Special

Engineering in Canada

Visit globeandmail.com/engineeringincanada

The right stuff

Developing skills for specialized demands

Engineering schools, government and industry have to work together to ensure that programs are preparing graduates with the specialized skills that future careers will require, says Paul Acchione, acting CEO for the Ontario Society of Professional Engineers. ISTOCKPHOTO.COM

The broad disciplines from the past have given way for higher levels of specialization, says Adrian Chan, associate professor of engineering at Carleton University, but ultimately companies will need smart people who understand technology and can solve complex problems, the characteristics of the engineering profession.

Technology is now engrained in medicine, for example, making a technical engineering background more and more important, says Prof. Chan.

"Engineers are now expected to have an understanding of medicine, because we will be working with researchers, doctors, nurses and physiotherapists. Engineers work as a part of a trans-disciplinary team to help with the integration of devices or processes that will reduce the length of hospital stays and medication errors, improve monitoring and ultimately patient outcomes," he adds.

Given Canada's aging population, there will be a huge demand for engineers with biomedical specializations. Engineering schools must adapt to meet the skill gap, because in the future, their graduates will increasingly work in non-traditional engineering jobs.

"At Carleton over the last few years, we've introduced a number of new undergraduate and graduate level engineering programs, such as our biomedical and electrical, biomedical and mechanical, aerospace, sustainable and renewable energy, and architectural conservation engineering programs," Prof. Chan says.

The challenge is to educate and train the next generation of engineers to be better equipped with the right blend of technical, intellectual and management skills required to land a job and survive in the working world, says Paul Acchione, a professional engineer and both acting CEO and board past-chair for the Ontario Society of Professional Engineers (OSPE).

In 2012, according to Engineers Canada, more than 18,500 students completed undergraduate and graduate engineering degrees from 271 accredited engineering programs at 43 schools across Canada. So while there isn't a shortage of graduating engineers right now, engineering schools, government and industry have to work together to ensure that programs are preparing graduates with the specialized skills that future careers will require, Mr. Acchione says.

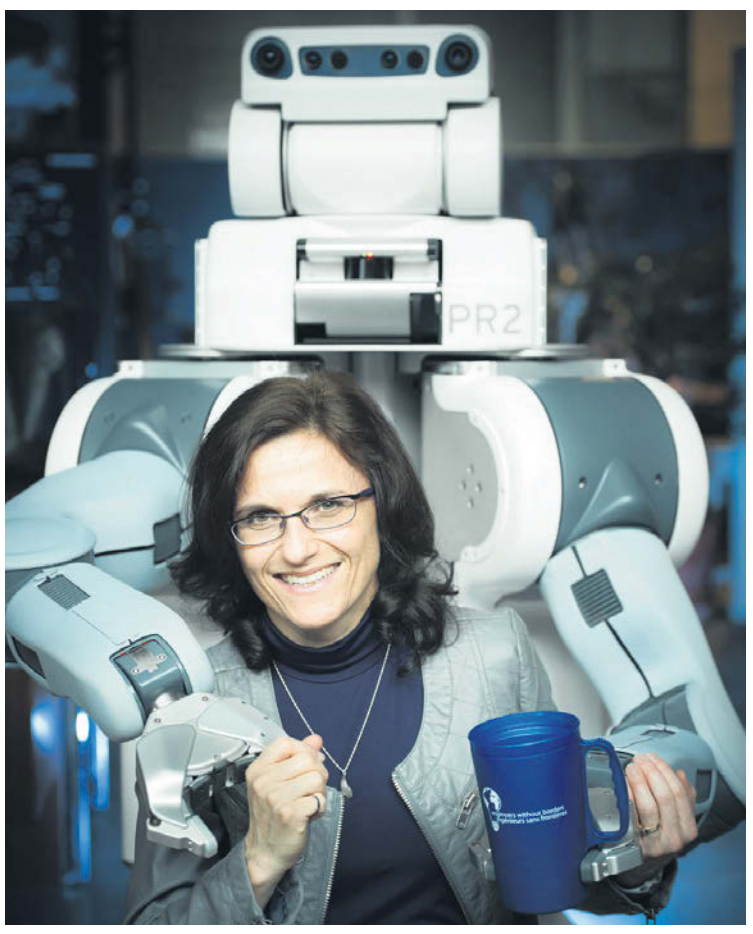
A 2014 OSPE report highlighted a current disconnect between what employers need and what engineering graduates are being prepared for. In fact, less than 30 per cent of engineers with a bachelor degree or higher were actually working as an engineer or engineering manager. Also, in 2013, Engineers Canada released its most recent labour market study predicting that more than 1,300 engineering positions will remain unfilled annually in Ontario. This will become increasingly important as an estimated 95,000 engineers will be retiring by 2020.

