of establishing accreditation systems for their engineering and technology programs, and CEAB volunteers and staff are frequently called upon to advise and assist them by virtue of Canada's acknowledged expertise in this area."

In the same year, our United States counterpart, the Accreditation Board for Engineering and Technology (ABET), resolved to become the international gold standard and accredit programs at non-US institutions and phase out the "substantial equivalency" system favoured by EC. ABET now accredits programs in 30 countries while EC has substantially equivalent agreements with two. So maybe the days of us being the gold standard are over, if they ever existed at all?

DEFINING CURRICULA

In 1920, several US licensing boards formed what is currently known as the National Council of Examiners for Engineering and Surveying (NCEES). To ensure reciprocity of registration, a standardized examination system was developed: the modern fundamentals of engineering exam. By 1936, the forerunner of ABET, the Engineers' Council for Professional Development, started to accredit whole programs. In the same year, the Canadian Council of Professional Engineers (CCPE)—the forerunner of EC—was founded. Three decades later, our accreditation system came into existence.

ABET fits into the US system by accrediting engineering programs and graduates who are qualified to take the NCEES fundamentals of engineering exam. Thus, the US has a two-stage academic process, whereas our system has only one: an accredited degree. The ABET syllabus is determined by 35 professional societies and the fundamentals of engineering exams set by NCEES on behalf of the state regulators. The Canadian syllabus is solely the responsibility of the EC board of the CEAB, consisting of at least six regulator-appointed members and six EC board-appointed members-at-large, acting as the main advisor. Hence, our regulators are the major decision-makers in deciding the undergraduate curriculum, with our universities and colleges being the regulated that must follow the curriculum defined by the regulators if they wish to be accredited. This unique system appears to have served our profession well. However, in other countries, professional societies and educators play a far greater role in defining the curricula. Maybe the tacit preclusion of such groups gives us our much-envied system?

The keystone of our system is the "minimum path" concept that specifies the amount of instructional time all students must receive in engineering science, natural science, mathematics, engineering design and complementary studies. These components have not changed since the 1960s, although the amounts required have been subject to modest amendments. Recently, an "other" category was introduced to be used by universities and colleges to describe curriculum elements complementary to the technical instruction, but how this category differs from complementary studies is not clear.

In 1995, the accreditation unit (AU) was introduced to measure content, with 1800 AUs being the minimum requirement, within which 1545 AUs were prescribed to cover the five components, leaving 255 AUs largely to the discretion of the universities and colleges: "The CEAB gives sympathetic consideration to departures from these criteria in any case in which it is convinced that well-considered innovation in engineering education is in progress." Later, the 1800 AU minimum was adjusted so that it was "expected that accredited programs will have additional accreditation units to demonstrate innovation…." So, apparently, the discretionary 255 accreditation units had proved insufficient to demonstrate innovation.

But how many additional AUs would be required? The actual number of units required appeared somewhat arbitrary and ad-hoc. The National Council of Deans of Engineering and Applied Science requested that a precise "absolute" definition be provided. Eventually, the EC board implemented an 8 per cent increase to the original program minimum. The universities and colleges were given time to make these adjustments with the new minimum becoming mandatory only in 2014–2015. The minimum components remained the same, but now 405 AUs were for innovation. By 2015–2016, an average engineering program had just over 2100 AUs, corresponding to between 26 and 29 in-class hours per week, considerably more, by as much as 40 per cent, than in the US and the United Kingdom.

For regulators, then, our present system could be described as the gold standard in terms of quantitative input measurements in both scale and topics. They define the curriculum content and the minimum number of hours of instruction required. Some flexibility is allowed, as 20 per cent of the overall program (compared with 40 per cent in the US) may be decided by universities and colleges, as long as the course content deals with at least one but no more than three of the major components, with each representing at least 25 per cent of the overall content. There are no stated educational or quality assurance reasons for these specifications, but they enable curriculum components to be readily identifiable during accreditation visits.

Curriculum components are not the only input measurement. For example, unlike in other systems, there is an EC requirement for a minimum number of academic faculty to be licensed engineers, with

compulsory registration necessary for deans and program leaders; licensure in any other country is not acceptable. However, if Canadian students study overseas for part of their degree, "engineering science and engineering design curriculum content can be transferred, provided the courses have been taught by engineers who are permitted to practise engineering according to the laws of the jurisdiction where the transfer credits are acquired." Thus, while the EC criteria may be considered rather severe by some, they are usually written in such a way to provide as much flexibility as the regulators deem safe.

