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SPECIAL ISSUE ON ME EDUCATION

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SPRING 2015

COVER PHOTO: U OF T ENGINEERING COMMUNICATIONS

The special issue on mechanical engineering education

"Dear Processor Sinton …"

the email read. I sympathize with the student as this error survives a spell-check. The Processor title, however, resonated with me in the context of my role in ME education.

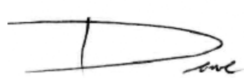
First, it is easy to see one's instructor role as that of a processor, processing problem sets, midterms, labs, exams and ultimately graduates. As the school year wears on it can sometimes feel like a grind to both instructors and students. Of course it is an instructor's duty to recognize and remember the privilege and opportunity of the teaching role. For me, that aspect is most apparent when I'm personally engaging with students. Even in a large lecture class I'm now trying to speak directly to individuals, something I wasn't doing before taking a communications short course (Science Leadership Program at U of T, open to applicants from across Canada). Out-of-class discussions can also help engage both instructors and students. The challenge there is finding a balance of effective time management while having enough one-on-one interactions such that not all interactions involve grievances.

Second, perhaps the most significant change I've observed over the last 10 years or so, is the number of processors in the classroom. I recently mistakenly turned out all the lights in a windowless lecture hall, and about 5 % of students faces 'lit up', not with the thrill of learning, but with the glow of their phones. Teaching students with video streaming and social media in their hands is akin to teaching in a movie theatre packed with all their friends and relatives. Teaching has always been a performance art, but personal electronics have raised the bar. One recent study showed that laptop multitasking hinders classroom learning for users (no surprise) and nearby peers (surprise) [Computers & Education, 2013, 62, 24]. Such is the new reality of classroom teaching, a reality being addressed and even leveraged by some of the ME education innovations being implemented across Canada.

In this Special Issue on Education, I'm delighted to have some great examples of these innovations from across the country. These include inventive programs that are attracting record numbers of female students, flipping the classroom, doing away with traditional lectures, clustering content-delivery and practice, and integrating design early and often. In Chair's Corner, Professor Sheldon Green of UBC provides thoughtful insight on UBC's 2nd year reforms and what it takes to make change happen.

It is exciting to consider these changes. Although traditional lectures are my favourite way to teach, they are not necessarily the most effective way for students to learn. I'm reminded of my parents' visit to one of my lectures as a new engineering professor in Victoria. I thought I had delivered a more-exciting-than-usual lecture with many examples. After the lecture I asked, "Mom, how was your first engineering lecture?" and my mother's measured response was, "Well David, it was pretty dry".

Enjoy the special issue.



DAVID SINTON
PhD, PEng, FCSME, FASME, FEIC
Editor-in-Chief, CSME Bulletin
Professor–Mechanical & Industrial Engineering University of Toronto

PRESIDENT'S MESSAGE

I WOULD LIKE TO SHARE WITH YOU A FEW INITIATIVES AND SUCCESS STORIES of our society. To have a proactive role for CSME in mechanical engineering education across Canada, we have launched a national design competition to provide Canadian students an opportunity to engineer, build and assemble their designs. With the aim of building partnership between industry and academia, the theme of the design challenge this year is Additive Manufacturing towards high quality 3D printing, a high priority topic for many Canadian industries. Our mechanical engineering students from east to west will demonstrate their achievements through creativity, innovation, application of sound engineering design principles, and business development skills to address a technology readiness of the proposed innovative design in which technical and business merits and challenges are integrated.

We have been successful in motivating Codes and Standards activities in our society, which is of interest to many Canadian industries. Currently we have a board member from the Canadian Standard Association (CSA) group who is actively providing relevant information and communications through our website. Finally, I would like to congratulate our Bulletin editorial team led by Dr. Sinton for their hard work and brilliant ideas in order to connect mechanical engineers by highlighting/promoting innovation and research among our members in Canada.

Sincerely yours,

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

MESSAGE DU PRÉSIDENT

J'AIMERAIS PARTAGER AVEC VOUS LES DÉTAILS d'initiatives et réussites récentes de notre société. Afin d'avoir un rôle actif dans l'éducation d'ingénieurs mécaniques au Canada nous avons lancé une compétition nationale de design qui fournira une opportunité aux étudiants canadiens de construire et d'assembler leurs conceptions. Puisque nous avons comme but d'établir un partenariat entre l'industrie et le milieu universitaire, le thème de la compétition cette année sera « Additive Manufacturing towards high quality 3D printing », un sujet de haute priorité pour de nombreuses industries canadiennes. Nos étudiants en génie mécanique démontreront leur compréhension de bons principes de génie, ainsi que leur créativité, innovation, et compétences en affaires, pour répondre aux besoins actuels de l'industrie.

Nous avons réussi à motiver nos membres à mettre en œuvre des codes et des normes, une réussite qui capte l'intérêt de plusieurs industries canadiennes. Nous avons présentement un membre du conseil du Groupe CSA qui fournit activement de l'information pertinente sur notre site web. Finalement, je voudrais féliciter l'équipe éditoriale du Bulletin dirigée par Dr. Sinton. Cette équipe a réussi à faire ressortir l'importance de l'innovation et de la recherche de nos membres et a donc créé un réseau d'ingénieurs mécaniques.

CHAIR'S CORNER: PROFESSOR SHELDON GREEN

Mech 2: A developer's perspective

SHELDON GREEN,
PhD, PEng, FCMSE, FCAE, FASME. Sheldon earned his BASc from the University of Toronto in 1984 and his PhD from Caltech in 1988. He joined UBC Mechanical Engineering in 1989, served as Assistant Head responsible for Undergraduate Education 2000-2007, and has been Head of Mechanical Engineering at UBC since 2007.

It is my hope that many readers are already familiar with the Mech 2 program at UBC. For the benefit of those who are not, I will start my column with an overview of Mech 2, and include some metrics that suggest that it is a leading educational program. The bulk of my column will be devoted to describing the history of Mech 2 development, the subtext of which will be some elucidation of how administrators can foster new educational programs. I will close with some general conclusions. I would like to thank Dr. Peter Ostafichuk, the lead instructor of MECH 223, and the founding Director of Mech 2, for his helpful feedback on this column.

