THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE

FALL / AUTOMNE 2014

BULLETIN

STUDENTS FROM THE UBC SUPERMILEAGE TEAM

Welcome to the new Bulletin

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We welcome submissions of events, announcements, job postings, and feature articles relevant to mechanical engineering from researchers and engineers in Canada.

Please send your input to
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COVER PHOTO BY ALEX TANG

Welcome to the *new* Bulletin

The CSME Bulletin has a new look and a new focus — to become the source for information on the Canadian ME community. The new Bulletin reflects the main goals of the CSME in that it will:

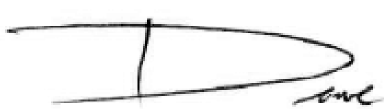
1. connect the Canadian ME community;
2. acknowledge outstanding achievements within the ME community;
3. promote ME research; and
4. leverage NSERC for increased support for ME research.

I am excited by the opportunity to contribute to these goals as Editor-in-Chief. I feel passionate that as the main voice of the CSME community, the Bulletin is a key linkage for the Canadian ME community. I bring to this position zero experience in running a publication, but much experience as a student, a graduate student (in Ontario and Quebec), and a professor (in British Columbia and now Ontario). I am committed to strengthening our community, and am dedicating my efforts over the next two years to shape and grow this publication.

The content of the new bulletin will be focused on news and people, the type of content that reaches a broad audience. In short, **WE WANT YOU, TO WANT TO READ IT.** The feature article in this issue is on the UBC Supermileage team's recent challenges and a reminder of the importance of safety in student teams. We will have short features on some of the most exciting and far-reaching Canadian research efforts across the discipline. These Research Highlights will be focused on the broad impact and the people, not the technical details. We will also feature new faculty profiles — an opportunity to introduce new members of our community. In this issue the new faculty focus is on Alberta. Another mainstay of the new Bulletin is Chair's Corner, a contribution in each issue from a past or present Canadian ME Department Chair. Following this Editorial page is the Op-Ed — a place for invited and submitted letters. In this kick-off issue, I'm delighted to feature perspectives from thought leaders in ME education. We're also working to include the critically important undergraduate perspective, graduate student perspective, and the views of Canadian ME alumni in industry and academia.

This issue includes Alumni-Q&A with 1998 graduate Sally Atalla, an Accenture executive. The new Bulletin brings together a talented and motivated team. Sigrun Wister is head of magazine design, page design and management of the website and printing. I'm already very indebted to Sigrun who is woefully overqualified for this publication! Her long c.v. includes design of *Chatelaine*, *MacLean's* and others. In the CSME head office, Louise McNamara and John Plant ensure we get the correct distribution of both printed and electronic copies. To feature the best and brightest Canadian ME Research Highlights, I've been fortunate to recruit the best and brightest technical editors – early career faculty that are great researchers and great communicators. The growing team includes Brendan MacDonald (Thermofluids – UOIT), Amy Bilton (Energy and Water – U. Toronto).

A hearty thanks to the outgoing CSME Bulletin Editor, Xiaodong Wang (U of A) and Technical Editor, Prof. Kamran Siddiqui (Western) for their many contributions over the years. Welcome all to the new CSME Bulletin!



DAVID SINTON
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Professor–Mechanical & Industrial Engineering
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TECHNICAL EDITOR,
AMY BILTON, U OF T

TECHNICAL EDITOR,
BRENDAN MACDONALD, UOIT

PRESIDENT'S MESSAGE

IT IS TRULY AN HONOR TO SERVE AS THE PRESIDENT OF THE CANADIAN Society for Mechanical Engineering (CSME) for the next two years. I would like to take this opportunity to thank the past President, Dr. Christine Wu for her outstanding leadership and contributions. She took CSME to different heights; more than ten events were supported by the CSME student affairs and many new members have joined CSME in the past couple of years. Importantly, for the first time ever, our International CSME Congress took place alongside the CFD Society of Canada at the University of Toronto with more than 400 participants from academia and industry. Many thanks to Drs. Jean Zu and Markus Bussmann for their endless effort to make it a very successful congress with the largest number of attendees.

As the incoming president of your society, I am looking forward to working with various stakeholders from academia and industry to build collaborative partnerships in order to better serve mechanical engineers across the country. By increasing the visibility of CSME and support of all members, we are aiming to increase the number of members from industry and extend our student chapters to include all of the sustaining member universities in the coming years. We are also looking forward to expanding our partnership with other engineering associations to further promote mechanical engineering in the next CSME Congress in Kelowna, British Columbia in 2016.

Finally, I would like to thank Drs. Xiaodong Wang and Kamran Siddiqui for their long time contributions and commitment to the CSME bulletin as editors, and welcome Dr. David Sinton as our new editor of the CSME bulletin. I wish him and his dynamic team all the best.

ALI DOLATABADI,
PhD, PEng, FCSME Professor Department of Mechanical and Industrial Engineering Concordia University

MESSAGE DU PRÉSIDENT

CE SERA UN HONNEUR QUE DE POUVOIR SERVIR EN TANT que président de la Société canadienne de génie mécanique (SCGM) pendant les deux prochaines années. Je voudrais profiter de cette occasion pour remercier la présidente sortante, Dr Christine Wu pour sa direction et sa contribution exceptionnelle. Pendant les deux années passées, elle a eu plus de dix événements soutenus par l'association des étudiants de la SCGM, en plus d'avoir augmenté le nombre de membres de la SCGM. Pour la première fois, notre Forum de la SCGM a eu lieu à l'Université de Toronto conjointement avec la société canadienne de CFD où nous avons eu plus de 400 participants provenant de l'industrie et des universités. Un gros merci à Dr Jean Zu et Dr Markus Bussman pour tout le travail qu'ils ont fait afin que le forum soit réussi avec un si grand nombre de participants.

À titre de nouveau président de la SCGM, j'attends avec impatience la chance de travailler avec tous les partis venant de l'industrie et du milieu universitaire afin de construire un partenariat de collaboration pour mieux servir les ingénieurs mécaniques à travers le pays. Dans les prochaines années, nous allons augmenter la visibilité de la SCGM et le soutien de nos membres afin d'augmenter le nombre de membres de l'industrie ainsi que de commencer des divisions d'étudiants à toutes les universités qui sont membres. Nous avons aussi hate d'élargir notre partenariat avec d'autres associations d'ingénieurs afin de promouvoir davantage l'ingénierie mécanique au prochain Forum de la SCGM à Kelowna, en Colombie-Britannique en 2016.

Je tiens aussi à remercier Dr Xiaodong Wang et Hl

rDr Kamran Siddiqui pour leurs contributions et engagement au bulletin SCGM en tant qu'éditeurs, et j'aimerais accueillir le Dr David Sinton, notre nouveau rédacteur en chef du bulletin SCGM. J'offre les meilleurs souhaits au Dr Sinton et à son équipe dynamique!