LEARNING OUTCOMES APPROACH

In 1989, EC, along with five other international agencies, became founding signatories of the Washington Accord, an international agreement recognizing that its accreditation of university-level programs was substantially equivalent. According to the Washington Accord website, there are currently 19 signatories, and "the Washington Accord model has become the international gold standard for mutual recognition of engineering education." However, being part of the accord now requires that our programs use learning-outcomes-based assessment, partly as a result of increasing pressure from governments to demonstrate efficiency and cost effectiveness. So, instead of instructors being assessed on what they have taught, students are assessed on what they have learned. The commitment to the outcomes approach was made in 2005 by Washington Accord signatories, subsequently becoming compulsory in our system in June 2015.

The learning outcomes approach was embodied in ABET's "revolutionary" engineering criteria in 2000. The criteria required programs to state their educational objectives, link them to specified student learning outcomes—11 in all, now consolidated into seven—and demonstrate how these outcomes were to be measured. These requirements would be additional to the usual measurement of program inputs.

In Canada, efforts were made by EC in conjunction with CEAB and the National Council of Deans of Engineering and Applied Science to formulate an outcomes-based system. Eventually, EC decided in 2008 to wholly adopt the 12 graduate attributes of the Washington Accord compliance, requiring universities and colleges to "demonstrate that the graduates of a program possess these attributes," but exactly how universities and colleges were expected to measure and demonstrate the attributes was not addressed. It would be in 2016 that an interpretive statement was provided by CEAB, stating the "expectations regarding minimum levels of conformance" with graduate criteria with the intention "to assure common reporting requirements across institutions." The appearance of a lengthy passage to the full implementation of outcomes is somewhat misleading, since having decided on the fundamental way ahead a great deal of time and effort has been expended by all stakeholders to bring the system to fruition.

Nevertheless, the decision to incorporate the full suite of Washington Accord exemplars in our criteria, unlike the approaches of other signatories, has never been fully explained or at least understood. The accord itself states: "The graduate attributes provide a point of reference for bodies to describe the outcomes of substantially equivalent qualification…[they] do not, in themselves, constitute an international standard for accredited qualifications but provide a widely accepted common reference." Maybe EC's policy played a part in the protracted implementation process, or perhaps it has been the regulators' perceived need to maintain our gold standard of accreditation. Only time will tell, as our outcome system is still in its infancy, and not all regulators appear convinced or are at least agnostic.

Normally associated with outcomes is a different quantitative measure of curriculum content with more emphasis placed on what students learn rather than what they are taught. Thus, in many jurisdictions, content measurement has two components: instructional time and learning time. The concept of the latter is viewed with trepidation by some regulators and universities and colleges, which may explain why our students spend more time in class than others.

So, is the EC accreditation system the global gold standard? Most certainly our constituent agencies appear generally comfortable with the system, since they are key players. Yet the educational overtures for change should not be unappreciated if our system is to maintain its universal credibility. **e**

Graham Reader, PhD, P.Eng., is a mechanical engineering professor and former dean at the University of Windsor. He served on the Canadian Engineering Accreditation Board until 2017.

P.ENGs AND STUDENTS RECOGNIZED WITH PRESTIGIOUS AWARDS

By Marika Bigongiari

University of Windsor Professor **Nihar Biswas, PhD, P.Eng.,** received an honourary degree from the University of Guelph to recognize his work on clean water. Biswas, whose work has improved the lives of people around the world, was honoured for his contributions to environmental engineering education and clean water technology. Biswas is a fellow of the Canadian Society for Civil Engineering and co-editor of the *Canadian Journal of Civil Engineering*.

Graham Taylor, PhD, P.Eng., an associate professor at the University of Guelph, has been named one of Canada's Top 40 Under 40. Taylor, a machine learning expert at the university's School of Engineering, was recognized as a young business leader and innovator and was also recently awarded a new Canada research chair in machine learning systems. Taylor works extensively with artificial intelligence (AI) and belongs to Toronto's Vector Institute for Artificial Intelligence. He is also the academic director of NextAI, a Toronto accelerator for AI-enabled businesses.

University of Windsor Professor Nihar Biswas, PhD, P.Eng. (left), received an honourary degree from the University of Guelph for his work on clean water.