Mech 2 is a unique integrated program in which students take only a single technical course at a time: a technical practicum (MECH 220), a course in dynamics/materials/solid mechanics/circuits/ODEs (MECH 221), a course in fluids/thermodynamics/vector calculus (MECH 222), and a course in design (MECH 223). Communication (MECH 226 or MECH 227) is taught concurrently with the technical courses. Mech 2 has won internal awards at UBC, and also won the STLHE Alan Blizzard Award and the ASME Curriculum Innovation Award. We have published papers showing that the students find Mech 2 more engaging than the previous second year curriculum, and that student understanding was improved when Mech 2 was implemented.

From my perspective, Mech 2 started as a cross between a manifesto and a proposal, which was co-signed by four engaged faculty members, and given to me as Associate Head–Undergraduate (my administrative role at the time). Prior to Mech 2 our students had taken a very conventional second year, with separate courses in dynamics, solid mechanics, electric circuits, materials, calculus, fluid mechanics, thermodynamics, technical communication, and design. The proposal decried the lack of cohesion between the different engineering science courses, despite the fact that (at minimum) the courses share the common language of mathematics. Some of the courses share much more: RLC circuits are entirely analogous to mass-spring-damper systems, and conservation of mass applied to a control volume is fundamental to both open-system thermodynamics and fluid mechanics.

Mech 2 developed from this original proposal into what it is today. When students arrive in MECH (admission to MECH occurs at the end of a common first year of engineering), they start in the technical practicum course a week before the Labour Day weekend. The early start is required to ensure that the remainder of the term is not excessively condensed. The practicum is four weeks during which students do hands-on work in machining, drafting, electronics, and CAD. The astute reader will note that none of those topics was mentioned in the original manifesto. How did those topics come to be part of Mech 2? In the course of departmental discussions about Mech 2, one or more colleagues observed that on average our incoming students have less exposure to the physical world than was previously the case (students now play electronic games whereas in the past they might have performed automobile maintenance). A practicum in machining and electronics was suggested by one colleague, and a different colleague then suggested the practicum be expanded to include drafting, three-dimensional visualization, and CAD.

"Mech 2 is a unique integrated program in which students take only a single technical course at a time."

The course in dynamics/materials/solid mechanics/circuits/ODEs (MECH 221), and the course in fluids/thermodynamics/vector calculus (MECH 222) are now very similar to the courses outlined in the manifesto, except that, as a result of some careful administrative consultation, mathematics was incorporated directly into the courses. The essence of the consultation was to assure the Mathematics department that Mech 2 would be revenue neutral to them, and in fact that the new curriculum would strengthen relations

...continued on page 17

CHAIR IMAGE: ISTOCK

Record: Over 30% female enrollment in U of T engineering

HAPPY U OF T STUDENTS

Women now account for 30.6 per cent of first-year students in University of Toronto engineering programs—a record number that surpasses all other Ontario universities.

"U of T Engineering is a rich environment for talented, bright women to become engineering leaders," says Cristina Amon, the Faculty's Dean and the Alumni Chair Professor of Bioengineering at U of T's Department of Mechanical and Industrial Engineering.

Today, one quarter (25.8 per cent) of U of T Engineering's entire undergraduate population is female, compared to a province-wide average of 19.7 per cent. Across Canada and the United States last year, those averages were 18.9 and 19.9 per cent respectively, according to Engineers Canada and the American Society of Engineering Education.

"Diverse perspectives are the foundation of our culture in research, education, service and innovation," says Dean Amon. "This achievement is encouraging as we continue our proactive efforts to foster diversity within the Faculty, among universities, and across the engineering profession."

U of T Engineering's targeted recruitment efforts have contributed to this increase, with overall female undergraduate enrolment up from 21.3 per cent just six years ago. This is amid a more competitive admissions landscape with first-year entrance averages reaching a record 92.4 per cent.

For those first-year students who have already declared a major in mechanical engineering, 20.8 per cent are female. This number has more than doubled from 10.2 per cent in 2008. In the undeclared Track One stream, 32.8 per cent of first-year students are female. Among all declared majors, industrial engineering has the highest proportion of first-year women at 47.5 per cent.

"It's exhilarating to be part of such a diverse and talented student community," says Teresa Nguyen, a fourth-year civil engineering student and president of the Faculty's Engineering Society. "At U of T Engineering, it doesn't matter what your background is—it's about the ideas, expertise, and reasoning you bring to the table."

With its reputation as a leader in engineering education and research, U of T Engineering continues to attract world-class faculty. The complement of female faculty members has increased more than twofold in the past eight years, from 21 in 2006 to 44 in 2014. Seventeen per cent of faculty members are women, which is three points higher than the Ontario average (14 per cent) and four points higher than the Canadian average (13 per cent).

These numbers are expected to grow in the years ahead, as early-career faculty members move up the academic ranks. More than a quarter (27.8 per cent) of U of T Engineering's associate professors (early-career, tenure-stream faculty members) are now women, compared to an Ontario average of 15 per cent and a national average of 15.7 per cent. In the Faculty's Department of Mechanical and Industrial Engineering, 37.5 per cent of associate professors are female.

DEAN CRISTINA AMON

For those first-year students who have already declared a major in mechanical engineering, 20.8 per cent are female. This number has more than doubled from 10.2 per cent in 2008.

"Engineering has changed significantly from when I began at U of T several decades ago," says Professor Susan McCahan, U of T's new vice-provost, innovations in undergraduate education, and the University's first female faculty member in mechanical engineering. "It is increasingly recognized as a vibrant and innovative profession: one that encourages broad perspectives and collaboration to drive positive changes that improve our world."

As of 2013, women accounted for just 11.7 per cent of all professional engineers in Canada, according to Engineers Canada. Growing numbers of female engineering students signal a promising future for gender balance in the profession.

"There is more work to be done in attracting women to the diverse and rewarding field of engineering," says Dean Amon, who notes that U of T Engineering just launched a new microsite for prospective students, called "Say Yes To Engineering." The site (found at women.engineering.utoronto.ca) showcases the incredible opportunities in the engineering profession through student and alumni profiles, video interviews, student social media streams, and letters from current students.

