THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE
FALL/L'AUTOMNE 2016

BULLETIN

SPECIAL ISSUE ON

INNOVATION, TECHNOLOGY, COMMERCIALIZATION & ENTREPRENEURSHIP

ADVERTISING IN THE BULLETIN

BECOME A CSME MEMBER

WWW.CSME-SCGM.CA
WWW.FACEBOOK.COM/CSMESCGM
TWITTER: @CSME_SCGM

ADMIN.OFFICER@CSME-SCGM.CA
PHONE: 613-400-1786

OR MAIL:

MOHAMMUD EMAMALLY
ADMINISTRATIVE OFFICER
P.O. BOX 40140
OTTAWA, ON
K1V 0W8

MEMBERSHIP FEES

FELLOW	$175
MEMBER	$140
FIRST YEAR	$85
STUDENT	FREE

CONTENTS

FALL/L'AUTOMNE 2016

CONTRIBUTE 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

COVER PHOTO: THE TECHNOLOGY MANAGEMENT & ENTREPRENEURSHIP (TME) PROGRAM, UNIVERSITY OF NEW BRUNSWICK. PHOTO: KAITLIN HAZZARD, JEREMY BOWMASTER, JORDAN SORENSON, CODY BRADLEY

Editor's Letter

POUYA REZAI, PhD, LEL, MCSME
Associate Editor, CSME Bulletin
Assistant Professor & Graduate Director
Department of Mechanical Engineering
Lassonde School of Engineering
York University

I AM DELIGHTED TO INTRODUCE THIS FALL 2016 ISSUE OF THE CSME BULLETIN. I must admit that my role has been much more limited for this issue due to my maternity leave. In these last months, I had to put on hold most of my professional responsibilities to focus on my baby boy. Thus, Prof. **Pouya Rezai**, Associate Editor, needs to receive most of the credit for putting together the different pieces of this issue. Thank you Pouya! Before going further, I also want to congratulate Prof. Sushanta Mitra for his new leadership role at the CSME.

The Fall issue follows a similar layout to what has been applied to the previous issues. We may become more adventurous with time, but this structure seems to work well. We welcome any feedback for further improvement. The idea is to feature a good mix of people and experience, and various aspects of mechanical engineering. I am a strong believer of diversity and this is particular true for our discipline that has so many different facets. We have a special issue on entrepreneurship, in particular focused on how universities try to foster initiatives and creativity among students with the goal of creating a start-up and how research can lead to commercialization. There is so much more to show and the present articles represent only a small snapshot of what is currently happening in Canada. In the future, we may return to the idea of featuring entrepreneurship focusing more on the venture and experience perceived by the creators and the students themselves.

I let you discover the sections of the bulletin with the Chair's Corner prepared by Prof. Marilyn Lightstone, the Research Highlights selected by Profs. Bilton and MacDonald, the new faculty spotlight series focused on Atlantic Canada with Profs. Landry and Locke, Alumni Q&A with Dr. Gerard Francis McLean, a note from Reza Pedrami, the CSME Student Affairs Committee Chair and last, but not least a special article prepared by Prof. Mitra in honour of Prof. N. Djilali for his great research accomplishments.

I hope you will enjoy reading this new issue.

CÉCILE DEVAUD, PhD, P.Eng., MCSME
Editor-in-Chief CSME Bulletin
Associate Professor
Department of Mechanical
& Mechatronics Engineering
University of Waterloo

Je suis ravie de présenter ce numéro automne 2016 du bulletin SCGM. Je dois admettre que mon rôle a été beaucoup plus limité pour cette édition à cause de mon congé maternité. Ces derniers mois, j'ai dû suspendre la plupart de mes activités professionnelles pour me consacrer à mon petit garçon. Donc, Pr. Poua Rezai, éditeur associé, doit recevoir le crédit pour avoir assembler les différentes pièces. Merci, Pouya! Avant d'aller plus loin, je veux aussi féliciter Pr. Sushanta Mitra pour son nouveau rôle de direction de la SCGM.

Cette édition automne suit une configuration similaire à celle déjà utilisée dans les derniers numéros. Nous serons peut-être plus téméraires avec le temps mais cette structure semble bien marcher. N'hésitez pas à nous envoyer vos commentaires pour des améliorations supplémentaires. L'idée est de présenter un bon mélange de personnes, expériences and divers aspects du génie mécanique. Je crois dur comme fer à la diversité et c'est particulièrement vrai pour notre discipline qui a de multiple facettes. Nous avons une édition spéciale sur l'entrepreneuriat, en particulier sur la façon dont les universités encouragent les initiatives et la créativité parmi les étudiants avec l'objectif de créer une start-up et comment la recherche peut mener à la commercialisation. Il y a bien plus à montrer et les articles sélectionnés représentent seulement une petite partie de ce qui se passe au Canada. Dans l'avenir, nous retournerons peut-être sur une édition spéciale sur l'entrepreneuriat mais plus centrée sur les efforts et l'expérience perçus par les créateurs et les étudiants eux-mêmes.

Je vous laisse découvrir les sections du bulletin avec "le coin du directeur" préparé par Pr. Marilyn Lighstone, les articles de recherche sélectionnés par Prs. Bilton and MacDonald, une nouvelle série sur des nouveaux professeurs des provinces de l'Atlantique avec Prs. Profs. Landry and Locke, Questions-Réponses avec Gerard Francis McLean, un article écrit par Reza Pedrami, directeur de la section SCGM étudiante et non pas moins important, une note spéciale rédigée par Pr. Mitra en honneur à Pr. Djilali pour ses accomplissements de recherche importants.

J'espère que vous apprécierez ce nouveau numéro.

PHOTO: COURTESY OF THE LASSONDE SCHOOL OF ENGINEERING

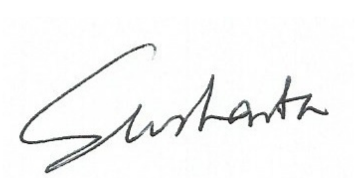
President's Message

IT IS A GREAT PRIVILEGE TO LEAD AND SERVE the Canadian Society for Mechanical Engineering, one of the oldest professional societies in Canada. As a mechanical engineer, we have lot to offer and definitely we would like to have our say in terms of how as a nation Canada revamps its overall innovation agenda. Today, our members have taken up number of key roles in our society – educator, researcher, industry lead, etc. and in every aspect they are challenging the very notion of what defines a mechanical engineer. Hence, we see a number of our members actively involved in starting up their own ventures, creating new spin-off companies out of university, boot-strapping a start-up and many other entrepreneurial activities. They are providing opportunities for new jobs and defining Canada as a country of innovators and entrepreneurs. As an organization, we wholeheartedly support such endeavors of our members.

I would like to take this opportunity to make you aware that each of us has a great responsibility to move the society ahead and make it more accessible to all mechanical engineers, particularly making efforts towards equity and diversity. I urge you to join us and ensure that all of you are engaged with our society and putting efforts to make this a more vibrant one. This is a society based on volunteering and hence I would like to particularly acknowledge and thank all of our volunteers - the Executives, Board Members, and Technical Committee Chairs and also behind the scene countless students and well-wishers who are working tirelessly to make CSME a great technical society.

As our country celebrates its 150th anniversary next year and we are heading closer to our 50th year of CSME existence, lets all pledge together to take a CSME to a new height and bring out initiatives that will celebrate the success and impact of the mechanical engineering as a profession in Canada.