University of Toronto Professor Milos Popovic, PhD, P.Eng. (right), received the March of Dimes Canada lifetime achievement award for his work in rehabilitation engineering. Photo: Jonathan Sabeniano

University of Toronto Professor Olivier Trescases, PhD, P.Eng., was named a tier 2 Canada research chair in power electronic converters. Photo: Johnny Guatto

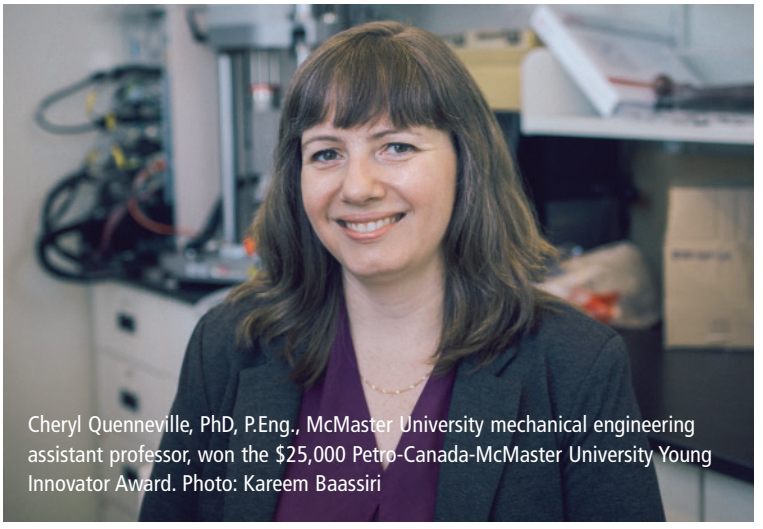
Milos Popovic, PhD, P.Eng., was recently honoured with the March of Dimes Canada lifetime achievement award. Popovic, who is a professor at the University of Toronto's (U of T's) Institute of Biomaterials and Biomedical Engineering and the director of research at the Toronto Rehabilitation Institute, is a renowned researcher in the field of rehabilitation engineering. He works to develop technologies that help restore voluntary limb function in persons with disabilities as well as other rehabilitation devices.

Several U of T engineering faculty members were recently named Canada research chairs: **Olivier Trescases, PhD, P.Eng.,** was named a tier 2 Canada research chair in power electronic converters; **Ashish Khisti, PhD, EIT,** was named a tier 2 Canada research chair in information processing; **Glenn Hibbard, PhD, P.Eng.,** was named a tier 2 Canada research chair in multi-scale materials dynamics; **Ted Sargent, PhD, P.Eng.,** was named a tier 1 Canada research chair in nanotechnology; and **Yu Sun, PhD, P.Eng.,** was named a tier 1 Canada research chair in micro- and nano-engineering systems. The Canada Research Chairs Program was established as part of a national strategy to make Canada one of the world's top countries in research and development. The program invests approximately $265 million per year to attract and retain some of the world's most accomplished minds, with chairholders aiming to achieve research excellence in engineering and the natural sciences, health sciences, humanities and social sciences. In 2000, the Government of Canada created a permanent program to establish 2000 research professorships in eligible degree-granting institutions across the country.

Mena Morcos, a graduate student in civil engineering at York University's Lassonde School of Engineering, received an honourable mention for his paper *Numerical Modelling of Slender Superelastic-Shape Memory Reinforced Concrete Shear Walls* in the 2018 Best Paper Competition at the Canadian Society for Civil Engineering's annual conference. Morcos's study focuses on understanding how shear walls can regain vertical alignment after being displaced by natural disasters, such as earthquakes, and he's engaged in ongoing research to improve earthquake safety worldwide.

A team of students from U of T's department of materials science and engineering took first place at the international 2017–2018 Hydrogen Student Design Contest for their plan for a hydrogen-powered luxury boat. Their design centres on a

University of Toronto students win an international competition for sustainable yacht design. From left to right: Professor Steven Thorpe, Bryan James, Jessica MacInnis, Matthew Chen and Yuri Savguira. Photo: Steven Thorpe



Cheryl Quenneville, PhD, P.Eng., McMaster University mechanical engineering assistant professor, won the $25,000 Petro-Canada-McMaster University Young Innovator Award. Photo: Kareem Baassiri

hydrogen-fueled amphibious motor boat and its companion refueling station, designed to use off-peak renewable energy to convert water into hydrogen. Their project—which grew out of a U of T course taught by Professor Steven Thorpe—presents an environmentally-friendly, sustainable, noise-free and emission-free alternative to the boating industry. The team included: **Bryan James**, **Jessica MacInnis**, **Matthew Chen** and **Yuri Savguira**.