Je vous prie d'agréer mes salutations distinguées.

A former Chair's view: The NSERC Discovery Grants program

"There seems to be an assumption that, overall, we will get better value for our research dollars by putting more of them in fewer hands. This may be true for 'big science', but I am very skeptical that it is true for engineering."

DAVID WEAVER,
PhD, P Eng., FCSME, FEIC, FCAE, FASME
David is Professor Emeritus of mechanical engineering at McMaster University. He served 3 terms as Chair of ME at McMaster, 2 years as Chair of the NSERC ME GSC, was a member of the College of Reviewers of the Canada Research Chairs Program, and past President of CSME.

CHAIR IMAGE: ISTOCK

Congratulations to David Sinton for taking on the position as CSME Bulletin Editor and using the opportunity to give it a new look and a new role in exchanging ideas and stimulating discussion on issues which affect us all. While my 'Chairing' days are long behind me, my 'caring' days are not, so I am honoured to have been asked to start the ball rolling for this column. In these brief remarks, I will try to stimulate some thinking and hopefully some action regarding problems I see with the NSERC Discovery Grants program.

Traditionally, our NSERC Discovery Grants program has made Canada the envy of the international academic research community because these grants have provided a flexible and stable source of research funding with a long term vision. Given the chronic underfunding, the lack of designated funds to support first time applicants, and the pressure to reduce success rates, I wonder if that reputation can survive. The roots of the problems lie not only with government budgeting (it's too easy to blame it all on the government) but also, in my opinion, on NSERC policy regarding how its limited funds are spent.

Funding of First Time Applicants: There can be no question that new blood in academia is the essence of our future. Yet we seem to put numerous obstacles in the way of new faculty member's progress. One such obstacle is an abysmal success rate for first time NSERC applicants. NSERC has repeatedly stated that success in obtaining an NSERC Discovery Grant should not be taken as a performance indicator. Pretending that university tenure and promotion committees ignore this indicator is as absurd as the Holy Office condemning Galileo for insisting that the earth rotates around the sun. To be certain, a high level of quality must be demanded. However, I would argue that new faculty need to be better mentored and that a designated fund, which recognises growth and shrinkage in the different disciplines, be established by NSERC for first time applicants.

Underfunding of Mechanical Engineering: Over the past 40 years, mechanical engineering has shown a remarkable robustness through the ups and downs of the economy. This is the direct result of the relatively stable employment market for our undergraduate and graduate students. There have been tough economic times when mechanical and electrical engineering were virtually carrying the rest of the engineering disciplines. Then, even electrical engineering enrolments dropped with the burst of the IT bubble. Mechanical engineering departments were growing because of the student demand for positions while other engineering disciplines were having difficulty filling their seats. This created all kinds of pressure on resources, both physical plant, financial, and human. Clearly, the relatively strong market for our graduates was a reflection of significance of mechanical engineering to our economy. Yet these so-called 'discipline dynamics' seemed not to influence NSERC resource distribution. Thus, the success of mechanical engineering put further pressure on our mechanical engineering research budget. Mechanical engineering as a discipline needs to do a better job of lobbying both government and NSERC for our fair share of the research budget.

Reducing Discovery Grant Success Rates: There seems to be an assumption that, overall, we will get better value for our research dollars by putting more of them in fewer hands. This may be true for 'big science', but I am very sceptical that it is true for engineering. I would argue that engineers place more of their HQP in industry and that the best training of HQP is in a research intensive environment where the majority of faculty are engaged in advancing the frontiers of knowledge. This has enormous benefits

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UBC Supermileage team rebuilding after severe crash in transit

If the ability to manage through periods of adversity is any indicator of competitive mettle, the University of British Columbia's Supermileage Team is about to face its toughest challenge yet.

The student volunteer team, which enters high-tech, high-mileage vehicles in international fuel efficiency competitions across North America, has proven an overwhelming success story since its founding in 2001. Just this year, for example, the team placed third in the Shell Eco-Marathon Americas challenge in Houston, with mileage rankings for their aerodynamic urban concept car topping out at 325 mpg.

That's in addition to impressive performances by the team's futuristic gas-powered prototype car—designed solely for fuel efficiency and not driver comfort, unlike its urban concept cousin—which placed first in the competition from 2003 through 2006, and topping out at a whopping 3,145 mpg, before slipping to a still-respectable 1,383 mpg and a fifth-place ranking last year.

Team captain Katelyn Currie puts the UBC Supermileage team's past and present success down to a cultural focus on advancing sustainable transportation technologies above all else. "We want our cars and our technology to make a difference," the fourth-year UBC mechanical engineering student explains. "One of the reasons we've been so successful is because we're trying to make our cars as useful as possible in the real world."

Of course, their success is due to more than a collective can-do attitude.

IMAGES OF THE CAR BROKEN AFTER THE TRANSPORT TRUCK CARRYING THEM, ROLLED OVER.

As UBC Department of Mechanical Engineering professor and Supermileage team advisor Jon Mikkelsen explains, Currie and her teammates have incorporated weight-reducing innovations into their designs including carbon fibre body panels, aircraft-grade honeycomb chassis designs that deliver high strength-to-weight ratios, as well as custom fuel injection systems that deliver peak engine efficiency. That's in addition to a focus on minimizing the rolling resistance that can increase fuel consumption.

"Because the team divides themselves into groups to work on different tasks like chassis or body design, each one spends a lot of time focusing on aerodynamics and applying lessons they learn in courses like thermodynamics," Mikkelsen says of the Supermileage strategy for success. "There's a real dedication to improving a bit over last year's team, and because there's constant turnover, students can try new things all the time."

The team of about 60 students—some of whom spend up to 10 hours a day, five days a week working on the vehicles—have their work cut out for them if they're to replicate those heady results in the years ahead.

"There's a real dedication to improving a bit over last year's team, and because there's constant turnover, students can try new things all the time."

That's because tragedy struck on the return trip from this year's Shell Eco-Marathon Americas competition when the truck carrying both the prototype and urban concept cars rolled over and plunged down an embankment in Nevada while en route to Vancouver. There were no fatalities, although the truck's drivers were airlifted to hospital with non-life-threatening injuries.

The vehicles, on the other hand, were not recoverable. Both were destroyed, compromising years of work and more than $35,000 in materials. Highway crews were able to return only mere fragments of both vehicles.

It was a heartbreaking loss for the team, in part because their urban concept car had undergone a complete rebuild just two years earlier. "It was a freak accident that could have happened to anyone," Currie says.

Undeterred, UBC Supermileage is already drawing up plans to rebuild their cars from scratch.