Best wishes,



SUSHANTA MITRA, PhD, P.Eng., FCSME, FEIC, FCAE, FAAAS
Professor, Mechanical Engineering
Lassonde School of Engineering
Associate Vice-President, Research
York University

Message du président

C'est un grand privilège pour moi de diriger et de servir la Société canadienne de génie mécanique, une des plus anciennes sociétés professionnelles au Canada. En tant qu'ingénieurs en mécanique, nous avons beaucoup à offrir et devrions certainement avoir notre mot à dire dans la façon dont le Canada peut refondre son programme global d'innovation.

Aujourd'hui, nos membres tiennent des rôles clés dans notre société - éducateur, chercheur, chef d'industrie, etc. - et dans toutes ces facettes, ils redéfinissent ce que signifie le génie mécanique. Par conséquent, nous voyons plusieurs membres participant activement à la mise sur pied de leurs propres entreprises, de nouvelles entreprises dérivées de la recherche universitaire et de nombreuses autres activités entrepreneuriales. Ils créent des possibilités de nouveaux emplois et contribuent au Canada en tant que pays d'innovateurs et d'entrepreneurs. En tant qu'organisation, nous appuyons sans réserve ces efforts de nos membres.

Je voudrais saisir cette occasion pour vous rappeler que chacun de nous a une grande responsabilité pour faire avancer la société et la rendre plus accessible à tous les ingénieurs en mécanique, et en particulier pour faire des efforts vers l'équité et la diversité. Je vous invite à nous rejoindre et vous activer au sein de notre société pour la rendre plus dynamique. La SCGM est une société basée sur le bénévolat et je voudrais donc sincèrement remercier tous nos bénévoles - les cadres, les membres du Conseil, les présidents des Comités techniques et aussi en arrière-plan les étudiants innombrables et les sympathisants qui travaillent sans relâche pour faire de la SCGM une grande société technique.

Alors que notre pays célèbre son 150e anniversaire l'année prochaine et que la SCGM se dirige elle-même vers sa 50e année d'existence, engageons-nous tous pour amener la société vers de nouveaux sommets et de mettre en valeur les meilleures initiatives pour célébrer le succès et l'impact du génie mécanique en tant que profession au Canada.

Salutations,

Chair's Corner

Professor Marilyn Lightstone

Some thoughts on academic leadership – or lessons learned as a Department Chair

Dr. **MARILYN LIGHTSTONE**, PhD, P.Eng., MCSME
Marilyn obtained her BASc from Queen's University in Mathematics and Engineering followed by a Masters and PhD from the University of Waterloo in Mechanical Engineering in the area of CFD. After obtaining her PhD in 1992, she joined Atomic Energy of Canada Limited as a safety analyst working in nuclear thermalhydraulics. While she enjoyed her work in the nuclear industry, she realized that an academic career was her long-term career objective. She received a NSERC Women's Faculty Award and joined the Department of Mechanical & Industrial Engineering at the University of Toronto in a CLA position in 1995. She subsequently joined the Department of Mechanical Engineering at McMaster University and has been the Chair of Mechanical Engineering at McMaster since 2013.

PHOTOS: RON SCHEFFLER

LIKE MANY DEPARTMENT CHAIRS that I have spoken with, becoming a Department Chair was not a career path that I had envisioned for myself. I had been an Associate Chair (Undergraduate) for many years and really enjoyed that role. In that position I was able to directly help undergraduate students who were facing academic or personal challenges and I felt that I was making a difference in our students' lives. It was an extremely fulfilling and rewarding role. I knew that the Chair position would be different since it involved management of the faculty and staff. I expected that there would be "people" problems and was concerned about having the right skills and experience to be able to navigate these inevitable challenges. Moreover, I had never had any formal training in academic leadership or management. I also worried about the impact of the new role on my research (will I lose my NSERC-DG?) and more importantly on my family. My youngest son was in grade 7 at the time and I knew that the five year term as Chair would span his entire time in high school. My time is further challenged by the minimum of two-hours of commuting to work from Toronto. Despite these misgivings, I viewed the role as a challenge for personal growth and an opportunity to positively impact on the Department and the Faculty. I had been Associate Chair for a long time and it was time to move on to something new. This short article describes many of the things that I have learned in my three years as Department Chair and the leadership attributes that I am striving (and definitely not always attaining) to bring to the role.

So what I have a learned so far?

<u>Things are much more complicated than they appear from the outside</u>: This is probably the most important thing I have learned. There are multiple points of view and complexities in interactions with people. It is important to engage those who are involved in an issue and try and understand their point of view before reaching a conclusion. It is also important to seek advice from appropriate people on how to manage a difficult situation; McMaster's Dean of Engineering (Dr. Ishwar Puri) has been phenomenal in this role, providing outstanding guidance and support. I should note that it is very easy to criticize decisions or behaviours when one is outside of the situation and I think that Department Chairs are often given a tough time because of this. Moreover, transparency in decision making is not always possible if confidentiality or sensitivities are involved.

<u>Our staff are critical to the department's success</u>: One of the great benefits of being Department Chair is the privilege of being able to work closely with our staff. We are blessed in our department with superb staff in both the administrators in the Mechanical Engineering office and the technicians in our Project Laboratories. They are highly dedicated and knowledgeable and also really fun to work with. Our staff have a lot to contribute and should be included in department decisions. In fact, when we interview candidates for faculty positions, we have the staff members interact with the candidate so that we can get a sense of how the candidate treated the staff member. It is unacceptable to be disrespectful to a staff member (with such behaviour being a warning of things that might come) and we use this as a filter for our job candidates.

<u>There is a need to set expectations and create accountability</u>: At my first department retreat I gave a presentation that included (among many other things) a list of expectations. For example, the things my colleagues could expect from me included: respectful discussions, a positive attitude, clear communication of department issues, transparency (where appropriate – see point above) and inclusivity in decision making, availability to discuss problems and help find solutions, recognition of their achievements, and support in their career development (for example through mentoring). In return, what I expected from them included: respectful discussions, a positive attitude, completion of actions on time and with diligence (including their committee work), and engagement in department affairs (i.e. CEAB, attendance at meetings and department events). It is also important to create accountability. If the faculty understand what their tasks are and have had the appropriate training (an example being measurement of graduate attributes for accreditation), then it is reasonable to expect the completion of those tasks (presuming that there has not been a personal event which has interfered with their ability to work). The bottom line is that professors are highly paid and should be accountable.

The importance of transparency and inclusivity: Transparency is critical for getting buy-in from the faculty and staff. As mentioned above, transparency is not always possible if confidential personal issues played a role in an action. Most department decisions, however, are a result of non-confidential information which can be shared. The process of coming to a decision or developing policy about an issue should include input from faculty and staff.

There is a wealth of knowledge in the department, especially from the senior members who may have previously seen similar issues. Meaningful communication with colleagues to explain what the constraints are or the reasons why something needs to be done and then seeking input on the best way to execute or implement is critical. The inclusivity also helps to generate good-will and consensus within the department.