"Engineers work as a part of a trans-disciplinary team to help with the integration of devices or processes that will reduce the length of hospital stays and medication errors, improve monitoring and ultimately patient outcomes."

Adrian Chan
is associate professor of engineering at Carleton University

Mr. Acchione has observed two trends. "One is from academia itself, that is getting far more sophisticated and focused on speciality areas at universities, because the knowledge base is growing tremendously, so everything seems to require greater specialization to get sufficiently deep in the subject area to be useful," he explains. "The second trend is that employers are demanding much greater specialization before they'll hire people, so we are encouraging the various players to work together."

"Students who have been exposed to real life work experiences before they finish their degree, whether it is internships, co-ops or taking a year off school to get work experience, are much more successful finding an engineering job," Mr. Acchione says, adding that he has seen a growth in co-op programs, for example.



Elizabeth Croft, professor of mechanical engineering at UBC, has helped Charlie the robot deliver a cup of coffee without spilling. She believes that the focus on how engineering impacts people appeals to prospective female students. SUPPLIED

WOMEN IN ENGINEERING

Shifting the focus from technology to people

If you'd like your cup of coffee delivered by a robot, you'll be glad to know that professor Elizabeth Croft and her team are working diligently on making the handover go smoothly.

As the area of service robotics is growing, Elizabeth Croft, professor of mechanical engineering and associate dean of education and professional development at the University of British Columbia (UBC), is especially interested in the interactions between people and robots.

The focus on how engineering impacts people can be found in all aspects of the profession, and Prof. Croft believes this appeals to a diverse group of prospective engineers, including women.

Pondering the question whether robots should be designed for people or people should conform to robots, Prof. Croft leans toward the former approach. She uses analysis of human behaviour as a basis for defining the parameters of a robot's design.

"If a robot brings me coffee, I want the robot to hand me the cup in a way that I feel comfortable it's not going to end up in my lap," Prof. Croft says. To determine how to safely pass things back and forth, she and her team designed an instrument measuring human handover.

The rules for human handover are that the giver is responsible for the safety of the object, while the receiver is responsible for the timing of the transfer, Prof. Croft explains.

People-centric, Page EC 3

INSIDE

By the numbers

More than
18,500
students completed undergraduate and graduate engineering degrees in Canada in 2012.

18.1%
of total enrolment in university engineering programs in Canada are women in 2012.

11.3%
of professional engineers in Canada are women.

Less than
30%
of engineers with a bachelor degree or higher were actually working as an engineer or engineering manager.

More than
1,300
engineering positions will remain unfilled annually in Ontario.

16,000
new engineering jobs will be created due to investments in resource and infrastructure projects, between 2011 and 2020.

Sources: Engineers Canada and Ontario Society of Professional Engineers

This report was produced by RandallAnthony Communications Inc. (www.randallanthony.com) in conjunction with the advertising department of The Globe and Mail. Richard Deacon, National Business Development Manager, rdeacon@globeandmail.com.

ENGINEERING IN CANADA

By integrating renewable energy sources – like solar voltaic projects – into the strategy for electricity production, Canada can move closer to meeting its greenhouse gas emissions reduction target. SUPPLIED

ENERGY

Applying engineering skills to climate change challenge

Ours is a country that is famous for being cold. Yet Canada has actually been warming up over the last 66 years by 3.2° Celsius, according to Environment Canada – this 0.048° Celsius average per year is higher than most other regions in the world.