Beyond the good fortune of there not being any fatalities stemming from the crash, Mikkelsen manages to find a silver lining in the devastating incident: "I feel the team's disappointment, but I also recognize that there's an opportunity for new students to learn the skills of building a complete vehicle. It's early days, but I think that opportunity might lead to some interesting innovations that may have been limited in past years because they already had their vehicles."

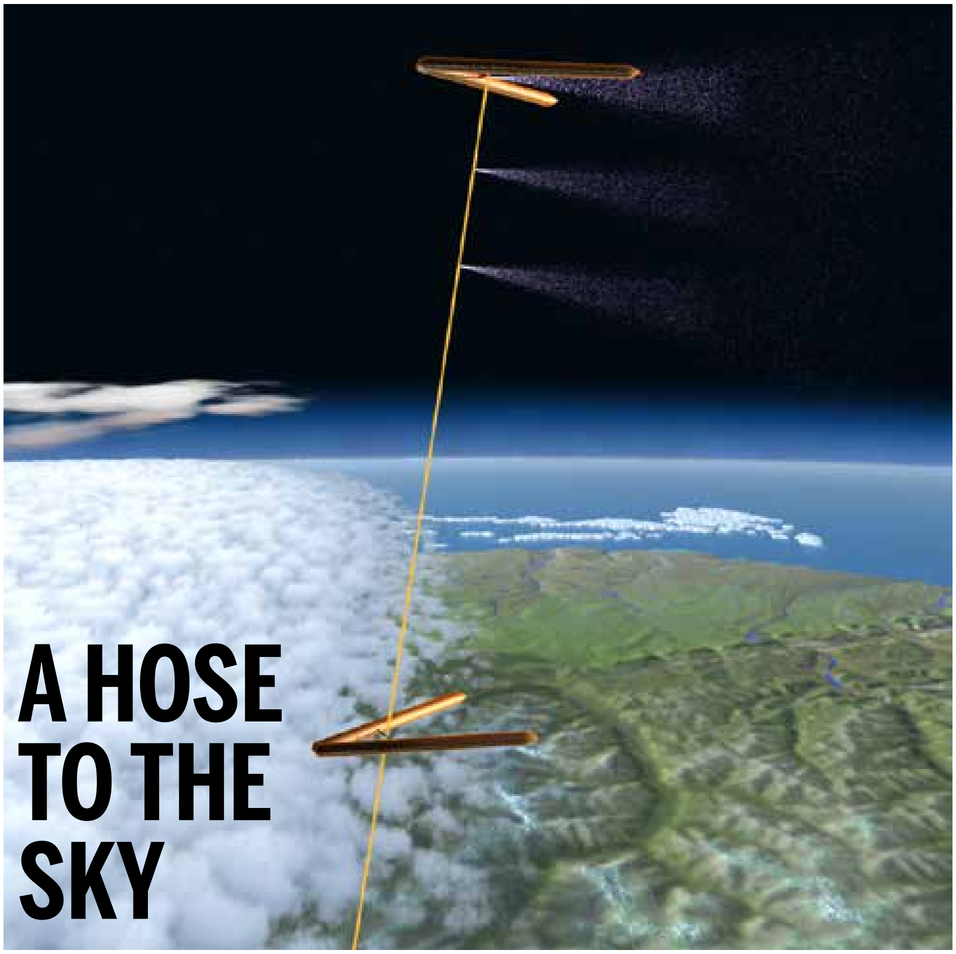
Currie, who will lead the team until early 2015, laments that tough breaks are the nature of this sort of competition. No matter how much a team prepares, unknown or unpredictable factors can sometimes prove disastrous. Her advice to other teams is simple: focus on what can be controlled and avoid unnecessary risks at all costs.

"They need to work on logistics and schedule in advance around people's school schedules to get the project done," she says. "But one of the most important factors is just being conservative." —*Chris Atchison*

PLEASE TURN TO PAGE 19 FOR

SAFETY AND STUDENT TEAMS:
Three common-sense tips for student and faculty.

HIGHLIGHTS



A HOSE TO THE SKY

A hose to the sky is a concept that has received some attention recently as a possible method of controlling the Earth's climate. Such a system would enable the pumping of materials into the atmosphere.

Frédérick Gosselin from École Polytechnique de Montréal and Michael Païdoussis from McGill University investigated the technical feasibility of a hose to the sky by analyzing the stability of a hose that is vertically supported by aerostats (or balloons). The focus of their analysis was on the effect of the internal flow on the hose system. They found that the nozzle discharge at the tip of the hose is critical since an atomizer at the tip that discharges the flow radially can eliminate instability by buckling. With a straight discharge of the flow at the tip of the hose, the hose can lose stability by buckling; however this instability can be avoided by having a sufficient minimum tension throughout the length of the hose. They showed that Coriolis damping can be significant and can be increased through appropriate selection of the number of aerostats and flow velocity. Designing a hose to the sky to maximize Coriolis damping would provide passive damping of its motion.

Further work would involve an investigation into the role of external forces, such as strong winds, and consider the effect of both external and internal flows on the stresses experienced by the hose. —*Technical Editor, Brendan MacDonald*

F. P. GOSSELIN AND M. P. PAÏDOUSSIS, DYNAMICAL STABILITY ANALYSIS OF A HOSE TO THE SKY, JOURNAL OF FLUIDS AND STRUCTURES, 2014, 44, 226-234.

HOSE TO THE SKY IMAGE: DAVID FIERSTEIN / INTELLECTUAL VENTURES

PICTURED: STUDENTS MARTIN COTE, ALEX GORDON, QUEENIE YUAN AND JESSICA TOMASI

Engineering the perfect knuckleball

Have you ever wondered whether a knuckleball pitch – the most difficult ball for players to hit – could be perfectly repeated? Three Toronto students set out to answer this question with a unique capstone design project.

Typically grasped by the finger nails and raised knuckles, the knuckleball isn't thrown by many major league players; the Toronto Blue Jays' Cy Young Award-winning pitcher R.A. Dickey is among the few. A perfect knuckleball can take years to master.

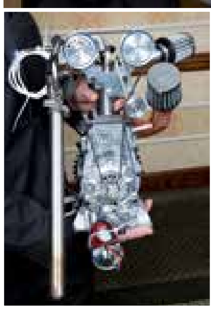
Mystery has always surrounded the pitch. Generating truly repeatable and controllable motion from the knuckleball, mechanically, would make history. Generating truly repeatable and controllable motion from the knuckleball, mechanically, would make history.

Students Martin Cote (MechE 1T3 + PEY), Alex Gordon (MechE 1T3 + PEY), Jessica Tomasi (MechE 1T3 + PEY) and Queenie Yuan (MechE 1T3 + PEY) set out to design a knuckleball-pitching machine for their capstone design project, and continued with the research after graduation.

Building their prototype with PVC tubes, motors, an actuator, sensors and a used pitching machine, the team used slow-motion cameras and radar guns to test the ball's orientation, spin, speed and flight path. They also took particular note of the ball's seam positioning. The team developed their machine in-house using the department's fabrication lab.