The value of a positive department culture: One of my goals as Department Chair was to build on our existing culture of collegiality, trust, and collaboration. Transparency and inclusivity discussed above also pertain to this point. To build on this positive culture we have increased the number of social events – for example, department lunches – with the understanding that there is value in getting to know our colleagues on a more personal basis. People are busy with work and family, so we try to avoid scheduling social events after work hours. In addition, it is important to recognize and celebrate the achievements of individuals. We have an awards committee which is becoming more active in nominating our faculty and staff. I am very proud that this past year we had three McMaster University President's Award winners: our head technician (Ron Lodewyks) for outstanding service; Dr. Greg Wohl for outstanding contributions to teaching and learning; and Dr. Samir Ziada for excellence in graduate supervision.

Importance of mentoring of new faculty members: In the fall of my first year as Chair, I met with the executive officer for the Faculty of Engineering (Maria Massi) to talk about putting together a workshop for new faculty members. At that time, there had been a number of new hires across the faculty so it made sense to develop a workshop to help them succeed in their new

positions. The idea was that it would be a very informal and fairly general workshop where we would talk about what they needed to do to succeed at the University and to get tenure. It focused on practical advice for teaching, research, service, and work/life balance. We did not aim for perfection in this workshop, but rather for just getting it done. It was very successful and Maria then extended the concept to create the "Faculty Development Academy (FDA)" in 2014. The FDA has numerous workshops covering topics such as teaching large classes, experiential learning, research proposal writing, research integrity, work/life balance, and many others. The FDA is an outstanding initiative and I am delighted to have been a part of its development.

Importance of "picking your battles". Not every battle is worth fighting: Indeed, there is value in "giving in" on the small things in order to maintain good will with your colleagues. Having said that, however, it is important to stand up for what is right and in particular to always keep the students' interests at heart since they are the reason that we are here. We are role models for our students and need to set examples of ethical and professional conduct. Life is too short to argue over everything, so I have learned to focus on what is really important when taking a stand on an issue.

In summary, leadership styles can vary from authoritarian, to participative, to delegative. My own style is blend of participate and delegative. It allows for team building and hopefully provides a sense of inclusion by the faculty and staff. According to a "Wilderness Committee Newsletter" that I found at home, Canadians value honesty, accountability, and kindness. In my opinion, those qualities are well aligned with what is needed for success in academic leadership.

Board of Directors Meeting

CSME had a very successful 157th Board of Director's meeting at York University on 16 October 2016. Among key decisions taken at the meeting:

- Effective 2017, student memberships will be free. The Board considers it crucial to reach out to and recruit as many ME students as possible so they can benefit from what the society has to offer, and vice versa. Students represent the future of mechanical engineering and CSME. Please share this excellent news with your peers.
- The Board established a small Strategic Planning Committee who will perform a SWOT analysis and come up with recommendations to revamp the society's main activities over the next 5 years.
- The new School of Sustainable Design Engineering at UPEI in Charlottetown, PEI, will host the 2020 CSME Congress. The Board had agreed at its meeting last June to hold its Congress on an annual basis as of 2018. York University will host it that year, while the University of Western Ontario will be hosting the 2019 event.

CALL FOR NOMINATIONS

Please nominate your deserving colleagues and peers for the 2017 **CSME Medals and Fellowships Awards**.

Further details and nomination forms are available on the web site: www.csme-scgm.ca/awards
Nomination deadline is **January 31, 2017**.

Let's also own the podium at the **Engineering Institute of Canada Award Gala** on April 1, 2017. Please consider nominating stellar mechanical engineers for the EIC medals and fellowships: www.eic-ici.ca/honours_awards. Deadline for submission is **November 15, 2016**.

ILLUSTRATIONS: SHUTTERSTOCK

Exposure and support inspire student entrepreneurs at Waterloo Engineering

WATERLOO ENGINEERING ALUMNUS KURTIS McBRIDE, CO-FOUNDER OF MIOVISION, A KITCHENER COMPANY THAT IMPROVES TRAFFIC FLOW BY MONITORING AND ANALYZING DATA IN REAL-TIME.

KURTIS MCBRIDE PHOTO BY CAM DAVIES / COURTESY OF THE UNIVERSITY OF WATERLOO

Kurtis McBride can trace his entrepreneurial inclinations all the way back to childhood, when he alarmed his parents by trying to raise mice for sale in the basement of the family home.

But it was as an undergraduate student in systems design engineering at the University of Waterloo that his natural interest in business really took off with the right combination of exposure, encouragement and inspiration.

McBride was working at a transportation company on a co-op job placement – a hallmark of the practical approach at Waterloo Engineering since its founding almost 60 years ago – when he realized there must be a better way to collect traffic data.

"They would pull me in on weekends, and I would sit on a lawn chair and count the cars that went by," he recalled. "I started to see a market need through that experience."

McBride and two fellow Waterloo Engineering graduates went on to found Miovision, which uses a combination of hardware and software to monitor and analyze traffic in real time, then adjust traffic lights to improve the flow of vehicles.

More than a decade later, including early years spent at a University startup incubator called the Accelerator Centre, the thriving Kitchener company is just one of many success stories with roots in Waterloo Engineering's multi-faceted approach to fostering student entrepreneurs.

Well over 600 companies in Canada and abroad were launched by students, graduates or faculty members, including smartphone trailblazer BlackBerry and, more recently, Thalmic Labs, with its gesture-controlled Myo armband.

At the core of the entrepreneurial culture Waterloo Engineering prides itself on is its co-op program, now the largest in the world, which was a priority from the get-go for business leaders who founded what became the University of Waterloo in 1957.

All engineering students must do six four-month terms in the world of work, encouraging them to apply academic lessons, soak up experiences, develop confidence and, like McBride, spot real problems to solve via new businesses.

With hands-on innovation also nurtured through a full roster of student design teams – from a celebrated solar car to a pedal-powered submarine – the entrepreneurial spirit gets lift as well from the University's liberal intellectual-property (IP) policy.

Formalized almost two decades ago, but applied in practice from the early days on, it paves the way for the commercialization of research and ideas by granting ownership to the inventor, helping attract both researchers and students with an entrepreneurial bent.

Once bitten by the business bug, or if they are still preparing to venture out on their own, Waterloo Engineering students have numerous financial and practical programs to turn to for support. Included are:

- **Engineer of the Future Trust** – a pool of discretionary micro-seed funding for budding entrepreneurs that was created by the Dean of Engineering with support from alumni in Canada and abroad.
- **Waterloo Engineering/Spectrum 28 Student Venture Program** – a partnership between Waterloo Engineering and a Silicon Valley venture capital firm founded by alumnus Lyon Wong, it offers cash, mentoring and other resources.
- **Capstone Design** – a range of financial awards are available to support the commercialization of fourth-year engineering projects. The Myo armband is but one successful venture that got its start in the program.
- **Research Entrepreneurs Accelerating Prosperity (REAP)** – an entrepreneurial program that hires undergraduates to develop innovative uses and markets for interactive display technologies.
- **Velocity** – offers numerous free programs – including Velocity Garage, Velocity Foundry and Velocity Science – to provide the knowledge, tools, space and network needed to go from idea to commercialization. The largest free startup incubator in the world, it also does not take an equity stake in companies.
- **Accelerator Centre** – dedicated to building and scaling sustainable, globally competitive technology firms and commercializing advanced research technologies emerging from the University.
- **Conrad Business, Entrepreneurship and Technology Centre** – a hub for entrepreneurship, it offers undergraduate courses, options and minors, a unique co-op enterprise program, and a Master of Business, Entrepreneurship and Technology (MBET) degree.
- **Waterloo Commercialization Office (WatCo)** – helps researchers commercialize innovations by developing startups or licensing technology to existing companies. Services include IP management, commercialization support and access to funding programs.