"We have re-imagined engineering education by introducing program innovations, new resources for students and outreach activities to continue to attract an even more diverse range of applicants, including women," she says. — *A.J Taylor*

U OF T ENGINEERING COMMUNICATIONS

The renaissance engineer: flipping the classroom in the new ME program at York University

One of Canada's newest Mechanical Engineering programs is flipping the classroom on its head in a bid to educate a new kind of engineer.

LEFT TO RIGHT: MECHANICAL ENGINEERING DESIGN SPACE COMING TO YORK UNIVERSITY AND CHAIR, PROFESSOR SUSHANTA MITRA.
BELOW: ILLUSTRATION OF THE FUTURE HOME OF THE BERGERON CENTRE FOR ENGINEERING EXCELLENCE.

THE LASSONDE SCHOOL OF ENGINEERING at York University is racing to educate what it calls "Renaissance Engineers™," broadly educated professionals who draw upon flexible skills to tackle complex, global issues. For Professor Sushanta Mitra, Chair of the newly established Department of Mechanical Engineering, the opportunity to build a path-breaking program from the ground up was enormous.

"Too often, engineering programs beat the creativity and passion out of their students. The problem is that traditional teaching methods don't connect with today's students. There are better ways to teach, and we now have the technology and the commitment to use them," said Prof. Mitra.

His department is harnessing the power of the flipped classroom, a teaching and learning methodology that inverts the traditional classroom experience. Students learn concepts and complete problem-sets outside of class time, with instructional hours dedicated to hands-on practice and discussion. The aim is to enable active, rather than passive, learning and make intelligent use of students' and professors' time.

To support the flipped classroom, the Lassonde School of Engineering is constructing a stunning new building to house its Mechanical Engineering program, the Bergeron Centre for Engineering Excellence. The most curious feature about the building, set to open in September 2015, is that it will have zero lecture halls in the traditional sense.

The building is being purpose-built for the flipped classroom methodology, where grand lecture halls are an anachronism. In their place are flexible, technology-equipped workspaces that enable team collaboration and experimentation. Rather than speaking behind a podium, instructors will be expected to interact with students, literally, at their level. Another architectural feature that Mechanical Engineering students will enjoy in their new home will be the multitude of informal learning spaces, the many break-out rooms and gathering spots that encourage spontaneous encounters and ideas.

But why go through such lengths to break from tradition? The answer lies in the far-reaching changes that have taken place in education, technology, and culture.

"Mechanical Engineering today is nothing like it used to be in the 1800s, when learning simply passed from the mind of the professor in front of the class to the ears of students," says Prof. Mitra.

"We can make classrooms engaging by rethinking them. Society is better served when engineers know how to think both rigorously and creatively. It's my hope that the flipped classroom will set our students apart and prepare them for success. It will be a new era for experiential learning in engineering education."
—Brian Tran

“Design from the start” at UBC’s School of Engineering on the Okanagan Campus

UBC’s School of Engineering in Kelowna presents modern mechanical engineering pedagogy

HOMAYOUN NAJJARAN, ASSOCIATE PROFESSOR AND MECHANICAL ENGINEERING PROGRAM COORDINATOR

Today’s engineers work in teams to solve a vast array of complex problems. They must draw upon a set of broad fundamental engineering skills. At UBC’s School of Engineering on the Okanagan campus, the goal is to create well-rounded engineers prepared for the realities and demands of the modern workplace. We offer a unique and innovative curriculum to prepare students for graduate studies and engineering practice. Our close-knit, student-centred program of study affords high levels of student-professor interaction and collaborations, enhanced laboratory experiences, and opportunities for field trips. Here students will begin first year with math and science courses, taught by engineering professors to directly and immediately link fundamentals and practical applications. Students work in teams on design projects using our “Design from the Start” approach to highlight engineering practice and sustainability in all years of study. They acquire a broad understanding of engineering principles within Applied Sciences (APSC) before selecting one of three Engineering (ENGR) programs: Civil, Electrical, or Mechanical Engineering.

All three programs begin with Engineering One & Two—foundation years rooted in project-based team learning and lead to a Bachelor of Applied Science degree. With this foundational learning model at UBC’s Okanagan campus—distinct among Canadian universities—students focus on integrated and multidisciplinary engineering courses. The first-year curriculum, Engineering One, lays engineering skill foundations, and offers first-year students an opportunity to implement engineering design projects. The common learning format provides all students with more interdisciplinary approaches to engineering education, which strengthens design teams and their projects. First-year engineering design projects include 3-D printing, computer-aided design and manufacturing (CAD/CAM), and the opportunity to implement the principles of engineering in a second-term design project. The Engineering Two program builds on the foundation courses while expanding into engineering specializations. It culminates in the Hovercraft Competition, which incorporates elements such as electronics, magnetism, statics, dynamics, fluid flow, and materials. With a solid foundation, students choose a specific concentration: Civil, Electrical, or Mechanical Engineering. Mechanical engineering is at the crossroad of other engineering disciplines shaping a practical, hands-on way of creating and improving physical systems. The interdisciplinary nature of the School of Engineering at UBC’s Okanagan campus provides an ideal environment for training mechanical engineers with exceptional skills to meet the demand of modern industries, from automotive, aerospace, and energy systems to biomedical, mechatronics, and manufacturing. The “Design from the Start” approach continues through third-year project-based learning and the fourth-year Engineering Capstone Design Project—in collaboration with our industry partners. Innovative capstone design projects involving interdisciplinary teams have led to potential entrepreneurial opportunities.