Cheryl Quenneville, PhD, P.Eng., a mechanical engineering assistant professor at McMaster University, was recently awarded a $25,000 Petro Canada–McMaster University Young Innovator Award for fostering undergraduate research. Quenneville's own research focuses on injury biomechanics, particularly fractures and the prevention of traumatic injury. She incorporates undergraduate students into her research because that's how she got into research herself and ultimately decided to pursue graduate studies.

The Canadian Academy of Engineering (CAE) inducted 59 new fellows in a June ceremony in Calgary. All CAE fellows are engineers with outstanding abilities and accomplishments from diverse backgrounds, ranging from academics to industry and government. The CAE is a national institution through which Canada's most distinguished and experienced engineers provide strategic advice on critically important matters. Members are nominated and elected by their peers as fellows and are committed to ensuring Canada's engineering expertise is applied to benefit all Canadians. This year's inductees include: **Samuel Ariaratnam, PhD, P.Eng.,** professor and construction engineering program chair, School of Sustainable Engineering and the Built Environment, and senior sustainability scientist, Arizona University; **Annette Bergeron, P.Eng., FEC,** president, Engineers Canada; **Amir Fam, P.Eng.,** professor and Donald and Sarah Munro chair in engineering and applied science, associate dean, research and graduate studies, Queen's University; **Diane Freeman, P.Eng., FEC,** councillor, City of Waterloo; **Marilyn Gladu, P.Eng.,** Member of Parliament, Government of Canada; **Louise Grondin, P.Eng.,** senior vice president, environment, sustainable development and people, Agnico Eagle Ltée; **Richard Holt, P.Eng.,** professor, department of mechanical engineering, Queen's University; **Farrokh Janabi-Sharifi, PhD, P.Eng.,** associate professor, mechanical and industrial engineering, Ryerson University; **Fakhreddine Karray, PhD, P.Eng.,** university research chair professor in the department of electrical and computer engineering, co-director of the Artificial Intelligence Institute, and director of the Centre for Pattern Analysis and Machine Intelligence, University of Waterloo; **Frank Kschischang, PhD, P.Eng.,** professor, digital communication, department of electrical and computer engineering, U of T; **Ray Lapierre, PhD, P.Eng.,** professor and chair, department of engineering physics, McMaster University; **David Lapp, P.Eng., FEC,** manager, globalization and sustainable development, Engineers Canada; **Joseph Liburdi, P.Eng.,** president, Liburdi Turbine

Anston Emmanel (left), a fourth-year mechanical engineering student at the University of Toronto, won the 2018 Canadian Academy of Engineering William G. Belfry SAE Award.

Jane Illarionova (right), a second-year computer engineering student at the University of Toronto, won the 2018 Canadian Academy of Engineering Bruce Aubin SAE Aerospace Design Award.

University of Toronto graduate Katie Gwozdecky won the Northern Lights Aero Foundation Rising Star Award.

Services; **Yan-Fei Liu, PhD, P.Eng.,** professor, electrical and computer engineering, Queen's University; **Wayne J. Maddever, PhD, P.Eng.,** portfolio manager, Bioindustrial Innovation Canada; **James Nicell, PhD, P.Eng.,** professor and dean of engineering, McGill University; **Angela Pappin, P.Eng.,** vice president, technology, ArcelorMittal Dofasco; **Michael Pley, P.Eng.,** Pley Consulting Inc., and chair, McMaster engineering dean's advisory board; **Susan Tighe, PhD, P.Eng.,** professor, department of civil and environmental engineering, and deputy provost and associate vice president, integrated planning and budgeting, University of Waterloo; **Xianbin Wang, PhD, P.Eng.,** professor, electrical and computer engineering, Western University; **Mary Wells, PhD, P.Eng., FEC,** dean of the College of Engineering and Physical Sciences at the University of Guelph, professor in the department of mechanical and mechatronics engineering at the University of Waterloo, and chair of the Ontario Network of Women in Engineering; **Helen Wojcinski, P.Eng., FEC,** president, Wojcinski & Associates Ltd.; **Jun Yang, PhD, P.Eng.,** professor, mechanical and materials engineering and biomedical engineering, and director of WIN 4.0, Western University; **John Tze-Wei Yeow, PhD, P.Eng.,** associate professor, departments of systems design engineering, mechanical and mechatronics engineering and electrical and computer engineering, University of Waterloo, and director of the university's Advanced Micro & Nanodevice Lab.