As governments and various organizations look at potential strategies to address the problem of global warming, the country's engineers – drawing from their in-depth understanding of energy systems – are playing a critical role in finding solutions.

"We have some very knowledgeable engineers in Canada, who are definitely prepared to address the issue of climate change," says Robert Evans, a professor emeritus of the University of British Columbia's faculty of engineering.

Today, the country's engineers are involved in a number of initiatives aimed at reducing Canada's greenhouse gas emissions. In 2009, after signing the United Nations' Framework Convention of Climate Change's Copenhagen Accord, the Canadian government set a greenhouse gas emissions reduction target of 17 per cent below 2005 levels by 2020.

There continues to be misunderstanding about the energy system as a whole. In particular, many people don't realize that there are only three primary sources of energy: fossil fuels, nuclear energy and renewable energy such as hydro, wind and solar.

Robert Evans
is a professor emeritus of the University of British Columbia's faculty of engineering

"About 80 per cent of greenhouse gases in Canada come from the burning of fossil fuels," explains Oskar Sigvaldason, a retired civil engineer who is leading the Trottier Energy Futures Project (TEFP), a partnership between the Montreal-based Trottier Family Foundation and two national organizations, the Canadian Academy of Engineering and the David Suzuki Foundation.

"This is a significant challenge that we need to address," says Dr. Sigvaldason, whose career includes many years of investment planning of energy projects around the world, as well as planning and development of environmental studies.

TEFP's 12-person team – a multidisciplinary group that includes engineers, environmental experts, economists, system analysts and technology specialists – is developing a blueprint for Canada to cut its energy-related greenhouse gas emissions by 80 per cent below 1990 levels by 2050. Achieving this goal will require major reductions in fossil fuel consumption and related emissions.

This means Canadians will need to live, work and operate businesses with greater energy efficiency, produce more electricity from low- or non-carbon sources, use more biofuels, and use electricity in more applications than they do today, including heating, personal transportation and certain industrial processes.

TEFP's goal is to present strategies that can help Canada reduce greenhouse gas emissions while continuing to grow its economy, and its report is scheduled for public release by end of 2014, says Dr. Sigvaldason, who is president and owner of SCMS Global, which provides advisory services for sustainable infrastructure development. He adds that decarbonizing the electricity supply system is one such strategy.

Canada already has a relatively low-carbon system. Hydroelectricity – produced by harnessing the power of moving water – makes up approximately 60 per cent of electricity supply in Canada, while nuclear power accounts for about 15 per cent. Non-hydro renewable sources, such as wind and solar, contribute about three per cent to Canada's electricity supply. Close to 15 per cent comes from fossil fuels, which include coal, natural gas and petroleum.

"Coal-producing plants produce a lot of CO_2," notes Dr. Sigvaldason. "There's impending legislation aimed at getting all conventional coal-fired plants shut down at the end of their economic life."

Prof. Evans, a mechanical engineer and part of the TEFP team, says there continues to be misunderstanding about the energy system as a whole. In particular, many people don't realize that there are only three primary sources of energy: fossil fuels, nuclear energy and renewable energy such as hydro, wind and solar. Knowing this can help Canadians make better decisions about their own energy use.

"Everything we do ultimately comes from one of those sources," says Prof. Evans, author of *Fueling Our Future: An Introduction to Sustainable Energy* (Cambridge University Press, 2007). "This is important to understand because when you look, for example, at something like a hydrogen-powered car, what people often miss is the fact that, although you don't get emissions from hydrogen, it has to be made from one of those primary sources, and there are emissions at source."

By the numbers

Canada's electricity supply comes from:

Approximately **60%** hydroelectric power

15% nuclear power

3% non-hydro renewable sources, such as wind and solar

Close to **15%** fossil fuels

Source: Canadian Electricity Association

CAREERS

The search for the 'global engineer'

Many leaders in Canada's engineering community believe foundational shifts in the profession and the problems it must solve are fuelling demand for a new breed of engineer.