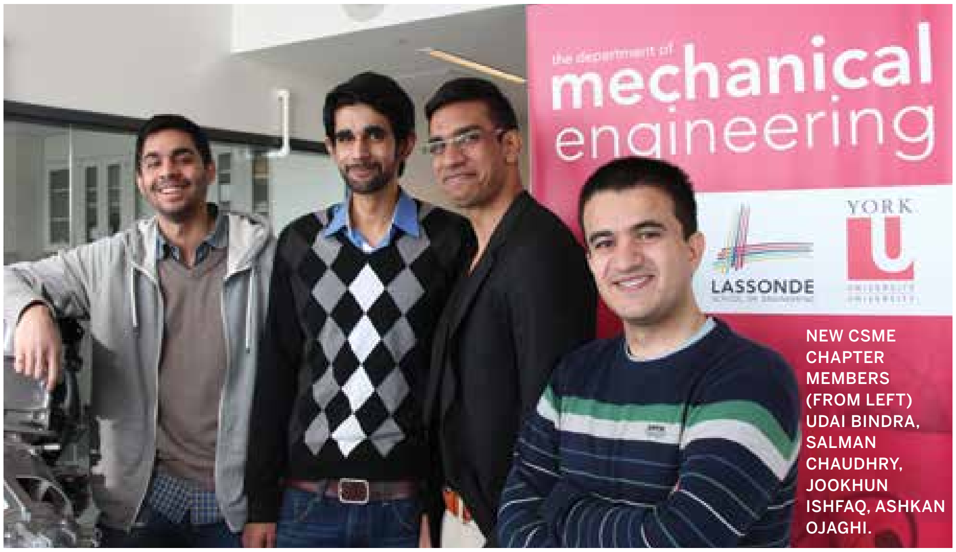
The Engineering Two program builds on the foundation courses while expanding into engineering specializations.

A collaborative, entrepreneurial spirit underpins UBC research in fields of critical importance, both locally and globally. The Okanagan campus—a community of 10,000 students, faculty and staff from more than 80 countries—has earned a reputation as a respected centre of learning and research around the world. Part of UBC’s century-old Faculty of Applied Science, the School of Engineering provides a modern environment for finding creative engineering solutions that positively impact the community and the world.

— Publicity Committee, School of Engineering, University of British Columbia

ME NEWS & RESEARCH

HIGHLIGHTS



NEW CSME CHAPTER MEMBERS (FROM LEFT) UDAI BINDRA, SALMAN CHAUDHRY, JOOKHUN ISHFAQ, ASHKAN OJAGHI.

Students kick-off a new CSME student chapter at the Lassonde School of Engineering

The Lassonde School of Engineering at York University this year launched its CSME student chapter, marking a milestone for the new Mechanical Engineering program. Masters student and inaugural chapter president Salman Chaudhry is keen to connect his peers to leading-edge developments at the national level.

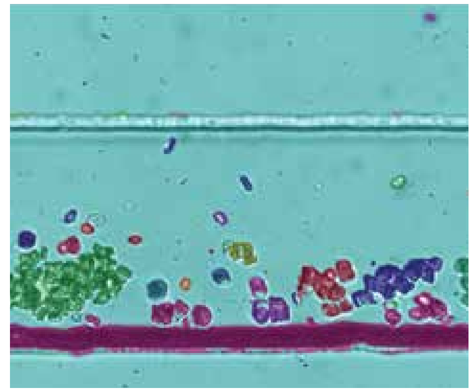
"In addition to local events, the CSME student chapter will give us a platform to participate in Canada-wide events such as annual conferences and student national design competitions. It would also give us the kind of exposure that will help us excel in our fields and build a name for ourselves," says Chaudhry.

The creation of the student chapter follows the launch of the Department of Mechanical Engineering itself. As of one Canada's newest engineering schools, Lassonde is growing rapidly to develop students who are engaged with entrepreneurship, innovation and social prosperity.

MCGILL STUDENT CHAPTER WELCOMES INDUSTRY

The first annual Industry Dinner organized by the McGill CSME Student Chapter (McGill Association of Mechanical Engineers, MAME) on Feb 5th was an instant success. Representatives from six engineering companies, including two CEOs, participated including: Schlumberger, TRU Simulations, RWDI Consulting, National Instruments, Pepsico, and MDA Satellites. The event at the McGill Faculty Club provided many opportunities for networking, including a round of speed networking following dinner. The following day was McGill's Engineering TechFair. The event was a great success and is likely to become tradition at McGill.

LASSONDE SCHOOL PHOTO: BRIAN TRAN, MCGILL STUDENT CHAPTER PHOTO: IAN RICHARDSON



UNDERSTANDING BLOOD FLOW

Blood flow is strongly influenced by red blood cells. Under certain flow conditions, the cells assemble and form three-dimensional aggregates, which contribute to the non-Newtonian behaviour of blood.

A team led by Marianne Fenech and Catherine Mavriplis at the University of Ottawa has provided direct measurements of red blood cell aggregates in a microfluidic device. They used a micro-PIV system and a high-speed camera to obtain measurements on porcine blood. They were able to determine the size of aggregates for various hematocrit levels and flow conditions, and ascertain that lower shear rates correspond to larger aggregate sizes for 10% and 15% hematocrit. This finding is an important step towards understanding red blood cell aggregation and characterizing blood flow behaviour.

Ongoing and future work will relate aggregate size to apparent viscosity and involve experiments with human blood, which is shown in the image. The experiments are challenging to perform, and according to Dr. Fenech "this research would not be possible without the dedication and patience of our grad students. At this scale, the care of detail is paramount in particular working with fresh human blood."

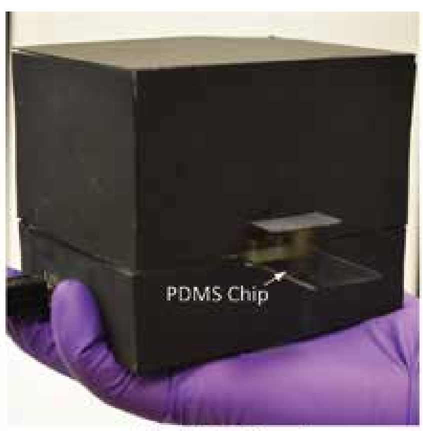
—Technical Editor, Professor Brendan MacDonald

R. MEHRI, J. LAPLANTE, C. MAVRIPLIS, AND M. FENECH, INVESTIGATION OF BLOOD FLOW ANALYSIS AND RED BLOOD CELL AGGREGATION, JOURNAL OF MEDICAL AND BIOLOGICAL ENGINEERING, 2014, 34, 469-474.