While the machine successfully throws breaking and wobbling knuckleballs, they're still striving for a perfect, repeatable, knuckleball. They also began testing with official Major League baseballs.

Students develop engine for 2700 MPG



The most recent Shell Eco-marathon America's competition was a showcase for Canadian ME student team talent. First prize went to Laval University with over 2800 MPG, with the runner-up team from University of Toronto with just over 2700 MPG. To put these numbers in context, this is equivalent to driving from Vancouver to Halifax using under 1.4 G (5.3L). While the vehicles, as pictured in the previous issue of the bulletin, are extremely minimalistic as compared to current vehicles, all Canadian teams deserve recognition for their impressive performance. The Toronto group also took home two awards, the Technical Innovation Award and the Pennzoil Tribology Award – both for their innovative new engine which was designed and machined from scratch. Pictured here is the engine with Award winning team, Ryan Billinger (George Brown College), Jonathan Hamway (Toronto), and Nikita Singarayar (Toronto).

ENGINE STORY PHOTO BY JACLYN ATLAS

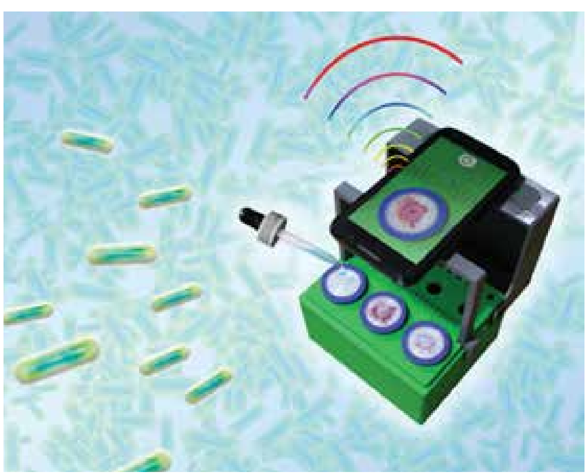
WALKING ENERGY

Waterloo team develops human energy harvesters for more power at walking frequencies

Mir Behrad Khamesee and Pratik Patel at the University of Waterloo have developed a micro electromagnetic energy harvester which is tailored to harness energy from human movement. This system improves on previous energy harvesters for this application by generating more power at the low frequencies experienced during human motion (0-35 Hz) while maintaining a small size. The system is composed of permanent magnets, copper coils, and functions using Faraday's law of induction to convert vibrational energy into electrical energy at low frequencies. This research explored the different system configurations to maximize the energy production for the desired low frequency range. The resulting harvester was capable of producing up to 38 mW of power. Since the submission of this paper, the research team has filed a provisional patent on an improved device, called the "3D harvester". —*Technical Editor, Amy Bilton*

DEVELOPED MICRO ELECTROMAGNETIC ENERGY HARVESTER NEXT TO A PEN FOR SCALE.

PATEL, P., AND KHAMESEE, M. B, MICROSYSTEM TECHNOLOGIES, VOL. 19, PP. 1357-1363, 2013.



SMARTPHONE BASED TEST PLATFORM FOR TOTAL COLIFORM AND E. COLI BACTERIA IN WATER

The Mobile Water Kit

Could smartphones help bring clean drinking water to remote locations?

A team lead by Sushanta Mitra at the University of Alberta, in collaboration with Tata Consultancy Services (TCS) and Bhavans Research Center in India, has developed a simple, low-cost test kit to detect total coliform and E. coli bacteria in water samples. This platform has the potential to provide an early warning system for water-borne diseases in remote locations. The system, called the Mobile Water Kit (MWK), concentrates the water samples before addition of custom chemical regents which act as fluorometric or colorimetric chemosensors. A smartphone with a custom application then photographs the samples and analyzes the images to detect the presence or absence of total coliform and E. coli. The test results, along with GPS locations, can also be uploaded by the smartphone to central monitoring agencies. In field trials, the system was able to detect total coliform and E. coli in 30 minutes or less, much reduced from the 24-48 hours typically required. Mitra and his team have successfully tested the MWK in remote locations in Seattle King County, USA and Mumbai, Chennai, and Bangalore in India. The research team plans to perform more such field trials in limited resource communities and also in Canada's North, thereby empowering people with their choice for safe and secure drinking water. —*Technical Editor, Amy Bilton*

KUMAR GUNDA, N. G., NAICKER, S., SHINDE, S., KIMBAHUNE, S., SHRIVASTAVA, S., MITRA, S., ANALYTICAL METHODS, VOL. 6, PP. 6236 – 6246, 2014 (COVER ARTICLE).

Q&A:

Sally Atalla,1998 ME graduate

1998 ME graduate Sally Atalla talks to the Editor about her unique career path, and provides her perspective on her ME education.

You were a fresh ME graduate in 1998. Then what happened?!
When I graduated, I wanted to help create something innovative or challenge the integrity of something. In the case of engineering, this meant designing or stress testing something to total destruction. Seemed like fun but there were not job opportunities in these areas. Surprised that Management Consulting was an option for engineering graduates, I decided to give it a try. I never really liked having to choose one thing because I have too many interests. Even when choosing a discipline in engineering, I decided on Mechanical, since I saw people here as the closest thing to the "Renaissance Engineer" (knowledgeable, educated, or proficient in a wide range of topics). I worked across various industries and was told I had to "specialize", so I moved into something socially oriented. I chose healthcare, thinking as a tax payer and recipient of services, as these services help people, and where these services could use some improvements. While in this group I took a temporary assignment overseas in a program we had for consulting in international development. I spent 6 months in South Africa, Kenya and Tanzania doing feasibility study expansion work for a non-profit that serves entrepreneurs. I was then asked to go to Switzerland to help a global donor in public health, which lasted for about 2 years. At this point, I made the move to be part of this global team, where several of us run this program for others and I still participate on projects at the same time. Since then, I've been privileged to work in Haiti post-earthquake emergency recovery and in headquarters locations for international non-government organizations (iNGOs) in the US.

ME graduates pursue a remarkable variety of careers. What elements of ME education or your engineering undergraduate experience do you apply in your current work?
The company wanted me to help in technology and process work, since I was coming from an engineering background, but I gradually moved into roles I was more suited to as liaison between technical and business people, project management and change management. Problem solving is the most useful thing I use. This is applied to anything from small day to day issues to big and complex programs. We are trained well to break things down into small parts and put them back together again. Also, the whole cycle of analyzing, gathering requirements, designing, building, testing and demonstrating applies very much to what we do. All of the team projects or labs that we do are relevant because we learn to brainstorm, hypothesize different scenarios, and learn to work with others.