In an increasingly connected global society, Canadian engineers operating around the world are called upon to do more than design and build structures or extract resources. They must consider the societal implications of projects and seek ways to strengthen economies and bring long-lasting benefits to people. Engineering has a growing need for "big-picture, systems thinkers," according to Sal Alajek, a portfolio manager with Engineers Without Borders Canada (EWB).

This new engineering paradigm is at the heart of the mandate of EWB, which is active in what it calls "systemic change initiatives" designed to alleviate poverty both in Canada and in Africa. Mr. Alajek points to a recent water and sanitation project in Malawi.

"We recognize our approach needs to be equally focused on engineering technology and on what is needed in the communities we are working in," he says. "A water system will ultimately fail if we don't also build policies and business models to support long-term maintenance and repairs." In this case, villages across Malawi are now operating the systems through their own organizations, without the support of EWB.

While the demand grows for engineers to address pressing and complex global issues from poverty to climate change, the supply is increasingly strained, due to declining numbers of engineering graduates. Mr. Alajek believes the profession is still too often trying to attract students with an outmoded portrayal of the engineer as a technical problem-solver only.

"I think other professions were much faster at defining in bold ways the impacts of their discipline on global challenges," he says. "Our role is changing, but we are still talking about the profession using old narratives. We can attract a broader range of young people by stressing the importance of system change and community as the larger context for addressing these challenges."

What is needed is a "global engineer," says Mr. Alajek. "This new breed is a holistic engineer who practises outside of silos and engages in public policy, and who looks at the planet's welfare and makes it paramount."

Visit globeandmail.com/engineeringincanada

Online assessment helps students determine suitability for engineering career

Breanna Borys is someone with firm ideas about the future.

Just finishing her third year of chemical engineering with a specialty in biomedical engineering at the University of Calgary's Schulich School of Engineering, Ms. Borys, 21, would like to work in the area of tissue and organ regeneration. An avid athlete, she especially wants to help young people recover from burns or injuries.

Back in high school, however, she was "really unsure" of her career path. Although she was a bright student who excelled in math and science, engineering wasn't in her plans. "I didn't want to work in the oil field and I didn't want to build bridges," she recalls her stereotypical views at the time, adding that the school's guidance office offered little help.

Her mother, a computer scientist, encouraged Ms. Borys to look into engineering nonetheless. When she started to do some research, the "cool options" for specializations such as biomedical engineering drew her to the field.

Career assessment tools add to sustainability of the profession by determining students' aptitude for engineering. ISTOCKPHOTO.COM

Now a career assessment tool being developed by Engineers Canada has confirmed Ms. Borys's aptitude for chemical engineering and biomedicine. She is among a group of students who are helping to test the CareerFocus powered by the Pathfinder Career System, an online assessment survey designed to help high school and first-year university students determine whether they are suited for engineering.

"We want to support the sustainability of the profession by seeing more people going into engineering, and ensuring that it's right for them," says Glenn Martin, acting practice lead for outreach at Engineers Canada, who is managing the project.

CareerFocus is available to students for a $75 fee. The assessment tool generates a report that predicts, with 90 per cent accuracy, their performance in engineering, based on a range of competencies and traits. Students then have the option of having a one-on-one consultation with a certified career counsellor, for an additional $100 fee.

"It's a way to help students and their parents know they are going in the right direction," says Ms. Martin, noting that CareerFocus is the only assessment tool that measures behavioural attributes rather than only interests or personality traits, which is important for engineering.

"Behavioural performance is a dominant factor in achieving success in a chosen career," explains Paul Frederick, a human resources consultant working on the CareerFocus program. He expects the assessment tool will help students and their parents get a true reading of their competencies in engineering. "There's a major need for it out there."

Engineers Canada is developing a second phase of the assessment tool for master's students. A third phase will target people already in the profession, for example, who might be considering new practice areas.

Ms. Borys says she's interested in taking those surveys when they are available. For now, she plans to get a master's degree and perhaps a PhD in chemical or biomedical engineering, and to eventually become a researcher and academic.