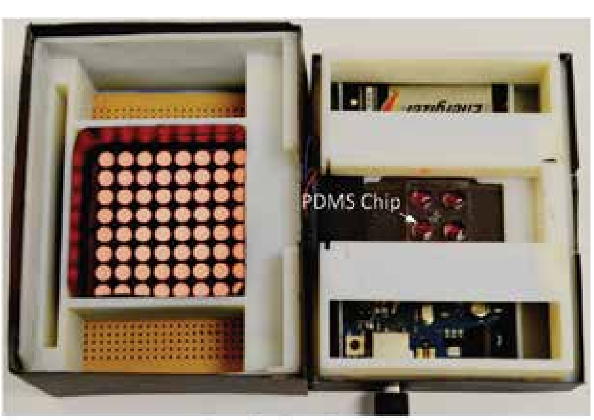
LAB-ON-A-CHIP TECHNOLOGY FOR METAL ION DETECTION IN DRINKING WATER

A team lead by Xinyu Liu at McGill University has developed a sensitive, low-cost, rapid detection system for metal ions in water. The technology detects lead and aluminum ions using gold nanoparticle based colorimetric methods with lab-on-a-chip instrumentation. The system, shown in the figure, consists of a PMDS microwell plate and a custom-made colorimetric reader. The microwell plate is used to simultaneously implement four single step assays. The colorimetric reader is used for signal quantification and consists of four main components: an array of narrow-band LEDs, four photodiodes, a microcontroller with USB communication, and a plastic casing. The method is able to provide a level of detection for lead and aluminum ions that is comparable to values obtained using bench-top spectrometry. With further refinement of the assay protocols, it is expected that this system will be suitable for testing lead and aluminum content in drinking water. This technology provides a simple and economic way to test water samples that could have broad application to water quality monitoring in the field and in resource constrained settings.— *Technical Editor, Professor Amy Bilton*

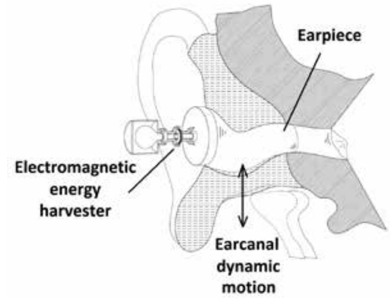
C. ZHAO, Z. GUOWEI, D.-E. KIM, J. LIU, AND X. LIU, "A PORTABLE LAB-ON-A-CHIP SYSTEM FOR GOLD-NANOPARTICLE BASED COLORIMETERIC DETECTION OF METAL IONS IN WATER," BIOMICROFLUIDICS, VOL. 8, NO. 5, 2014.

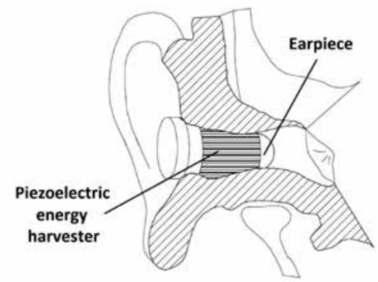


Outside Device



Inside Device





SOMETHING TO CHEW ON?

New energy technologies for in-ear devices

Aidin Delnavaz and Jérémie Voix from École de Technologie Supérieure (ETS) have recently developed a new concept to harness energy from ear canal dynamic motion. The mechanisms take advantage of the changes in ear canal volume that occur while chewing, smiling, yawning or speaking to generate electrical energy. In the study, the team measured 5 mW as the amount of mechanical power typically available from ear canal motion. Two different mechanisms were then tested to evaluate the capability to harvest the available energy. The first device, a hydroelectromagnetic energy harvester, in which a coil surrounds a moving magnet in water column, was shown to generate a cycle-averaged electrical power of 0.3 μW. The second device, a piezoelectric energy harvester, which would be easily compatible with in-ear devices, was able to generate a cycle averaged power of 0.2 μW. Since the latter energy harvester is more adaptable with in-ear devices, the research team is now focusing on the development of advanced piezoelectric materials and structures integrated into the custom-fitted earpieces. With expected increases in harvester efficiency, it is foreseeable in the near future that ear canal dynamic motion could provide at least partial power required by hearing aid devices, electronic hearing protection, and other in-ear electronic devices. —*Technical Editor, Amy Bilton*

A.DELNAVAZ, AND J. VOIX, "ENERGY HARVESTING FOR IN-EAR DEVICES USING EAR CANAL DYNAMIC MOTION," IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 61, NO. 1, PP. 583-590, JANUARY 2014.

"MANITOBA IN CANADA" BY TUBS

NEW FACULTY SPOTLIGHT SERIES:

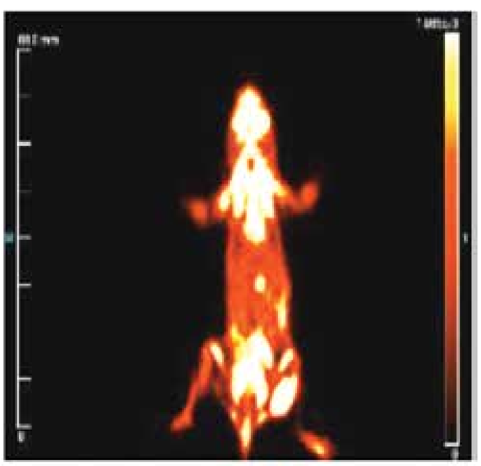
FOCUS ON MANITOBA

This recurring series will highlight new Canadian ME faculty members, by region. We focus on Manitoba in this issue, with two new additions, Dr. Malcolm Xing and Dr. Nan Wu. Both are from the University of Manitoba and are developing new tools for medicine, structural health, and energy.

University of Manitoba Professor, **Malcolm Xing**

Functional polymers for nanomedicine and energy applications

DR. MALCOLM XING (ABOVE) AND SOME EXAMPLES OF HIS FUNCTIONAL POLYMERS AT WORK IN THERANOSTIC NANOMEDICINE AND SUPERCAPCITORS (BELOW).