The CAE also announced the recipients of its 2018 national scholarship competitions. **Anston Emmanuel**, a fourth-year mechanical engineering student at U of T, won the 2018 CAE William G. Belfry SAE Award. Emmanuel is a dean's honour list student who gained intern experience working with General Motors in autonomous vehicle development. **Jane Illarionova**, a second-year computer engineering student at U of T, won the 2018 CAE Bruce Aubin SAE Aerospace Design Award. Illarionova was recognized for her skills in AI and neural networks as well as her dedication to volunteer work and community activities. The awards are given annually to top engineering students across Canada.

U of T mechanical engineering graduate **Katie Gwozdecky** has been selected to receive the Northern Lights Aero Foundation (NLAF) Rising Star Award. Gwozdecky, a private pilot with a fierce dedication to space exploration, joined the University of Toronto Aerospace Team (UTAT) while pursuing her studies. Her work with UTAT included building rockets, designing and manufacturing components for small satellites and leading the team as director of space systems to pass a student levy and fund what will be the launch of the first amateur satellite from U of T in 2019. Her passion for aerospace engineering has led her to pursue graduate work at U of T's Space Flight Lab in September. The NLAF is dedicated to attracting young women to careers in aviation and aerospace and celebrates the achievements of women in these fields. e

PEO PULLS OFF A HAT TRICK WITH CHANGES TO REGULATION

By Jordan Max

This year will go down in PEO regulatory history as a banner year for PEO's Legislation Committee, for successfully achieving regulation changes. Working co-operatively with the Ministry of the Attorney General's staff, PEO was able to get cabinet approval for a record three sets of changes to Regulation 941, pertaining to Council term limits, fees transfer to bylaw and a French translation of the regulation itself.

COUNCIL TERM LIMITS (O. REG. 35/18)

At its February 2016 meeting, PEO Council established the Council Term Limits Task Force to investigate how best to implement councillor term limits and succession planning at PEO. The task force analyzed the term-limit practices of other self-regulating organizations and engineering associations in Canada, the existing literature on term limits and the past 20 years of PEO Council membership. The final recommendations of the task force were presented at the June 2017 Council meeting and subsequently approved. Regulation changes were required to implement these new rules, which were approved unanimously by Council on February 2, 2018. The regulation changes came into effect on July 1, 2018, and will apply to the 2019 Council elections nominations.

In general, they place a cumulative limit of six years for an individual to be on PEO Council, regardless of what position they held. This is followed by a minimum waiting period of six years before seeking election for another Council position. However, a former Council member can run for vice president or president-elect immediately. A president is now limited to one term of office, and a vice president must wait another 10 years before running for the same position. Transitional provisions were also put in place to allow current councillors to complete their terms if already in their sixth year on Council. Accordingly, changes were made to sections 2, 2.1, 3, 14(4), and 15.1 (2.1).

FEES TRANSFER TO BYLAW (O. REG. 36/18)

In 2010, through the *Open for Business Act*, Council and the government passed amendments to sections 7(1).25 and 8(1)16 of the *Professional Engineers Act* (PEA) to change the authority for making changes to its fees from regulations to bylaws; however, it was not proclaimed due to another change to the members' bylaw confirmation threshold in section 8(3). Without this change, if PEO wanted to make any changes to its fees, it had to get permission from the provincial government by amending Regulation 941.

The legislature's passage of the *Stronger, Fairer, Ontario (Budget Measures) Act, 2017* on December 14, 2017, included a change to section 8(3) of the PEA, which returned PEO's bylaw confirmation threshold to its pre-2010 level of majority of the members voting (see *Engineering Dimensions*, March/April 2018, p. 25). This now made it possible to proclaim the 2010 changes, allow Council to set fees through passing bylaws rather than through making regulations. To do so, Regulation 941 had to be amended to remove all remaining prescribed fees and to refer instead to fees as specified in the bylaw at the same time.