The entrepreneurial culture at Waterloo Engineering owes a great deal as well to all the students who took risks, setting examples and creating momentum that now feeds on itself.

"It provided me with the courage and the conviction to go out and do this because I am not the only one," said Chanakya Ramdev, a management engineering student trying to make a go of Sweat Free Apparel, a startup developing special undershirts to keep wearers dry. *– Brian Caldwell*

LYON WONG, A WATERLOO ENGINEERING ALUMNUS AND SILICON VALLEY VENTURE CAPITALIST WHO PARTNERED WITH WATERLOO TO CREATE A $2-MILLION FUND TO BACK STUDENT ENTREPRENEURS.

Where Innovators, Entrepreneurs & Changemakers are pushing boundaries

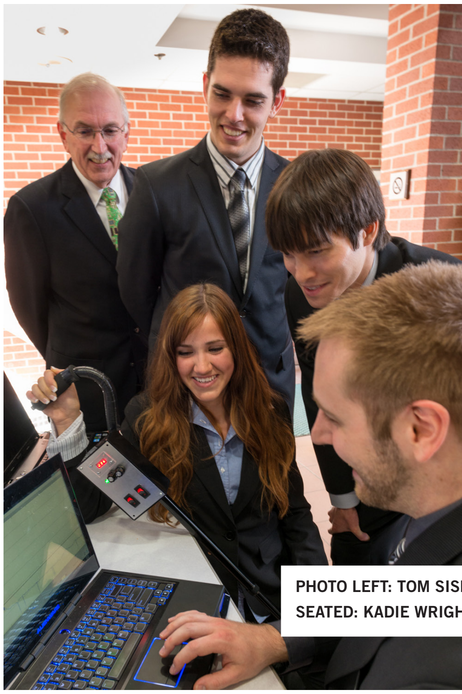
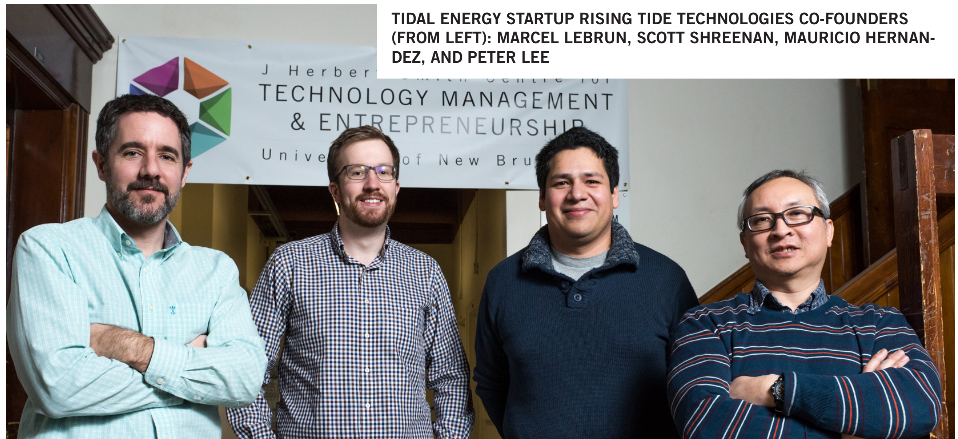


PHOTO LEFT: TOM SISK, ALEX BELYEA, GHISLAIN MAILLET; SEATED: KADIE WRIGHT, GRAEME POWELL



TIDAL ENERGY STARTUP RISING TIDE TECHNOLOGIES CO-FOUNDERS (FROM LEFT): MARCEL LEBRUN, SCOTT SHREENAN, MAURICIO HERNANDEZ, AND PETER LEE

Canada's oldest university, the original home of engineering. The first university to teach entrepreneurship to engineering students – where exciting new things are happening

THE TECHNOLOGY MANAGEMENT & Entrepreneurship (TME) program established in 1988 at the University of New Brunswick's J. Herbert Smith Centre for undergraduate students and has been teaching 21st century skills – critical thinking, creativity, collaboration, and communication – for more than 25 years. Dr. J. Herbert Smith graduated from the Faculty of Engineering at University of New Brunswick (UNB) in 1932 and went to work for Canada General Electric. He spent his entire engineering career with CGE, rising to President and Chief Executive Officer in 1957. He served 15 years as top man of CGE. His words and wisdom are some of the guiding principles at the Centre today. Dr. Smith, an inspirational intrapreneur, passed away on Oct. 16, 1995 at his home in Toronto, Ont. His years of industry experience and insightful observations on the future of the engineering profession in business and management will long be valued by the University of New Brunswick and the Centre that bears his name.

Although launched as a small program, TME has grown by 97 per cent in the last five years while enrolment has surged to more than 530 students. TME is an interdisciplinary program that draws upon the expertise of instructors from the faculties of engineering and business as well as industry leaders from a variety of fields to share their real world experiences. The students graduating from the program have gained employment three times faster compared to their peers. Students work in multidisciplinary teams to reinforce their managerial and innovative skills. Courses are delivered in the evenings, allowing students to easily complete the required courses.

The J. Herbert Smith Centre has continued to show leadership in its offerings by adding a Technology Commercialization Program, a Summer Institute and a Master's degree in TME. The Technology Commercialization Program assists aspiring entrepreneurs with prototype funding to support the often-overlooked, early new venture creation stage. The Summer Institute is a unique accelerator focusing on both non-technology and technology businesses, with a preference for creative economy startups and cleantech ventures, and is part of the Global Accelerator Network which is an elite group of accelerators. A new Master of Technology Management and Entrepreneurship was recently launched for students who have an undergraduate degree in engineering, computer science, or science, and are ready to make an impact. In this experiential program, students learn about innovation and management by actually starting a business, while receiving all the support they may need.

The TME program integrates Design Thinking and Lean Startup methodology. One of the most telling measures of TME's success is the fact that the program has served as the catalyst for more than 30 companies every year and was responsible for winning the top two prizes in the last three New Brunswick Innovation Foundation's Breakthru Business Plan Competitions – one of the biggest business plan competitions in the Canada.

Our students work closely with faculty members, mentors, industry, customers and investors, to create meaningful value for society to move humanity forward. Clearly the J. Herbert Smith Centre is one of the reasons Industry Canada ranked UNB number one in teaching and learning among Canadian higher education institutions that support entrepreneurship education. And in 2014, StartUp Canada recognized UNB's excellence on this front by naming UNB the Most Entrepreneurial Post-Secondary Institution of the Year.
– Dhirendra Shukla

Dr. **DHIRENDRA SHUKLA** *has been the Dr. J. Herbert Smith ACOA Chair since September 2009 based in the Faculty of Engineering offers the Technology Management and Entrepreneurship program at the University of New Brunswick. He did his BEng and MSc in Chemical Engineering and Computing and Performance Engineering from the University of Bradford (UK). Dhirendra worked for several years in the Telecom Sector for Nortel Networks (Canada) in various roles and prior to joining Nortel Networks he worked for Croda International (UK). Dhirendra obtained his MBA from the Telfer School of Management at the University of Ottawa (Canada) and completed his PhD in Entrepreneurial Finance from the University of London in the UK (King's College London). His current research interests are in Venture Capital, Syndication, Entrepreneurship, Corporate Finance, Performance and Governance, and Boards of Directors.*