Nanocarriers represent a therapeutic strategy which combines nanotechnology and biomaterials to release bioactive molecules that provide a suitable environment to repair damaged tissue. Successful nanocarriers are multi-component and include a drug delivery system. Polymeric nanocarriers have the ability to target specific cells and release loaded molecules in a predetermined, spatially- and temporally-controlled manner. One of the major challenges of using polymeric nanoparticles for controlled drug release is how to design polymers with single-, dual- or multiple functions to precisely deliver molecules of interest to target cells and cellular compartments. Understanding the mechanism by which nanoparticles are internalized by cells and trafficked intracellularly will be critical to overcoming this challenge.

Since joining the University of Manitoba, Dr. Xing has initiated a new research program in biopolymers and tissue engineering. In Xing's lab, he works with his students, post-doctoral fellows, research associate and clinical fellows working on biopolymeric nanocarriers for cancer therapy. Polymeric micelles have been widely researched for the delivery of hydrophobic anticancer drugs to solid tumors and cells. Core-shell micellar structures can be obtained from the self-assembly of amphiphilic copolymers. These well-developed micellar nanoparticles are capable of prolonged circulation time by avoiding rapid clearance by the renal and reticuloendothelial systems. Stimuli-responsive polymers have been developed to release drugs into cells upon changes in physical and chemical environment, such as redox potential, pH and temperature. pH change and redox potential are the major chemical stimuli to trigger drug release from polymer nanocarriers. He is working on the development of smart polymer modified magnetic nanoparticles with theranostic function to combine imaging, diagnosis, hyperthermia (using a laser to induce localized high temperature) and targeting delivery to the tumor micro-environment for breast cancer treatment. His lab has also designed a variety of hydrogels and nanofibers to deliver therapeutic agents for skin ulcers, myocardia infarction and bone defects. He is currently using biopolymers to design bio-devices such as nano-robots and implantable bioelectrodes for energy harvesting and e-skin.

DR. MALCOLM (MENGQIU) XING *is an Assistant Professor in the Department of Mechanical Engineering, Faculty of Engineering at the University of Manitoba. He obtained his PhD degree in Bioengineering from University of California at Davis in 2007. After that, he moved to the East Coast for his postdoctoral training in tissue engineering at Harvard Medical School. He is also the Associate Editor of the journal Frontiers in Bioengineering and Biotechnology (Biomaterials).*

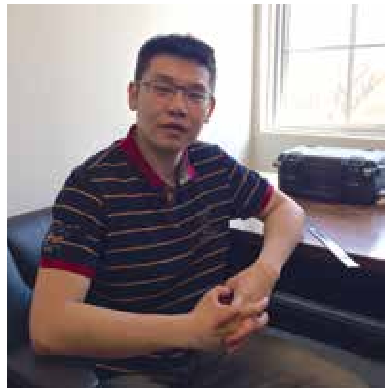
University of Manitoba Professor, **Nan Wu**

Structural health monitoring and enhancement with smart materials and structures

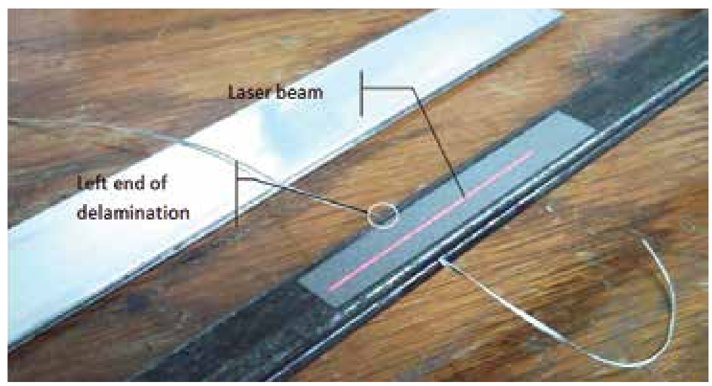
Damage such as cracks/notches or delamination in aerospace, mechanical and offshore structures due to fatigue, corrosion or accidence are inevitable. The damage can grow at an alarming rate due to the stress/strain concentration, causing structure failures. Thus, effective structural health monitoring and repair have become important research topics over the last several decades and attracted much attention in academy and industry.

One major problem of current structural health monitoring is low sensitivity, especially for damages at their initial stage. One method of improving the structural health monitoring sensitivity is to magnify the damage effect on the structure responses, such as deflection, vibration and wave propagation signals on the tested structures, through mathematical (e.g. wavelet analysis) and physical (e.g. active control) means. Spatial wavelet analysis is applied to amplify the perturbation in the structure deformation at the damage position and thus increase the sensitivity of damage detection. Dr. Wu and his students developed an active control process to tune structural vibration mode shapes and adjust the curvature distribution. The result was an increase in the damage detection sensitivity.

A key objective in a repairing/reinforcing structures is to lessen the stress/ strain concentration at the damaged part of a structure, e.g. the tips of the notch/crack and delamination. The traditional method is to meld or mount additional high stiffness patches onto the damaged area to improve the mechanical function of a damaged structure. However, additional stress concentration may possibly be induced at the bonding area, and a normal additional patch cannot adjust itself to newly induced damage due to unexpected external loadings. In view of this limitation, smart materials have been employed in applications of structural repair due to their adjustable mechanical property. Piezoelectric materials in particular exhibit the electro-mechanical coupling effect – producing an electric charge when an external load is applied, and conversely, producing a mechanical deformation when an electric field is applied. In repair of delaminated structures under dynamic loadings, Dr. Wu has developed and successfully demonstrated a design for the repair of a vibrating delaminated beam structure bonded by piezoelectric patches. Although structural repair using piezoelectric materials has been proven to be feasible with numerical simulations and experimental studies, several practical limitations remain. For example, the force generated by the normal piezoelectric patch, which is a widely used piezoelectric structure, is too small for the repair of large damaged structures, such as the frame of a large aircraft, the chassis of a heavy duty vehicle or common civil structures. For such cases, piezoelectric stacks with high mechanical strength and significant piezoelectric effect are under investigation.