You were very active in the Engineering Society. How were you involved and how did those involvements shape you and your career?
Extracurricular involvement was pretty important in getting and keeping the job. The person who interviewed me asked specifically if I was a volunteer, elected or appointed for nearly every position on my CV. From Committee Leads to Engineering Society President, I learned how to organize events and speak to a range of audiences, which applies to every meeting or trip I take. From music activities in stage, spirit, and musical theatre bands, I developed in quality, creativity and a light approach, which I try to apply to most of my projects. Overall, all activities involved with people from many cultural backgrounds and interests that I appreciate and look for in the people that I work with today.

Any advice for students who want to leverage their hard-earned ME education, while at the same time pursue a non-traditional career path?
The atypical career path is now the norm.
I would say
(1) Be flexible, open-minded and follow your gut. There are a so many options and path changes within or outside of the discipline to be considered.
(2) Be persistent and keep talking to people that are both practical (not conservative) and encourage you. Many people told me not to make changes at certain points in my career or didn't understand the changes I was making.
(*3) Be willing to get scared.* A job opportunity can be exciting, but something a little scarier is more likely to teach you something.

...continued on page 19

SALLY ATALLA *is an executive at Accenture in the international development sector and has worked in management consulting for 16 years. She is interested in any work with a social slant. Sally was an active participant of the engineering society, serving as member of Stage Band, music performer of annual musical/comedy revue, Professional Development Committee Lead, Student Activity Council Liaison Lead, and Engineering Society President. She graduated from University of Toronto in 1998.*

OPINION

Is a four-year program sufficient for engineering education?

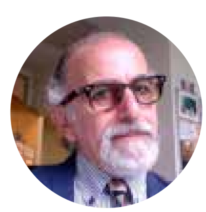
Engineering is one of the few regulated professions that one can enter into after a four-year post secondary education. Most regulated professions require a substantially longer formal study. For example, architecture, dentistry, physiotherapy, occupational therapy and speech pathology require a minimum of six years, medicine, optometry and law require seven years and psychology requires nine years. Based on these numbers, one would be inclined to presume that engineering education, and by extension the profession itself, are less complex and demanding than all those others. However, this is probably not the case. According to the Canadian Engineering Accreditation Board requirements, the attributes an engineering graduate must possess demand an impressive depth and breadth in a broad range of technical and non-technical areas. The expectations of employers from new graduates are equally extensive and demanding. These demands and expectations are certainly not unrealistic or excessive considering the ever-expanding body of engineering knowledge in every discipline of engineering coupled with the ever-increasing complexity of the engineering environment where engineers must perform in multi-disciplinary, and often multi-national, teams under stringent safety, environmental, economic, legal and social constraints.

The accreditation criteria of CEAB lists twelve required graduate attributes, each one more demanding than the other. To put into perspective the magnitude of the demands on the graduate, consider attribute 3.1.4 which requires a graduate to have "an ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations", attribute 3.1.5 which requires "an ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations" and attribute 3.1.9 which demands "an ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship".

The adequacy of engineering education must be viewed and assessed within this context of requirements and expectations. For decades the length of engineering education has been unchanged at four years while the requirements and expectations have expanded substantially. To be able to "squeeze" the delivery, and hopefully the absorption, of the requirements into a four-year (to be more exact, an eight twelve-week) program, engineering faculties created extremely dense programs and removed all un-prescribed content. This strategy resulted in two undesirable consequences: a clear disconnect between what can realistically be expected from students to absorb within a four-year program and what the program is supposed to deliver, and engineering students being exposed only to engineering type courses, isolated from the rest of the student body with little opportunity to rub shoulders with non-engineering types who they will have to work with for the rest of their careers.

"Most regulated professions require a substantially longer formal study."

Engineering is a complex and expanding discipline, the education for which requires no less rigour than that for physiotherapy or architecture. Engineering educators must stop pretending that all is well with the four-year engineering education and begin working collectively to add one or two additional years to engineering programs to reflect the demands of the profession and to serve the best interests of the society.



V. ISMET UGURSAL,
FCSME
Professor of Mechanical Engineering
Dalhousie University
Halifax

OPINION

Mechanical engineering education is ready for change

In the past decade the world of engineering education has been rapidly changing; partly in response to improvements in instructional technology and partly in response to research in engineering education. In fact, as a discipline, engineering education has emerged as a leader in professional education research second only to medicine. Like all good engineering, this field has drawn on the work done in other areas, such as higher education, and has produced our own research and innovations. As a result engineering education is changing rapidly as instructors apply an engineering design approach to their classroom experiences to create effective learning experiences for their students.

Mechanical Engineering is an ideal environment for innovation, and much of the change that is occurring is happening here. Faculty in Mechanical have long incorporated design projects, active laboratories and other active, collaborative teaching methods. I would postulate that Mechanical Engineering education will be transformed over the next decade as more instructors incorporate innovative teaching methods into their course design. In my opinion, the top 6 methods and approaches that will be important contributors to that change will be:

❶ **ACTIVE, COLLABORATIVE LEARNING METHODS WILL CONTINUE TO GROW:** Methods of this type have always been important in ME, but will expand. The research evidence supporting these methods is now overwhelmingly clear, which will support this expansion.

❷ **INVERTED AND BLENDED CLASSES:** Part of the expansion of active, collaborative methods will be due to the rise of inverted and blended classrooms. More lectures will be delivered asynchronously through online systems with brief, in-line assessments. Classroom time will increasingly be used to facilitate engaged problem solving activities.

❸ **COMPETENCY BASED EDUCATION:** The pressure from multiple stakeholders will begin to transform the way we measure and report on student learning. This impetus is already coming from our Accreditation Board, and is starting to be picked-up by industry and government. In addition to a transcript that reports on knowledge base (e.g. a 84% in Fluid Mechanics), we will see a move toward competency reporting on abilities such as communication, problem solving, and teamwork.

❹ **ENDEMIC USE OF INSTRUCTIONAL TECHNOLOGY:** Improvements in instructional technology are being adopted into ME education rapidly. The range of systems available for improving assessment, classroom interaction, and out of class communication are evolving so fast it is difficult to keep up with the technology innovations available. However, as instructional technology begins to coalesce around key features and attributes, instructors will find systems that enhance their teaching and move to incorporate these into their teaching practices.

❺ **AUTHENTIC ASSESSMENT PRACTICES:** Test-taking has always been a proxy for measuring the competency of a student in a particular area. Medical education has been implementing more authentic assessment methods for more than a decade now, and we can expect to see this moving into the realm of engineering education. In ME, this will include observing student performance on design teams, and using computerized exams so students are able to use packages (e.g. CAD) to demonstrate their abilities.

❻ **INTER-PROFESSIONAL EDUCATION:** Now a staple of medical education, inter-professional education (IPE) is still a novelty in Engineering. Design courses in ME are ideal candidates for IPE applications. We will see a growing number of experiments in IPE particularly in design courses, as this approach gains traction in engineering.