"I can't imagine being anything but an engineer," she adds.

FROM EC 1

People-centric: Profession benefits from diverse teams

"We had to make sure that the robot is perceived as being careful with the object, but willing to let go when the person has it," Prof Croft says. She studies "everyday interactions with robotic devices, aiming to have them do things that are intuitive and responsive." Rather than on technology, the focus is on its use for people.

Prof. Croft has noticed a difference in attitude when girls and boys visit her lab with their elementary and high school classes. "In my experience, girls are particularly interested in how engineered stuff works with people and whether it's something that makes their lives better," she says. "Boys tend to focus more on the coolness of the stuff itself."

Changing the story about engineering, Prof. Croft believes, can attract more female students into the field. This could advance UBC's goal to achieve gender parity in its engineering program, which currently has 22 per cent women enrolled.

In 2012, women made up 18.1 per cent of total enrolment in university engineering programs in Canada, according to Engineers Canada, and represented 11.3 per cent of professional engineers.

Diverse teams are smarter – they can draw on different backgrounds, strengths and capacities, Prof. Croft says, and most engineering projects, due to their sizes and complexities, are team efforts.

There is no question Prof. Croft's work is fascinating, but so are many aspects of a "great and diverse profession like engineering," she says. "Whether it's the water you drink, your cellphone or the power provided, every product you use has engineering behind it." Even the coffee you drink, whether it's been handed to you by a robot or not.

SUPPORT

Scholarships pave the way for advanced studies

More than three years into her job as a metallurgist for a mining company, Erin Bobicki decided to return to university for a doctoral degree in chemical engineering.

"I had my first child after my first semester back at school," says Ms. Bobicki, who is in the last year of her PhD studies, which started in 2010 at the University of Alberta's department of chemical and materials engineering in Edmonton. "With daycare, living expenses, books and tuition, it was a challenge."

A $12,500 scholarship eased that challenge for Ms. Bobicki and her family. In 2012, she was one of three recipients of the Engineers Canada – Manulife Financial scholarship, a national prize awarded to outstanding engineers who pursue advanced studies in engineering.

Ms. Bobicki, who has a degree in environmental engineering from the University of British Columbia and University of Northern British Columbia, has focused her doctoral research on a process that addresses climate change by permanently storing carbon dioxide in the mineral waste of mining companies. It was on the strength of this research that she applied for the Engineers Canada – Manulife Financial scholarship.

"I've always been passionate about the environment," says Ms. Bobicki. "Fortunately, the awards committee was looking for a sustainability-related project, and I guess they liked what they saw in my application."

Ms. Bobicki, who now has two children, says her scholarship win came as a surprise. "I didn't think I stood a chance, but I'm glad I applied," she says. "When you're already working and earning an income, it's hard to leave that environment to return to school. These scholarships are significant – it's a huge dollar value for a student, and it really helped me."

APPOINTMENT NOTICE

Paul Amyotte, FEC, P.Eng.

Engineers Canada is pleased to announce the election of Paul Amyotte, FEC, P.Eng., as its president for the 2014–2015 term. In the coming year, Dr. Amyotte and the Engineers Canada Board will support the organization's constituent associations to advance the engineering profession and its self-regulation in the public interest.

Dr. Amyotte lives in Dartmouth, Nova Scotia, with his wife, Peggy. They have four children: Jonathan, Matthew, Sarah and Lauren. He is a Professor of Chemical Engineering and the C.D. Howe Chair in Engineering at Dalhousie University in Halifax. He studied Chemical Engineering, obtaining his B.Eng. from the Royal Military College of Canada, his M.Sc. (Eng.) from Queen's University, and his PhD from the Technical University of Nova Scotia.

Dr. Amyotte's research and practice interests are in industrial safety and loss management, particularly in the areas of process safety and inherently safer design. He is an expert in the prevention and mitigation of dust explosions, and is the editor of the Journal of Loss Prevention in the Process Industries. Dr. Amyotte is the author of three books and has published or presented over 300 research and educational papers.