PHOTOS BY: ROB BLANCHARD

TechConnect – Idea to Invoice Methodology

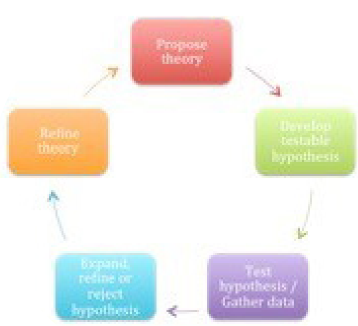
Making Technology Push Work

Faced with poor success rates for commercializing innovative technologies, and based on personal experiences, Drs. Maxwell and McNamee developed the novel TechConnect Idea to Invoice (I2I) methodology - a technology centric approach to commercializing new technologies. This approach is now being successfully deployed at both York and Temple Universities to:

Embed knowledge mobilization and commercialization plans into research funding requests
Act as a formal process to increase commercialization success rates of developed technologies
Create a learning opportunity bringing market perspectives into student capstone technology projects

APPROACH

Historically, 'technology push' commercialization approaches have been criticized relative to customer-centric 'market pull' approaches, because they do not focus on customer need. Indeed "Voice of the Customer" has become the de rigueur approach to new product development, in methods such as: Lean StartUp (Steve Blank / Eric Ries), Stage-Gate® (Robert Cooper), and Design Thinking (IDEO). However, relying heavily on market input and customer needs has significant issues that reduce potential impact, leading to the development of me-too product offerings with little intrinsic competitive advantage, and failing to bring radically new technologies and approaches that address customer unmet needs.



TECHCONNECT FOLLOWS THE SCIENTIFIC METHOD AT EACH STAGE OF THE MULTI-STAGE PROCESS

FIGURE: ANDREW MAXWELL

tial to successful innovation, as any new product or service offering *must* address some need that users perceive and customers are willing to pay for. The TechConnect process offers an alternate perspective by guiding process participants through a number of required stages, while keeping the market perspective kept in mind. At each stage, the TechConnect process uses the scientific method, that starts with a well informed question, and the development of a hypothesis that can be tested experimentally. The results of this experimental approach are used to firm up the original conjecture, or to suggest it was either wrong or incomplete.

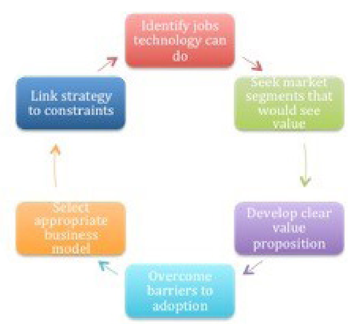
WHY IT WORKS

TechConnect works because it challenges the assumptions of those involved, allowing them to conduct an experiment to confirm their original hypothesis, or modify or reject it based on the results of the experiment. As a result of this approach, promising technologies are often re-positioned to address another application from that initially envisaged, or to target a different use or market segment. The process can also lead to the technology being offered in a different format, and/or delivered through a different business model. Alternatively, the outcome from the TechConnect process suggests that the likelihood of commercial success is low, or that the most likely approach to succeed is not one consistent with the desires of the innovator. In these cases, the decision is often made to discontinue commercialization plans. Overall, deploying TechConnect both increases the likelihood of success and speeds up the recognition of failure. This explains why it is being adopted by: a number of universities, several research intensive technology companies (i.e. InterDigital) and with global research organizations (i.e. NASA).

The rigour embedded in each stage of the process helps participants challenge incorrect assumptions such as: technology use, competitive advantage, first customer, or business model, and results in the creation of a viable commercialization approach. Once technology push approaches are released from the anchoring effect of the *initial* vision, it becomes possible to more objectively evaluate the novel tasks that the underlying technology can accomplish, allowing it to be matched with a wider range of candidate user needs, and market opportunities that create new business opportunities using n*ovel technical capabilities that embed intrinsic competitive advantage*.

HOW IT WORKS

The TechConnect methodology starts by challenging initial assumptions about the application of a specific technology innovation, using a formal creative problem solving approach that combines divergent thinking to search for options, and convergent thinking to select the most promising ways forward. Overall TechConnect follows an iterative process that first matches technology capabilities with jobs needed, then establishes a clear value propositions for customers that need those jobs to be done, before identifying a compelling value proposition for customers in attractive market segment. The behavioral science approach embedded in TechConnect, then asks participants to examine alternate approaches to the market in order to foster adoption, and how to choose between options, based on both organizational constraints, and personal motivation.



SIX STAGES OF THE TECHCONNET PROCESS

(initially technology focused in phase one, then market focused in phase two):

PHASE ONE

i. What novel outcomes does the technology deliver?
ii. Where and why are these outcomes possible?
iii. What are the strengths and weaknesses of the technology?
iv. When or where might these outcomes apply to jobs needed by individual customers, users, businesses or markets?
v. What are the existing incumbent solutions or alternatives?
vi. How well does the technology align with the candidate jobs and applications that have been identified?

PHASE TWO

i. What different Go-to-Market Options are available.?

continued on page 16...

Industry Validation of a Custom-built Heat Flux Sensor for Testing of Wildland Fire Chemicals – The First Step to Commercialization

In May 2016, the province of Alberta experienced one of its most devastating forest fires in Fort McMurray, a city that is approximately 400 km north of the capital city of Edmonton. The fires reminded those in the research community, as well as the provincial and federal governments, of the urgent need for innovation and technology that can be easily introduced into the stream of commerce to facilitate the development of preventative measures. The Advanced Heat Transfer and Surface Technologies Laboratory in the Department of Mechanical Engineering at the University of Alberta, in collaboration with FPInnovations, a non-profit scientific organization that supports the Canadian forest industry, has taken affirmative steps to develop a simple, low-cost, portable thermocouple-based heat flux sensor that is able to withstand high heat loads for extended periods of time without the need for external cooling. The heat flux sensor then forms an integral part of a test methodology that was developed for assessing the effectiveness of wildland fire chemicals based on the ignition time of vegetative fuel samples.

Currently, the measurement of high heat flux such as those observed in wildland forest fires are accomplished by using expensive, thermopile-based sensors that are coupled with mathematical models based on a semi-infinite length-scale. While these sensors are acceptable for experimental testing in laboratories, high errors, or the need for water-cooling limits their application, to the unfortunate exclusion of measurements conducted in the field. Therefore, a one-dimensional, finite-length scale, transient heat conduction model was developed and combined with an inexpensive, thermocouple-based rectangular sensor to create a rapidly deployable, non-cooled sensor for testing in field environments. The sensor is comprised of a 50.8 mm x 63.5 mm x 25.4 mm rectangular block of 6063-T6 aluminum, with thermocouples inserted for temperature measurement. The temperature difference between the back and front surfaces of the block was used to estimate the incident heat flux on the sensor by using the following expression that was derived from a heat conduction governing equation and use of applicable boundary and initial conditions:

$$q''_{\text{incident}}(t) = \frac{1}{\varepsilon}\left(\frac{k\Delta T}{(L-d)} + \sigma\varepsilon\left[T(d,t)^4 + T_1(t)^4 - 2T_\infty^4\right]\right)$$