SUSAN McCAHAN
FAAAS Professor,
Vice Dean, Undergraduate
University of Toronto

Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

Assistant/Associate Professor — Smart Cities

The Department of Mechanical & Industrial Engineering at the University of Toronto is home to the top mechanical and industrial engineering programs in Canada. We foster a world-class environment that excels in teaching, learning and research for our undergraduate and graduate programs. The department currently invites applications for a tenure-stream appointment in the area of smart cities. The appointment will be at the rank of Assistant or Associate Professor, and will begin on July 1, 2015 or shortly thereafter.

The successful candidate should have research expertise in one or more areas related to the computational study of cities, such as Information Architectures, Ontologies, Privacy & Security, Big Data Management, Data Analytics, and Information Visualization and Interfaces. Nevertheless, a research focus on any area of urban informatics is welcome. It is expected that the successful candidate will develop collaborative research linkages with departmental members in areas of information engineering, data analytics, and/or visualization. Applicants must have a doctoral degree in engineering, computer science, or a related discipline, an outstanding academic and research record including refereed publications and effective teaching ability. It is preferred that the candidates have an undergraduate degree in engineering and are eligible for registration as a Professional Engineer.

Duties will include undergraduate and graduate teaching, research, and departmental service. Evidence of excellence in teaching and research is required. Salary is commensurate with qualifications and experience.

All qualified candidates are invited to apply by clicking on the link below. Applications should include a cover letter, curriculum vitae, teaching dossier (including a statement of teaching philosophy), and a statement outlining current and future research interests.

If you have questions about this position, please contact **chair@mie.utoronto.ca** .
All application materials should be submitted online.

Submission guidelines can be found at: **http://uoft.me/how-to-apply.**
We recommend combining attached documents into one or two files in PDF/MS Word format.

Applicants should also have three referees to send letters directly to the department via e-mail to **chair@mie.utoronto.ca** by the closing date, November 30, 2014.

For more information on the University of Toronto, and the Department of Mechanical & Industrial Engineering, please visit our website: **http://www.mie.utoronto.ca**

Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

Assistant/Associate-Operations Research

The Department of Mechanical and Industrial Engineering at the University of Toronto invites applications for one tenure-stream faculty position in the area of Operations Research at the rank of Assistant or Associate Professor starting July 1, 2015 or shortly thereafter.

Candidates must have a doctorate degree in operations research, industrial engineering, or a related discipline by date of appointment or shortly thereafter.

Established in 1827, the University of Toronto is Canada's largest university, recognized as a global leader in research and teaching. U of T's distinguished faculty, institutional record of groundbreaking scholarship and wealth of innovative academic opportunities continually attract outstanding students and academics from around the world. The Department of Mechanical & Industrial Engineering at the University of Toronto is home to the top mechanical and industrial engineering programs in Canada. We foster a world-class environment that excels in teaching, learning and research for our undergraduate and graduate programs.

The successful candidate should have research expertise in one or more methodological areas as well as in key application domains related to operations research. An emphasis will be placed on the potential to strengthen the capacity of research and teaching of the existing faculty members in the area of operations research within the program. The successful candidate must have an outstanding academic and research record including refereed publications, and effective teaching ability.

It is preferred that the candidates have a undergraduate degree in engineering and are eligible for registration as a Professional Engineer.

Duties will include undergraduate and graduate teaching, research, and departmental service. Evidence of excellence in teaching and research are required. Salary is commensurate with qualifications and experience.

All qualified candidates are invited to apply by clicking on the link below. Applications should include a cover letter, curriculum vitae, teaching dossier (including a statement of teaching philosophy), and a statement outlining current and future research interests. If you have questions about this position, please contact **chair@mie.utoronto.ca** . All application materials should be submitted online.

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CSME
NATIONAL DESIGN COMPETITION 2015

The 2015 CSME National Design Competition challenges students from universities and technical colleges from across Canada to design and build a 3D printer. This competition is intended to provide mechanical and multi-disciplinary engineering undergraduate university and technical college students in Canada an opportunity to engineer, build and assemble their designs from basic components readily available in the market with a fixed budget.

Eight semi-final design projects will be selected and invited to 2015 Canadian Congress of Applied Mechanics (CANCAM). Three students from each selected design package team will be invited to present their design and business case to a panel of judges at this conference.

The CSME National Design Competition is open to all engineering undergraduate or technical college students in Canada. All students must be enrolled as undergraduate engineering degree or diploma programs in Canada at any time during the present academic year. All competitors agree to abide by the Engineering Code of Ethics.

The competition is open to individual students or groups of up to ten students. Each project is required to be authorized by a faculty advisor from the corresponding academic institution. Each engineering institution may only be represented by 1 team. In situations where multiple teams from an institution are organized, a committee of qualified judges from that institution will select and nominate one design team to represent the institution.

Teams will submit a package consisting of: a technical report that highlights the technical and engineering aspects, a business report that highlights the financial and marketing aspects, a 3D printed prototype part and a promotional video clip.

ALL SUBMITTED PACKAGES MUST MEET THE FOLLOWING DESIGN CRITERIA:

1. Final product must be able to produce (print) a solid object in 3 dimensions
2. Printer must have a build envelope of at least 7cm X 7cm X 7cm
3. Print material must be durable enough to handle without warping or breaking
4. Final product must be able to accept a solid model supplied in the .STL format
5. Once the print process has started, there can be no user interaction
6. Total component and material cost must not exceed $300 CAD. Machining cost need not be applied to this budget
7. There may be no alteration of the prototype part after printing
8. No team shall purchase or modify an existing 3D printer for submission. Certain base components may be purchased (e.g. extruder head, motor controller) but innovative designs are encouraged

The teams' design packages will be evaluated on five categories:
Overall design package, technical innovation, printed prototype quality, business case proposal, and communication and presentation.