At its February 2018 meeting, Council approved those regulation changes (the bylaw was simultaneously amended by Council on the same date to add those same fees), coming into effect on April 1, 2018. For sections where the fee payable was one of a list of requirements respecting a matter prescribed by Regulation 941, the fee prescribed in regulation was changed to a reference to the "fee specified in the bylaw." Accordingly, sections 79.1 to 80 and sections 82 to 87 were concerned exclusively with fee amounts and were revoked.

In the course of drafting the regulation changes, the Ministry of the Attorney General had also identified the need for corrections to wording in sections 32.1(2) and 68. PEO staff also identified the need to revoke section 88, which is no longer valid due to the government's stay of the industrial exception in the *Burden Reduction Act* in March 2017.

It is worth restating that the current fee amounts were transferred intact to section 39 of By-Law No. 1, while the requirement to pay fees for licence, certificate of authorization and consulting engineer designation applications and renewals as well as for examinations remain in Regulation 941. Council now has the authority to pass bylaws to change fees effective immediately, unless Council requires and specifies a confirmation vote by the members under the rules in section 8(3) of the PEA. There are no implications for any PEO fee changes at this time.

FRENCH VERSION (O. REG. 305/18)

At its November 2017 meeting, upon request by the Ministry of the Attorney General, Council authorized the ministry to draft a French language version of Regulation 941. This was intended to assist the Office of Legislative Counsel and the attorney general in achieving their commitment for bilingual legislation in the province. Increasingly, the expectation is for regulations to be bilingual. It is important to note that French versions of the PEA and regulations do not automatically create any operational obligation to provide service in French to francophones, although PEO has provided some services recently, such as translators for discipline hearings and French licence certificates. The PEA has had a French version since 1991.

In March 2018, Council approved a French version of Regulation 941, which included the two recent regulation changes mentioned above, and which became effective on July 1, 2018. The French version introduced a feminine term ("ingénieure") for seals in section 52 and for titles in section 55.1 as well as for consulting engineer ("ingenieur-conseil" or "ingenieure-conseil") and their plural forms in sections 59, 67-69 and 71. e

Jordan Max is PEO's manager of policy.

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Deadline for November/December is September 19, 2018. Deadline for January/February 2019 is November 23, 2018.

Asking the right question

Robert FitzGerald, P.Eng.,
Ottawa, ON

I believe the article "Are GMOs safe?" (*Engineering Dimensions*, May/June 2018, p. 54) asks the wrong question. A more pertinent question would be: Does the value to society of a given GMO justify its approval for use?

The piece takes the approach of describing concerns about GMOs, then countering those with assurances from Health Canada or GMO proponents that they have all the proper regulations and procedures in place.

What has happened to the principle of precaution, which is fundamental to public health policy? The absence of "published scientific evidence demonstrating novel foods are any less safe than traditional foods" must never be taken as proof that they are actually safe! This is especially true when Health Canada relies heavily on research conducted by the manufacturers for their data.

When dealing with public health, a substance must be proven to be both useful and safe before it can be approved. Although GMOs introduced to date may well be safe (lacking data to the contrary), and some have the potential to be valuable to society, it is clear the principal beneficiaries of the introduction of many GMOs have been their manufacturers. For example, seeds that rely on a specific herbicide for their success have proven immensely profitable for their manufacturers, of questionable value to farmers and no benefit whatsoever to consumers or society at large.

Now that Japan and South Korea have banned Canadian wheat because of the presence of some stray GMO plants appearing unexpectedly in non-GMO fields, will the seed vendor compensate farmers and the Canadian economy for the expected loss of several hundred million dollars per year? Sadly, this seems extremely unlikely.

If a GMO is developed that has overwhelmingly powerful benefits for the well-being of humanity, we may decide as a society to approve its use, even if we don't have long-term research to convincingly prove its innocuousness. Until there is such a superior product that is ready for commercial deployment, we must set a much higher standard for approval. The fact that a substance doesn't appear dangerous is simply not sufficient.

Engineers are part of the solution

Clara Tucker, P.Eng.,
Ontario Ministry of the Environment and Climate Change,
Toronto, ON

I'd like to congratulate you folks for the three articles related to the future of our food security that you published in the May/June issue of *Engineering Dimensions*.

The three articles ("Keeping our food safe," p. 45; "The future of food," p. 49; and "Are GMOs safe?," p. 54) are excellent, focused and provide great awareness for engineers on issues such as world food supply, environment and required innovations in the face of expected population growth.