DR. NAN WU (ABOVE) AND A DELAMINATED STRUCTURE UNDER TEST IN HIS LAB (BELOW).



Based on the piezoelectric effect of smart materials, Dr. Wu and his colleagues have also invented and developed several energy harvesting techniques and high efficiency harvesters. The goal is to collect the kinetic energy from nature resources, such as wind and water waves, with relatively large energy output from one single harvester, e.g. up to 1W from cross wind and up to 100 W from ocean waves.

DR. NAN WU *obtained his BEng and MSc from the Northeastern University in 2005 and 2008, respectively, and received his PhD degree in May 2012 from the University of Manitoba. Currently, Dr. Wu is an Assistant Professor in the Department of Mechanical Engineering at the University of Manitoba with teaching and research interests in the fields of mechanical vibration, structural health monitoring and enhancement with smart materials, energy harvesting and nanotechnology.*

Canadian teams dominate the 2015 Shell Eco-Marathon Americas competition

TORONTO ON TRACK.

...over 100 engineering design teams from 5 countries across the Americas came together to vie for top vehicle mileage efficiency

ABOVE: **FIRST-PLACE TORONTO SUPERMILEAGE TEAM.**
RIGHT: **A FRONT-VIEW OF A DRIVER.**

The 74th annual Shell Eco-Marathon Americas competitions came to a dramatic close this month following a final round victory by the University of Toronto Supermileage team from Canada. The Shell Eco-Marathon takes place annually, encouraging engineering students from around the world to explore technologies in energy efficiency improvement in vehicle design across a wide range of energy types such as gasoline, battery electric, diesel, compressed natural gas, and hydrogen fuel cell. Held for the first time this year in Detroit, Michigan, over 100 engineering design teams from 5 countries across the Americas came together to vie for top vehicle mileage efficiency.

Canadian teams took home 3 medals, including gold and silver in the gasoline prototype, the largest and most competitive category at the event. Tensions were high as the two Canadian teams, team Alérion from Université Laval and team Supermileage from the University of Toronto, duked it out for the gold. A seasoned veteran, team Alérion has won the last 5 of 6 competitions, and currently holds the Americas record for gasoline efficiency at 3,587 mpg (1,525 km/L), set in Houston in 2013. Holding the top spot throughout Saturday and Sunday with a mileage of 3,365 mpg (1.431 km/L), Alérion's victory seemed secure until the last run of the event. Sitting in second at just over 2,800 mpg, the University of Toronto team had conceded to another defeat by a very worthy rival following their second place finish at the 2014 event, where, after two days of nose to nose competition, team Alérion had emerged victorious.

TOP PHOTO COURTESY OF SHELL, TORONTO TEAM AND CAR DRIVER BY CALLUM BARTLETT

RACE DAY IN DETROIT.

RACE DAY TUNE-UP.

CELEBRATION!

TEAM ALÉRION OF LAVAL HOLD THE RECORD FROM 2013.

UBC SUPERMILEAGE AND URBAN CONCEPT VEHICLES.

In the last 5 minutes, team Supermileage was cleared for a final run, the last vehicle to enter the track. Following a series of failed runs and on-track collisions, expectations for a winning finish were not high. Nonetheless, the team pulled through with a final mileage of 3,421 mpg (1,454 km/L) – the equivalent of Quebec City to Vancouver on 1 gallon of gasoline. This was the best mileage of the 2015 competition and secured Toronto the first place in their third year competing at the Shell Eco-Marathon event.

In the Urban Concept category, another Canadian team, the University of British Columbia, lit up the podium with their second place finish in the gasoline fuel type category, holding a finishing mileage of 138 km/L. Other Canadian teams involved included:

Concordia University
Dalhousie University
École de Technologie Supérieure (Université du Québec)
Queen's University
Université de Moncton
University of Alberta
University of Ottawa
University of Waterloo

The continued success of Canadian teams at this international event is an inspiration for young engineers to take on grand challenges in energy efficiency. — *Mengqi Wang, University of Toronto Supermileage Team*

ALL PHOTOS ON THIS PAGE COURTESY OF SHELL. CELEBRATION VIDEO STILL BY CALLUM BARTLETT

LaurentianUniversity
UniversitéLaurentienne

BHARTI SCHOOL OF ENGINEERING
ÉCOLE DE GÉNIE

Master Lecturer Position in Mechanical Engineering/Mechatronics

The Bharti School of Engineering at Laurentian University invites applications for a full-time Master Lecturer position in Mechanical Engineering and Mechatronics, with a preferred starting date of July 1, 2015. The successful candidate will be part of the Mechanical Engineering program. The Bharti School of Engineering offers programs leading to B.Eng. degree in Chemical, Mechanical, and Mining Engineering, as well as M.Eng., M.A.Sc. and Ph.D. degrees in Natural Resources Engineering. Applicants must hold at least a Master's degree in Mechanical Engineering or Mechatronics with considerable experience at the start date of appointment. Candidates who have completed or near completion of a PhD in Mechanical Engineering/Mechatronics are also encouraged to apply. The successful candidate, preferably bilingual (English and French), will demonstrate a strong potential for outstanding teaching contributions in Mechanical Engineering and/or Mechatronics at the undergraduate level, and an ongoing commitment to academic and pedagogical excellence in support of the school's programs. Our programs incorporate innovative approaches to engineering education, with emphasis on professional skills development and building a rapport with students. Eligibility for registration as a Professional Engineer in Ontario is a requirement for the appointment.

The normal maximum teaching workload for a Master Lecturer is twenty-four (24) credits of which up to nine (9) credits may be assigned in the Spring session (May-July). A Master Lecturer may, where appropriate, elect to teach graduate courses. Master Lecturers may also engage in scholarly activity, and are entitled to participate in university governance and vote in Department/School meetings. Master lecturers are expected to remain current with relevant literature in their field as it applies to their teaching assignments.

A Member appointed to a Master Lecturer position without establishment in at least twelve (12) credits at Laurentian University shall have a probationary status of three (3) years.