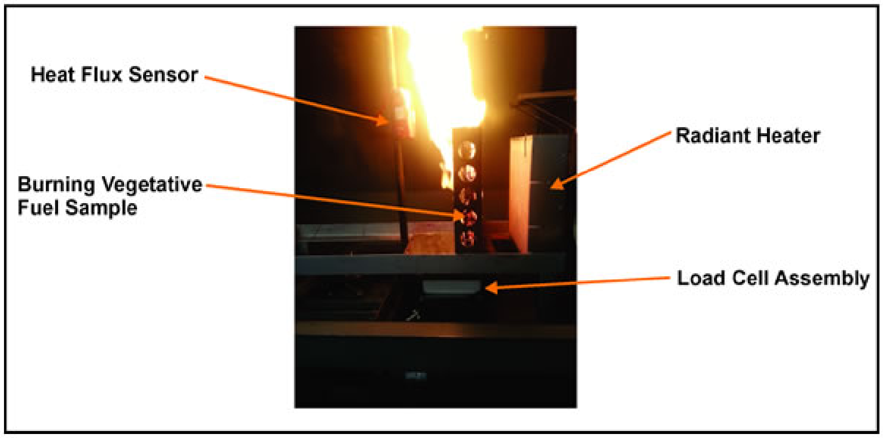


FIG. A: BURN TEST DURING COMBUSTION (FLAMING OF VEGETATIVE SAMPLE AFTER IGNITION)

where L is the length of the block, T1 is the transient temperature of the unexposed back surface of the block, and d is a location between the thermocouples located at the front and back surfaces of the block.

The simplicity of the heat flux sensor allowed for its use in assessing the performance of wildfire chemicals such as foam and gel, as well as water, in prolonging the time to ignition of vegetative fuels such as dried Lodgepole Pine. Samples of the dried Lodgepole Pine were treated with water, foam, or gel and positioned in front of a radiant heat panel to cause ignition. Untreated samples were used as controls. Upon ignition of the vegetative fuel, a rapid increase in the heat load was observed. The time to ignition was determined up to the time at which the nearly singular increase in heat load was observed. By using data obtained from the heat flux sensor, it was quickly found that foams were more effective at prolonging ignition than gels, which in turn was more effective than water treatment.

The research, modelling, and design concept that supported development of this heat flux sensor are simple and well-established in the literature; however, the novelty of the device stems from its low fabrication cost, it is easy to fabricate, is rapidly deployable in the field, and is able to provide data for use in the relative performance assessment of wildfire chemicals. Thus, the researchers at the University of Alberta have worked with FPInnovations and members of their industry consortium to validate the performance of the device. This validation process is the first step towards commercialization of the sensor, which is referred to as a "thermal cube" by the industry practitioners. They have conducted laboratory testing as well as field testing of the heat flux sensor to measure localized incident heat fluxes. The validation of sensor in the field has shown that the device is robust and can withstand the direct passage of high-intensity open flames and fires. This has led to the fabrication of a few dozen sensors for use in fires in Northern Alberta and the Northwest Territories to provide comparative indications of the fire energy release at various locations from the fire.
André McDonald

Dr. **ANDRÉ MCDONALD** *is currently an Associate Professor in the Department of Mechanical Engineering at the University of Alberta. He received his BSME and MSME from the City College of New York (CCNY), followed by a Ph.D. from the University of Toronto in 2007. His experience included a short post-doctoral fellowship at the National Research Council Canada in Boucherville, Québec. Dr. McDonald's current research involves the development of flame-sprayed and cold-sprayed next generation functional coatings that provide wear and erosion resistance and that provide heating and structural health monitoring to polymer-based structures. In the area of fire research, he has been working to develop heat flux sensors to qualify the performance of wildfire chemicals such as retardants and suppressants. Dr. McDonald contributes actively to his research field, and currently serves as the vice president of the Thermal Spray Society Board and Lead Editor of the Journal of Thermal Spray Technology.*

ME NEWS & RESEARCH

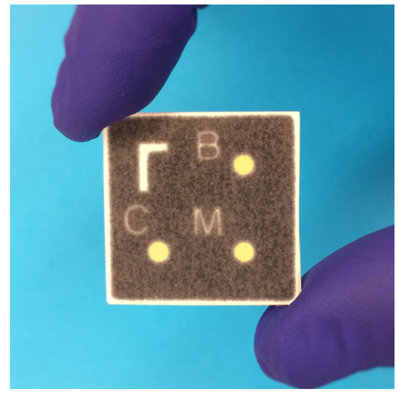
HIGHLIGHTS

Painless Micro-Needle for Drug Monitoring

University of British Columbia (UBC) Mechanical Engineering Professor **Boris Stoeber** and PhD student **Sahan Ranamukhaarachchi**, along with collaborators from UBC Pharmaceutical Sciences and Paul Sherrer Institute in Switzerland, have developed a new method to monitor patients during drug treatments without drawing blood. The method incorporates a half millimeter long micro-needle on patch which would be pressed against a patient's skin during treatment. The needle only pierces the outer layer over the patient's skin to draw a water-like fluid from called interstitial fluid in a painless manner. Less than one millionth of a milliliter of fluid is extracted, reacted within the microneedle, and read using an optical sensor to determine the drug levels. The researchers designed this method to monitor patients undergoing treatment with vancomycin, a popular antibiotic which is administered through intravenous lines. During this treatment, patient's blood must be extracted 3-4 times a day to monitor drug levels due to potentially dangerous side-effects. This method represents an inexpensive and pain-free method to monitor the drug levels. According to Stoeber, "the microneedle technology has the potential to change many aspects of health care. This technology enables new methods of diagnosis and medical treatment that are not possible with current technology." The microneedle technology is currently being commercialized through the UBC spin-off Microdermics. — *Technical Editor, Professor Amy Bilton*

S. A., RANAMUKHAARACHCHI, C. PADESTE, M. DÜBNER, U. O. HÄFELI, B. STOEBER, AND V. J. CADARSO, "INTEGRATED HOLLOW MICRONEEDLE OPTOFLUIDIC BIOSENSOR FOR THERAPEUTIC DRUG MONITORING IN SUB-NANOLITER VOLUMES," SCIENTIFIC REPORTS, JULY 6, 2016.

PAPER-BASED DEVICE MAY LEAD TO A HOME MALE INFERTILITY TEST



It is estimated that over 70 million couples are impacted by infertility worldwide, with male-factor infertility accounting for approximately half of the cases. A semen analysis can be used to determine male fertility potential, but conventional testing is costly and complex.

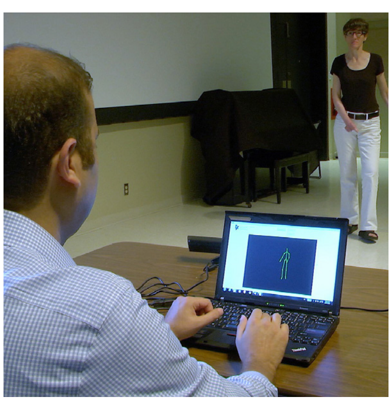
A team led by David Sinton from the University of Toronto along with Armand Zini from McGill University has recently demonstrated that a small paper-based device (pictured) can quantify male fertility potential. The device uses a colour change reaction that changes colour when in the presence of metabolically active sperm. After being placed on the device, the sperm are required to swim through a viscous buffer and a membrane filter before reaching the location where they generate a colour change signal, to asses the motility of the sperm (essentially measuring their ability to swim). By comparing this readout with another one on the same device, where the sperm are not required to swim to it, the device can measure three important factors: (1) live sperm concentration, (2) motile sperm concentration, and (3) sperm motility. They show that this device can generate the same results as conventional tests while also being low-cost and capable of generating a result in only 10 minutes.