Prizes for the finalists as selected at the CANCAM conference are as follows:

- ✷ **BEST OVERALL DESIGN PACKAGE:** $2000 to the team and one year of CSME membership for faculty advisor
- ✷ **BEST TECHNICAL MERIT:** $1000 to the team and one year of CSME membership for faculty advisor
- ✷ **BEST BUSINESS PLAN PROPOSITION:** $1000 to the team and one year of CSME membership for faculty advisor
- ✷ **BEST VIDEO CLIP:** $500 to the team and one year of CSME membership for faculty advisor

Educational Institutions must register their team by **November 30th, 2014.**
The design package must be submitted for committee review by **April 30th, 2015**.
Semi-finalists will be announced on **May 31st, 2015.**

For more information, visit:
www.csme-scgm.ca/content/csme-ndc15

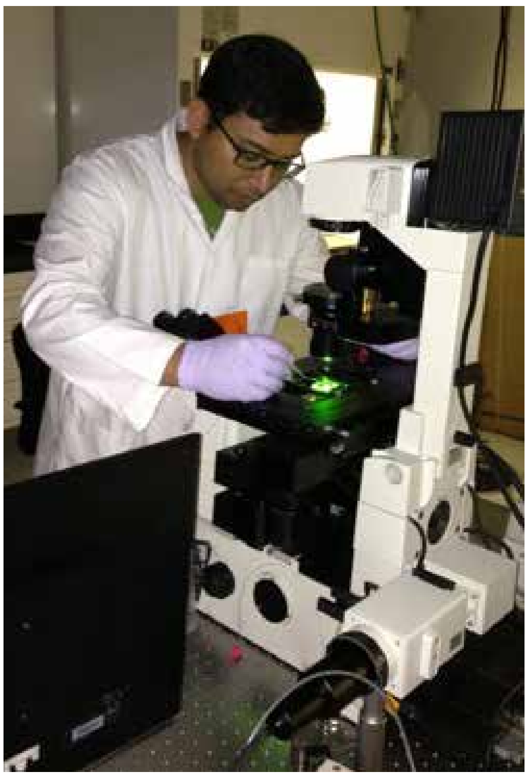
NEW FACULTY SPOTLIGHT SERIES:

FOCUS ON ALBERTA

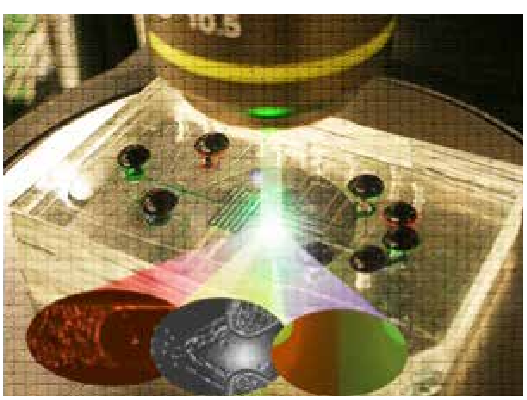
This recurring series will highlight new Canadian ME faculty members, by region. We kick-off the series with two bright young additions, Dr. Aloke Kumar of U of A, and Dr. Philip Egberts of U of C. Both share a passion for small-tech and are taking the discipline in exciting directions.

New University of Alberta Professor, **Aloke Kumar**

Bacterial biofilms in health, energy and the environment



DR. KUMAR IN HIS BIOMICROFLUIDICS LAB (ABOVE) AND SOME EXAMPLES OF HIS BIOMICROFLUIDIC APPLICATIONS (BELOW)



Bacteria are one of the most ancient forms of life on this planet. They are microscopic unicellular organisms, and they lead very interesting lifestyles. Bacteria can lead solitary lives, where they live as separate entities or they can live in bacterial colonies or communities. When bacteria form communities, they form very thin films on surfaces known as biofilms. Why do bacteria form colonies? As the age-old saying goes, there is strength in unity. Bacterial colonies can exhibit amazing resistance to external stresses such as antibiotic treatment and/or mechanical shear. Thus, the biofilm state of bacterial living provides bacterial cells a very sheltered environment.

But how do bacterial biofilms affect humans? Well, biofilms of pathogenic bacteria can be a significant health hazard, since they are difficult to treat with antibiotics. Artificial implants are especially susceptible to biofilm colonization, and such implant-based biofilms of pathogenic bacteria can lead to acute infections. In fact, biofilm related infections represent one of the significant burdens on our healthcare system. However, 'good' bacteria too form biofilms. Biofilms of 'good' bacteria, take part in many important activities including bioremediation, bioenergy generation and also environmental processes such as various cycles.

In the context of biofilms, there are several open-ended questions. Specifically, the role of the external environment in dictating biofilm development remains largely unknown. Questions such as what happens when you have biofilm development in a system with fluid flow versus a system without fluid flow need to be answered before we can develop technologies that can effectively regulate biofilm development.

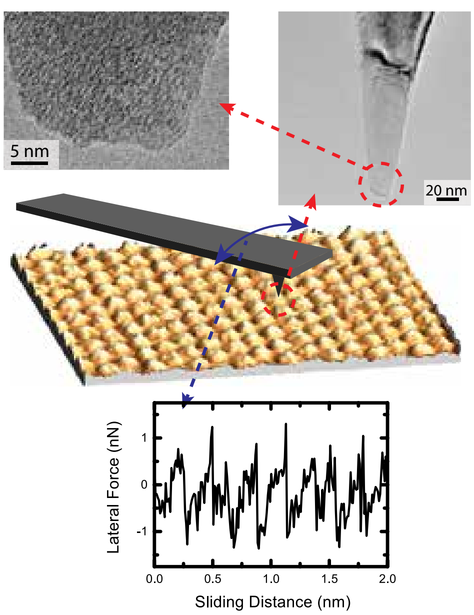
In the Kumar Biomicrofluidics Lab, Dr. Kumar and his students, use engineering and physics based tools to investigate the effect of the external environment on bacterial biofilms. By using nanotechnology, the group makes lab-on-chip devices. Lab-on-chip devices are miniaturized platforms, which integrate various laboratory scale processes on one device. These devices allow Dr. Kumar to modulate various environmental factors with very high precision and simultaneously study the response of bacteria to these conditions. Dr. Kumar focuses on these fundamental questions in order to develop technologies that can benefit health, energy and environmental research.

DR. ALOKE KUMAR *received his Bachelors and Masters degrees from the Indian Institute of Technology, Kharagpur, India in 2005 and his Ph.D in Mechanical Engineering from Purdue University, West Lafayette, USA in 2010. Dr. Kumar is currently the Canada Research Chair in Microfluidics for Biological Systems at the Department of Mechanical Engineering at University of Alberta. He is also the editorial board member of the Journal of Biosensors and Bioelectronics.*

New University of Calgary Professor, **Philip Egberts**

Understanding friction at the atomic scale

DR. EGBERTS IN HIS LAB (ABOVE) AND SOME EXAMPLES OF HIS ATOMIC SCALE FORCE MEASUREMENTS (BELOW).