Thank you very much, and I hope your articles opened the eyes of engineers about the issues we will be facing in the years to come and how engineers are part of the professionals finding solutions.

LETTERS TO THE EDITOR are welcomed, but must be kept to no more than 500 words, and are subject to editing for length, clarity and style. Publication is at the editor's discretion; unsigned letters will not be published. The ideas expressed do not necessarily reflect the opinions and policies of the association, nor does the association assume responsibility for the opinions expressed. Emailed letters should be sent with "Letter to the editor" in the subject line. All letters pertaining to a current PEO issue are also forwarded to the appropriate committee for information. Address letters to naxworthy@peo.on.ca.

The message must be clear

Peter Broad, P.Eng.,
London, ON

To graduate high school, I had to pass a Use of English exam, because it was recognized that engineers and scientists can have problems communicating. I barely got a passing grade and am often reminded of my failings, but I would advise others to at least be consistent in our message.

The term maverick has been used repeatedly over the past several years to describe Elizabeth Wettlaufer, a convicted former London and Woodstock caregiver. Using the term to describe a PEO president on the cover of *Engineering Dimensions* (July/August 2018) may not enhance public confidence in PEO as a regulator.

My father was a chemical engineer, conscripted by government to create antidotes for poison gas attacks immediately prior to World War Two. This created in me a strong ethical need to correct what I saw as undisciplined engineering in foreign jurisdictions.

To quote Klaus Schwab, founder and executive chairman of the World Economic Forum, in a presentation on the Fourth Industrial Revolution: "We do not yet know just how it will unfold, but one thing is clear: The response to it must be integrated and comprehensive, involving all stakeholders of the global polity, from the public and private sectors to academia and civil society."

We are the voice of PEO, so our message must be precise. I am confused by recent metaphors such as engineers standing "watching a moving train" depart. Does this not indicate we remain trapped in the First Industrial Revolution? We cannot stop conveyor belts to supplement their load, and although ISS1 has a station commander, its speed and position are regulated by engineers at mission control thousands of kilometres away. New engineers need to be ready and able to join activities already in progress.

Any idea of "putting a rope around what we can control" was not the intent of those who gave PEO the mandate to regulate engineering. Past problems in getting our message across may not be a weakness in our actions but due rather to inconsistent terminology: Even our current strategic plan contains significant variations of interpretation. Forensics is not about reinventing the wheel but rather about making what we have work more efficiently.

At the same time, should we not ask ourselves why the Canadian Engineering Accreditation Board qualifies engineers who are unable to obtain licensure? Why, if PEO finds difficulty in motivating volunteers, did we limit the service of experienced engineers on advisory committees? Could Council time be better utilized reaching out to committees and other experts rather than spending it rescinding previous actions? Perhaps our governance review will recommend repairing the resources we have, rather than burdening members with additional costs. So, though I strongly support PEO as a regulator, I question if we are trapped, like John Frankenheimer's 1964 film *The Train*, on a continuous branch line.

Again, quoting Schwab on the power we possess to shape the Fourth Industrial Revolution and direct it towards a future that reflects humanity's common objectives and values: "To do this...we must develop a comprehensive and globally shared view of how technology is affecting our lives and reshaping our economic, social, cultural and human environments. There has never been a time of greater promise or one of greater potential peril."

To remain a guardian of public safety, we (PEO) need to both embrace the future and clearly promote our ability.

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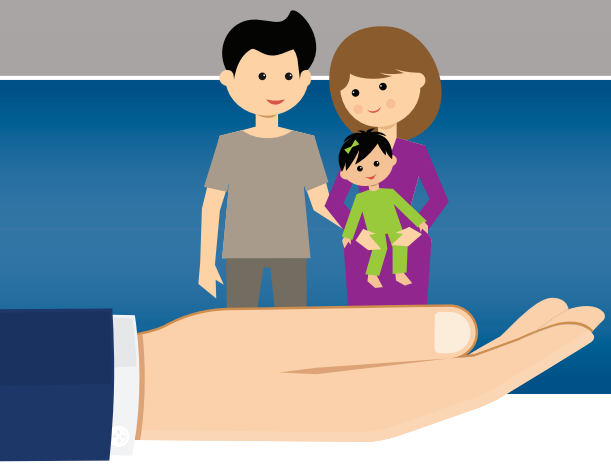

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