David Sinton's group currently has a partnership with Mount Sinai Hospital and a leading fertility clinic in Toronto to combine this device with a cell phone based reading application to offer this technology as an off-the-shelf product for male infertility assessment. This technology can potentially revolutionize male infertility screening for individuals, clinics, and the study of male infertility in populations for researchers and governments. – *Technical Editor, Professor Brendan MacDonald*

R. NOSRATI, M.M. GONG, M.C. SAN GABRIEL, C.E. PEDRAZA, A. ZINI, AND D. SINTON, PAPER-BASED QUANTIFICATION OF MALE FERTILITY POTENTIAL, CLINICAL CHEMISTRY, 62, 458-465, 2016.

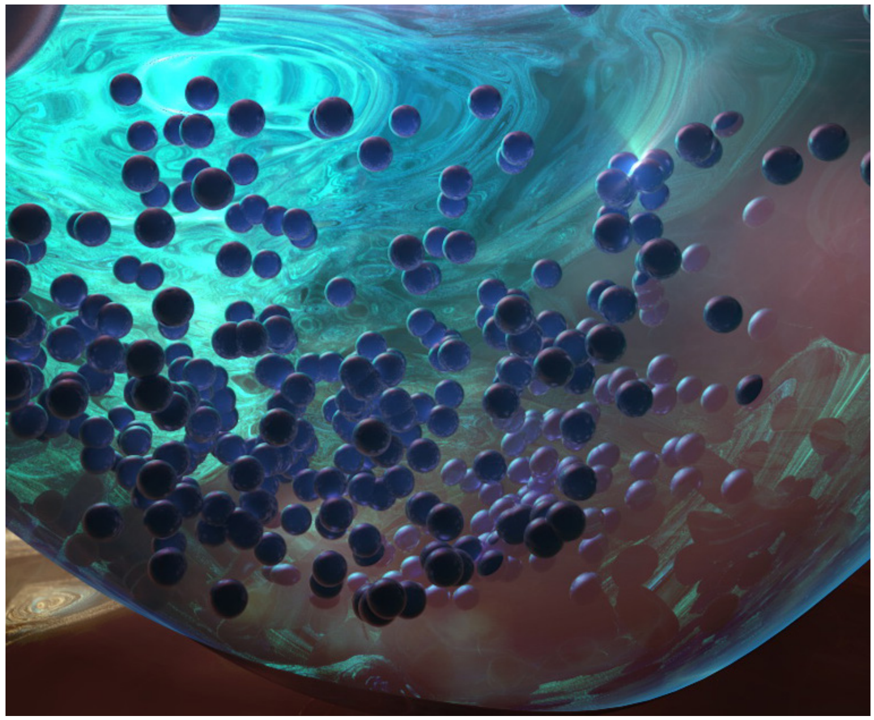
EVALUATION OF MULTIPLE SCLEROSIS PATIENTS USING INEXPENSIVE GAMING CAMERAS

Could a device which is currently in your living room lead to better characterization of multiple sclerosis patients (MS) walking patterns? McGill University Mechanical Engineering postdoctoral associate **Farnood Gholami** and Professor **Jozsef Kövecses**, have been developing an approach, based on a Microsoft Kinnect, which could be used to identify gait differences for MS patients. In collaboration with Daria Trojan from McGill's Department of Neurology and Neurosurgery, Behnood Gholami at AreteX Systems Inc., and Wassim M. Haddad at Georgia Institute of Technology, as system was developed and tested on 10 MS patients and a matched control group for evaluation. They found the system was able to characterize gaits for MS patients of differing levels of severity and identify gait abnormalities. Currently, MS patients are evaluated by physicians allowing for subjectivity and human error in the evaluation. The tool could be used in the future to track progression of MS symptoms, characterize effect of treatments, and has potential for tracking other diseases which effect the human gait.
—Technical Editor, Professor Amy Bilton



F. GHOLAMI, D. TROJAN, J. KÖVECSES, W. HADDAD, AND B. GHOLAMI, "A MICROSOFT KINECT-BASED POINT-OF-CARE GAIT ASSESSMENT FRAMEWORK FOR MULTIPLE SCLEROSIS PATIENTS," IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, VOL. 99, 2016.

SELF-ASSEMBLY USING MICROFLUIDICS CAN AID IN STEM CELL TRANSPLANTATION



Self-assembly refers to a process where an organized structure is spontaneously formed from individual components due to local interactions among the components. Self-assembly is a promising tool for passively creating new structures with a high complexity; however, we still require robust ways to accomplish self-assembly in practice.

A team led by **Scott Tsai**, MCSME at Ryerson University recently discovered a technique to produce controllable self-assembly of microparticles into clusters. They used a magnetic field to draw magnetic microparticles across a liquid-liquid interface and found that they could control the size of the clusters by varying the magnetic field and the interfacial tension of the liquid-liquid interface. They were also able to control whether the clusters were coated with a thin film as they formed, thus providing a method to selectively encapsulate the clusters. Their technique represents an important improvement in self-assembly for creating encapsulated clusters of microparticles.

Scott Tsai and his team are currently working towards applying this interfacial self-assembly technique to coat and encapsulate magnetized cells. One of the applications for this technology is in immunoisolating stem cells for transplantation operations. They have already demonstrated this with some success, and the technology has been exclusively licensed to STEMCELL Technologies Inc. of Vancouver, British Columbia.
–Technical Editor, Professor Brendan MacDonald

S.G. JONES, N. ABBASI, B.U. MOON, AND S.S.H. TSAI, MICROFLUIDIC MAGNETIC SELF-ASSEMBLY AT LIQUID-LIQUID INTERFACES, SOFT MATTER, 12, 2668-2675, 2016.

PHOTO TOP RIGHT: WILFRIED BERNS

NEW FACULTY SPOTLIGHT SERIES:

FOCUS ON ATLANTIC CANADA

This recurring series highlights some new Canadian ME faculty members, by region. In this issue, we focus on the Atlantic Canada, with research highlights from the
Dr. Benoit Landry, Université de Moncton and
Dr. Rocky Taylor, Memorial University of Newfoundland

Université de Moncton, Dr. **Benoit Landry**

Thermoplastic composites made from recycled production waste

Polymer composite materials continue to replace metal in a growing number of applications due to their recognized performance, tailorability, and manufacturing advantages. While the majority of aerospace composite structures are currently manufactured in autoclaves, this process is most cost effective for large, geometrically simple structures like wing and fuselage skins. For geometrically complex part features such as frames or ribs, complex layups with thickness variations significantly increase the cost of the component. Therefore, there is an emerging interest to use composite materials at a smaller scale to replace complex-shaped metallic components using fast and low-cost manufacturing techniques. This presents some unique manufacturing challenges, mainly because traditional continuous fibre composite materials are practically unusable for this type of application, while short-fibre injection moulded parts have limited mechanical properties, although being highly versatile geometrically. Lying between these two extremes are discontinuous long fibre (DLF) composites, a bulk moulding compound type of material that consists of small chips of pre-impregnated tape. Compression moulding of DLF composites into 3D complex-shaped parts has been shown to be very effective for forming net-shaped components having features such as varying wall thickness, tight radii, reinforcing ribs, flanges, mould-in holes, etc.