PHILIP EGBERTS *is an Assistant Professor in the Department of Mechanical and Manufacturing Engineering at the University of Calgary. He obtained his Ph.D. in 2011 from McGill University, while completing most of his research at the INM-Leibniz Institute for New Materials in Saarbrücken, Germany. Following his Ph.D. studies, he completed a postdoc at the University of Pennsylvania as a Natural Sciences and Engineering Research Council (NSERC) of Canada Postdoctoral Fellow (PDF).*

The basic laws of friction are taught to every high school student in physics class and are often not developed further in higher-level study. Amonton's law, or the law that the friction force is proportional to the applied load an object exerts on a surface, is how most people understand friction. This law is often still applied in developing many sophisticated, high-tech devices. However, this empirical friction law often cannot describe the friction encountered in many real systems and cannot be used in predictive mechanical models without experimental verification using matched material pairs. Furthermore, with the advent of nano- and microelectromechanical systems (N-/MEMS), such as those in DLP projectors and automobile air bag sensors, traditional lubrication strategies break down and thus new, low adhesion nano-lubricants are required. The importance of improving models and gaining further insight into friction becomes clearer when the economic and environmental impact of everyday activities are accounted for. Approximately 40% of the energy developed in a car engine is lost to friction, artificial joints in the body that do not last as long as natural joints, and wear-related failures in mechanical systems (cars, turbines, and other mechanical systems) are often a result of frictional processes. It has been estimated that improvements in lubrication technology could save billions of dollars in the Canadian economy.

The Egberts group works at understanding and developing models of friction by examining surfaces at the nanoscale. With the rapid development of experimental techniques, such as atomic force microscopy, it has become possible to examine the friction experienced between single atoms and measure forces with the same magnitude as single atomic bonds. The advantage of examining friction at the atomic length scale is that computer simulations replicating experiments with atomic level detail become possible. These simulations allow scientists to track the position and interaction of every atom in the sliding experiment, particularly those atoms at the interface of the two sliding surfaces that are nearly impossible to see in experiments.

Additionally, the Egberts group looks at developing and examining lubricants for MEMS and other nano-scale devices, which are typically only a single layer of atoms. However, because these lubricants are so thin, they often behave in unexpected ways. For example, graphene, or a single layer of carbon atoms, can effectively lubricate silicon surfaces. However, modifying graphene with fluorine, resulting in an atomically thin sheet of Teflon, a low friction coating used on cookware and other surfaces, shows higher friction than on graphene. This example also shows that even a single layer of atoms, for example on the cylinder wall of a car engine, could be the key to reducing fuel consumption in cars.

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A former Chair's view: The NSERC Discovery Grants program

for our graduate students through creating a stimulating intellectual environment, generating excitement in faculty for teaching the latest advanced material, and providing a critical number of courses available to broaden the students' technical background. I can recall when NSERC insisted that training of HQP was not its mandate. Now it is an essential component of its mandate. Why not take that to its logical conclusion and recognize that the best training of HQP will be in an environment where the majority of faculty involved are actively engaged in research. It seems to have become a popular notion that teaching and research are independent, a notion which I reject absolutely in a field like engineering which is changing so rapidly.

I would argue further that the commonly used performance metrics for science are not necessarily the same for engineering, although that seems not to be obvious in NSERC policy. Technology transfer and publications are often discussed as if they were the same thing. However, there is no doubt in my mind that the best technology transfer is done by our graduate students who go to work in industry, as well as by our faculty through their industrial collaborations. The results are instant and up-to-date. Indeed, many end users of engineering research do not read the top technical journals in which we are encouraged to publish and for which we are rewarded as academics. It follows that the best training ground for HQP and the greatest benefit to the end users of our research (and therefore Canada) will be achieved by funding the majority of our qualified engineering faculty. Such a policy need not negatively impact our top researchers since their level of funding is usually not affected significantly by the size of their NSERC Discovery Grants.

In summary, I think that a good case can be made that research funding should be increased to the Mechanical Engineering Discovery Grant budget and that the distribution of that funding should not be driven by policies more suitable for science. The contributions of engineering to Canada are different from those of science and NSERC policy should better reflect those differences. We have proven in the past that a concerted effort in creating a well-argued position statement which has the strong support of the mechanical engineering research community in Canada can be an effective mechanism for producing the desired changes in policy. That is your challenge.

....continued from page 9
Alumni Q & A, Sally Atalla

Since you left, Canadian ME departments have jammed more into the curriculum and can rarely agree on what to take out. Are there any 'untouchables' in your opinion?
Any components that are practical application of the theory should be untouchable. Much of what I value and use were from the latter years of study and internship. Everything makes sense and connects with people you work with when you can give it real life meaning. Anything related to communications, like team design projects or labs and effective technical writing classes, are also critical to success unless you are working in a closet.

Likewise, do you have any suggestions for additions/improvements to engineering education?
Let people have access or insight to electives sooner in education or even before they start the program. I would also consider applicable work in summers, short work terms or long internships as important in any program. I did at one point hear about programs that offered a Masters degree in business combined with a Bachelor engineering degree in 5 years that also sounded interesting and could open more doors in some organizations.

More change is likely coming to engineering education, particularly via online learning (more flexible, cheaper, but less personal). Any opinion?
I'm all for more accessible education. Let the learner decide what they want to pay for and how they want to use it. The bigger question is how a recruiter, hiring manager or organization lead might perceive the value of how or where the education was obtained, relative to the value of the individual that was educated.

How can the CSME better connect to ME Alumni like yourself? What would you be interested to read in the CSME Bulletin?
Compelling events or news like "inside or behind the scenes of X", where "X" is an annual fundraiser, unique activities, science or art exhibit, or a closed research facility. Casual socials and networking might be nice too. It might be good to take a survey on this one, because I don't follow the norm in terms of interests.

SAFETY AND STUDENT TEAMS:
Three common-sense tips for student and faculty advisors.

While not every accident can be avoided, engineering teams can take steps to mitigate the most obvious threats to health and safety.

"The people most knowledgeable about the risks are the ones closest to it," says John Kerr, director of risk management and insurance with the University of Toronto. "Once we get people thinking about risk, we extend that to other areas of the activity."

That means taking proactive steps to ensure that initiatives such as constructing, transporting and racing fuel-efficient vehicles are not only fun, but also as safe as possible.

Here are Kerr's three tips to help engineering students and faculty advisors cut the risks associated with their extracurricular activities:

1. PREPARE AND SIGN WAIVER FORMS—As Kerr explains, these documents help students highlight and understand the risks associated with their activities—a critical first step in maintaining their personal safety.

2. PROVIDE TRAINING—Engineering students are almost universally keen to build cool new machines, but in doing so need proper training to operate the sometimes dangerous equipment (think welders, drill presses or other heavy machinery) to bring their designs to life. Team members involved in vehicle construction should be required to undergo an orientation and training process before diving into their project, Kerr stresses.
"With any type of activity that takes place on a university campus, it should be subject to the policies, procedures and guidelines of university… and there should be health and safety oversight," he says.

3. DEVELOP EVENT-SPECIFIC SAFETY MEASURES—In recent years, Kerr helped the University of Toronto's Supermileage team develop basic rules for students to follow when transporting their vehicles to competition.
"We asked the students to restrict the hours they drove to daylight hours, limit the number of hours that any student would travel, and check in with their faculty advisor every few hundred miles to give an update," Kerr recalls. "That helped keep some of the more pressing safety issues front and centre in their minds."

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