He is a member of Engineers Nova Scotia, was its president from 2008 to 2009, and was the recipient of the F.H. Sexton Gold Medal Award in 2012. He has represented the association on the Engineers Canada Board since 2010. He has been a member of the Engineers Canada Audit Committee, Finance Committee, Awards Committee and International Committee (Chair 2011–2012), and currently sits on the Executive Committee and Presidents' Group, and is a board representative on the Governance Committee, and the Government Relations and Public Affairs Committee.

Dr. Amyotte was a member of the Canadian Engineering Qualifications Board from 1995 to 2006 (Chair 2002–2004), and currently chairs the Canadian Engineering Qualifications Board Nominating Committee as a board representative. He was a member of the Canadian Engineering Accreditation Board from 2006 to 2010.

Dr. Amyotte is also a member and past-president of the Canadian Society for Chemical Engineering, and is a member of the American Institute of Chemical Engineers. He is co-chair of the Materials and Chemical Engineering Evaluation Group of the Natural Sciences and Engineering Research Council of Canada, and is a Fellow of the Chemical Institute of Canada, the Engineering Institute of Canada, Engineers Canada, and the Canadian Academy of Engineering.

engineerscanada ingénieurscanada

ENGINEERS CANADA AWARDS
PRIX D'INGÉNIEURS CANADA

Engineers Canada Awards 2014

Presented annually since 1972 to recognize outstanding Canadian engineers, teams of engineers, engineering projects and engineering students, the Engineers Canada Awards highlight engineering excellence, as well as the contributions of Canadian engineers to their profession, their community and to the safety and well-being of Canadians.

GOLD MEDAL AWARD
Michael V. Sefton, P.Eng., FRCS
PEO
Professor Michael Sefton of the University of Toronto was the first to recognize the importance of combining living cells with synthetic polymers to create 'artificial' organs and tissues, a field now known as tissue engineering. His work can be summarized in three words: original, significant and scholarly. His current groundbreaking research into the creation of modular tissue components seeks to create cardiac muscle to treat heart failure and pancreatic tissue for diabetes, among other possibilities.

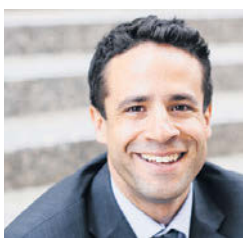
MEDAL FOR DISTINCTION IN ENGINEERING EDUCATION
Dr. Suzanne Kresta, P.Eng.
APEGA
Chemical engineering professor Suzanne Kresta teaches Mass and Energy Balances, Process Design, and Mixing at the University of Alberta. Her teaching interests include visual problem-solving tools, the use of storytelling and case studies, active learning and explicit use of cognitive levels with learning objectives. She is in constant pursuit of facilitating deeper learning in her students, and demands a transformative experience that provides for higher levels of cognition, confidence and security.

GOLD MEDAL STUDENT AWARD
Hanna Janossy
PEO (student member)
Fourth-year University of Toronto industrial engineering student Hanna Janossy has held leadership positions in several organizations, including the Bioengineering Association, Industrial Engineering Mentorship Group and Engineers Without Borders. She worked on the NEUWalk Project, researching ways of enabling paraplegics to walk again, and found a way to optimize the printing of tiny electrode arrays that are implanted into the spinal cord so the brain's electrical signal can jump over the problem area and directly reach the muscles.

NATIONAL AWARD FOR AN ENGINEERING PROJECT OR ACHIEVEMENT
Calgary West LRT Line Project Dave Weatherby, P.Eng.
APEGBC
The Calgary West LRT Line project is an extension of the existing Calgary C-Train system and is recognized as being one of North America's most successful light rail transit systems in terms of ridership and cost-effectiveness. The extension was the largest infrastructure project ever initiated by the City of Calgary, with approximately 100 professional engineers involved. The new LRT service has removed thousands of cars from the roads, and created new bike paths, pedestrian bridges and regional pathways.