Laurentian University is a bilingual, tri-cultural institution, and it is committed to equity in employment and encourages applications from all qualified persons, including women, Aboriginal peoples, members of visible minorities, and persons with disabilities. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents.

LU faculty is part of the Laurentian University Faculty Association (LUFA). Information about salary and the LUFA Collective Agreement can be found at www.lufapul.ca.

Applicants should provide a covering letter, a current curriculum vitae, a statement of teaching philosophy and interests with listing of courses and subject areas they are capable of teaching, and a list of three references to Dr. Robert Kerr, Vice-President and Provost, Laurentian University by email: vpap@laurentian.ca.

Review of applications will begin on May 1, 2015, and applications will continue to be accepted until the position is filled.

....continued from page 5 Chair's Corner

between the departments. The causal relationship is not clear, but it is the case that following the establishment of Mech 2 there is greater interaction (e.g., cross-appointed faculty) between Mathematics and Mechanical Engineering.

In the design course (MECH 223), students learn some design fundamentals and use their knowledge of engineering science and design to build working prototypes. These prototypes compete in immensely popular (even high school students and parents attend!) design competitions. This design course is split into two parts interleaved with the dynamics-intensive and the fluids-intensive composite courses. The first part culminates in a project that emphasizes the dynamics, solid mechanics, and electric circuits taught just previously (for example, an autonomous vehicle that must navigate a three-dimensional obstacle course). The second part of the design course includes modules related to more advanced design topics such as optimization, uncertainty and risk analysis, and economic considerations, and culminates in the design of something like a hovercraft (again reinforcing the engineering science of the preceding intensive course). The design course was also not part of the original manifesto. Rather, it was proposed during an extensive consultation process based on a review of the former Project Integrated Program (PIP) in Electrical and Computer Engineering at UBC. The fundamental idea of PIP is that students would learn engineering science concepts in the context of an engineering design. The design course turns that idea around and uses engineering design to reinforce engineering science concepts. Another unique feature of the design component is the incorporation of technical communication into the course. In conventional engineering curricula, technical communication is taught independently from other courses. Here, communication is taught in the context of design presentations, design reports, and poster presentations for each project. In recognition of the widely varying linguistic abilities of our students, beginning this year our students are now split into two groups; students who have weak language ability receive additional focused instruction during the summer following Mech 2.

In my view, Mech 2 strikes a careful balance between maintaining a strong basis in engineering science fundamentals while also introducing students to a myriad of the non-technical graduate attributes (team-work, problem analysis, investigation, design, use of engineering tools, individual and team work, communication skills, and project management) that are required by the CEAB.

The foregoing has provided an overview of Mech 2 and its development. Can we draw some broad conclusions about academic administration from Mech 2? I think we can:

1. Recruit and foster the best people. I consistently assign some of the best instructors to teach in Mech 2, and students appreciate the difference made by dedicated individuals. It is probably not a coincidence that the founding Director of Mech 2 has been named a STLHE National Teaching Fellow, nor is it a coincidence that a disproportionate fraction of the MECH 2 Teaching Assistants receive UBC recognition. It is also crucial to have dedicated and effective staff who can handle the hundreds of administrative details (room bookings, lab schedules, CEAB Accreditation, etc.) that, if improperly handled, will result in failure.

2. Listen to those people. When a group of committed individuals takes the time to prepare a thoughtful proposal, take the time to listen. Listening may not imply accepting a proposal wholesale, but it does imply careful consideration and a thoughtful response.

3. Create an open, collaborative environment. The fact that four individuals talked about modifying our curriculum was a sign of a positive environment. The fact that probably more than a dozen individuals contributed materially, over a decade, to the development and evolution of Mech 2 speaks further to that environment.

4. Be self-critical and flexible. Over the years the original vision of Mech 2 has broadened. It is rare for a program to start in "perfect" condition. Try to take your lumps with humility (I know from experience that this is easier said than done!) and seek continual improvements.

5. Handle administration efficiently. If paperwork gets bogged down without due cause, it can be dispiriting and enervating.

6. Apply dollars judiciously. Sometimes a few thousand dollars well spent (e.g., holding design competitions in a nice public venue) yields many times that amount of value (e.g., positive public perception).

CONTRIBUTING TO THE

CSME BULLETIN

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

bulletin@csme-scgm.ca

DALHOUSIE UNIVERSITY

Assistant Professor
Mechanical Engineering
Dalhousie University

The Department of Mechanical Engineering at Dalhousie University (http://www.dal.ca/faculty/engineering/mechanical.html) invites applications for a probationary tenure-track appointment at the Assistant Professor level. The Department has 15 full time professors, graduates more than 100 undergraduate students per year, and has more than 50 Masters and PhD students.

Candidates must have a Bachelor of Mechanical Engineering degree and an earned Doctorate in engineering, research credentials consistent with the development of a strong, externally-funded research program, and excellent teaching ability. Industrial, design, or relevant post-doctoral experience is desirable. Candidates must be registered professional engineers in Canada, or eligible and committed to registration in Nova Scotia.

The candidate will be expected to conduct control systems research with applications to marine systems or marine robotics. Marine-related research is an area of increasing importance within the Mechanical Engineering Department and is part of Dalhousie's Strategic Research Areas (http://www.dal.ca/research/about_research_atdal/PriorityResearchAreas.html). Teaching duties may include undergraduate courses in control systems, vibrations, and machine dynamics as well as graduate courses related to the successful candidate's research activities.

Applications must include a cover letter, curriculum vitae, and statements of teaching and research interests. Applications should be received by June 30, 2015 and sent to:

Dr. Andrew Warkentin
Chair of the Search Committee
Department of Mechanical Engineering
Dalhousie University
P.O. Box 15000
1360 Barrington St.
Halifax, Nova Scotia B3H 4R2
CANADA
andrew.warkentin@Dal.Ca

Three confidential letters of reference should be sent directly by referees to the above address. Electronic submissions must be in the form of a single, attached file in PDF format.

All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority. Dalhousie University is an Employment Equity/Affirmative Action employer. The University encourages applications from qualified Aboriginal people, persons with a disability, racially visible persons and women.

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