MERITORIOUS SERVICE AWARD FOR PROFESSIONAL SERVICE
Claudio Arato, FEC, P.Eng.
APEGBC
A chemical engineer with nearly 20 years of field experience, Claudio Arato specializes in clean technology process development and technology commercialization in the fields of cellulosic ethanol, industrial and municipal water treatment and soil remediation. An active volunteer within the engineering profession and the Greater Vancouver community for more than 17 years, he also played a critical role in founding the Cascadia Prosperity Forum – a not-for-profit organization that co-ordinates high-profile networking events for young professionals in Vancouver.

MERITORIOUS SERVICE AWARD FOR COMMUNITY SERVICE
Timothy J. Cartmell, M.Eng., P.Eng., FEC
APEGA
Tim Cartmell is a leader in executive and project management in both structural and forensic engineering. He believes in building strong, healthy communities, and has contributed countless volunteer hours to support school, sporting and community organizations. Using his professional skill set, he played a major role in bringing the Terwillegar Community Centre to fruition. The $140-million multi-purpose recreation facility is the first new centre built in Edmonton in over 25 years.



YOUNG ENGINEERING ACHIEVEMENT AWARD
Michael Branch, P.Eng.
PEO
President and CEO of Inovex Inc., which develops web and mobile software applications with a focus on the healthcare, energy and environment sectors, Mike Branch has led the company in the development of innovative software engineering solutions. A University of Toronto graduate with a BASc in computer engineering, his contributions to providing risk assessment tools and developing solutions for Canadian municipalities to better manage their energy consumption exemplifies the core values of engineering.

AWARD FOR THE SUPPORT OF WOMEN IN THE ENGINEERING PROFESSION
Sarah Devereaux, FEC, P.Eng.
Engineers Nova Scotia
Past-President of Engineers Nova Scotia and partner of Dillon Consulting, Sarah Devereaux has had a successful career as a civil engineer specializing in waste management and water resources. A well-known champion for women in engineering, she served as a member of the Engineers Canada Women in Engineering Advisory Group and has been a leader and role model promoting the value that engineering brings to society and the importance of encouraging women to enter the field.

AWARD OF JOURNALISM EXCELLENCE IN ENGINEERING
Anita Lahey
Anita Lahey's award-winning article "Alumina Upended" was written for ACCN (L'Actualité chimique canadienne) the *Canadian Chemical News*, Canada's magazine for chemical professionals. An artfully composed story showcasing a game-changing chemical engineering innovation within Canadian industry, the article takes an obscure topic – the manufacturing of high-purity alumina, used in smartphones and LED lights – and makes it an enlightening and engrossing read for both the general reader and industrial expert.

engineerscanada ingénieurscanada

Engineers Canada gratefully acknowledges the sponsors of the 2014 Engineers Canada Awards:

Visit www.engineerscanada.ca to learn more about the program, recipients and eligibility criteria.

The Engineers Canada scholarship program

BUILDING ON ENGINEERING KNOWLEDGE
ENGINEERS CANADA NATIONAL SCHOLARSHIPS PROGRAM

Launched in 1973 with five $2,000 scholarships, the Engineers Canada scholarship program has grown to seven annual cash prizes totalling $70,000 awarded to Canadian professional engineers who are building on their engineering background by returning to school to pursue advanced academic studies.

Three Engineers Canada-Manulife Financial scholarships, valued at $12,500 each, provide financial assistance to engineers returning to university for further study or research in an engineering field.

Three Engineers Canada-TD Insurance Meloche Monnex scholarships, valued at $7,500 each, support further study or research in a field other than engineering that favours knowledge-enhancing performance in the engineering profession.

The Engineers Canada-TD Insurance Meloche Monnex Léopold Nadeau scholarship, valued at $10,000 and created in honour of the late Léopold Nadeau, past executive director of Engineers Canada, is awarded for further study or research in the area of public policy development.

The scholarships are presented at a ceremony in Ottawa each October.

For more information on the program and its eligibility criteria, visit *www.engineerscanada.ca/e/pr_awards_2.cfm.*