Dr. Landry's research program aims at developing tools and protocols for the design, manufacturing, and analysis for the next generation of thermoplastic composite technologies. His current research is focused on the manufacturing and recyclability of DLF composites. While this type of composite can be formed from virgin raw material, Dr. Landry and his students are exploring an innovative aspect of this technology; converting recycled production waste (e.g. from cutting prepreg blanks into shapes) into complex-shape composites (see Fig. 1). In comparison with traditional composite recycling techniques such as thermomechanical fibre reclamation, this type of recyclate doesn't require any additional processing steps and can be used as is. The current work aims at understanding how processing can affect part quality and mechanical performance under static and cyclic loading. In the end, this research will lead to the development of a robust processing scheme for the manufacturing and recycling of thermoplastic composites. The technologies and methods developed in the framework of this research have a great potential for commercialization of new products, processes, and process control technologies.

DR. **BENOIT LANDRY** *started doing research on composite materials during his master's degree at Université de Moncton. He obtained his PhD in Mechanical Engineering from McGill University, where he worked on defect prediction during moulding of DLF composites in the Structures and Composite Materials Laboratory. Dr. Landry recently joined the Université de Moncton Mechanical Engineering Department as an assistant professor. His research focuses on manufacturing and recycling of thermoplastic composite materials.*

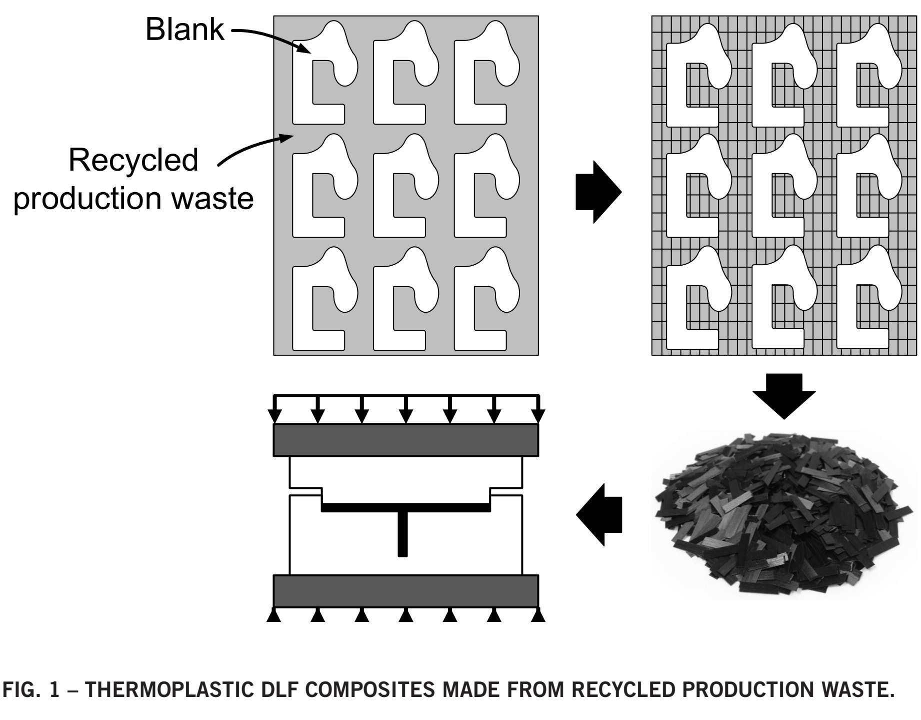


FIG. 1 – THERMOPLASTIC DLF COMPOSITES MADE FROM RECYCLED PRODUCTION WASTE.

Memorial University of Newfoundland, Dr. **Rocky Taylor**

Breaking the ice: CARD Chair in Ice Mechanics focusing on Arctic, sub-Arctic

PHOTO: CHRIS HAMMOND / MEMORIAL UNIVERSITY

Dr. **ROCKY TAYLOR**, BEng, MEng, PhD
Dr. Taylor has been with CARD since its inception in 2011, initially as a senior research engineer and then as a principal investigator for ice mechanics. A graduate of Memorial University, Dr. Taylor holds doctoral and master's degrees in ocean and naval architectural engineering, as well as an undergraduate degree in mechanical engineering.

Dr. Taylor's research encompasses a variety of significant ice-engineering problems, particularly those related to ice-load estimation for the design of offshore structures and the mechanics of compressive ice failure. Much of his work is focused on fracture processes in ice and the analysis of associated scale effects. Dr. Taylor recently completed a Research & Development Corporation (RDC) IgniteR&D-funded program focused on spalling, non-simultaneous ice failure and extension of the probabilistic fracture mechanics model developed during his doctoral studies, which were supported by C-CORE. He is also a co-investigator on a Statoil-RDC-Natural Sciences and Engineering Research Council-funded initiative focused on an investigation of dynamic interactions between ice and compliant structures.

As the new CARD Chair in Ice Mechanics, Dr. Taylor will lead research programs, build a team of full-time researchers and graduate students and develop collaborative relationships with other academic and industry-based researchers. Dr. Taylor will also contribute to a strong academic program in the Faculty of Engineering and Applied Science by teaching undergraduate and graduate courses, supervising student projects and theses and providing academic and professional service.

DR. ROCKY TAYLOR HAS HAD a fascination with ice since he was a kid growing up in a small community northwest of St. Anthony, NL, known as the iceberg capital of the world.

"Growing up in Raleigh, I developed a high degree of comfort around ice, and also a great deal of respect for the potential hazards it can create as well," he said. "Many outdoor activities in the winter were carried out on the ice and in the spring we spent a lot of beautiful afternoons playing on the ice in the harbor and on the bay. Sea ice and icebergs were just part of the backdrop of everyday life for much of the year, so working around and with ice is something I became quite accustomed to."

Ice failure processes

These days; however, Dr. Taylor's fascination with ice isn't for playing childrens' games. As an assistant professor (mechanical engineering) and the CARD (Centre for Arctic Resource Development) Chair in Ice Mechanics in Memorial's Faculty of Engineering and Applied Science, Dr. Taylor now collaborates with industry partners to conduct large-scale experiments and theoretical studies of ice failure processes in Arctic and sub-Arctic regions.

Through this chair position, which is funded through the CARD program hosted by C-CORE and jointly funded by Hibernia Management and Development Company Ltd. and the Terra Nova project, Dr. Taylor conducts research that focuses on three thematic areas – modelling ice-structure interactions, modelling ice failure properties and behavior and conducting field programs to help understand and characterize ice environmental conditions.

There are some very exciting opportunities here in the new frontier basins that have been discovered offshore Newfoundland and Labrador," said Dr. Taylor. "The research we are doing will support the safe, economic development of the vast offshore resources present in ice-prone regions, and support improved efficiency and safety of vessels operating in ice. An essential part of how we achieve this is through extensive collaboration with our industry partners, as well as through partnerships with other world-leading ice engineers and researchers."

Critical mass required

While many of his projects involve international collaborations, Dr. Taylor also highlights the importance of the strong relationships he has with his colleagues at C-CORE, the National Research Council (NRC) and Memorial, who all play a vital role in maintaining the critical mass needed to sustain a vibrant ice engineering community here in Newfoundland and Labrador.

"One exciting area of research we have been working on is investigating the role of temperature, interaction rate, scale and structural compliance in the synchronization of ice failures that can trigger ice-induced vibrations on structures," said Dr. Taylor. "We have conducted experimental and numerical analyses to improve our understanding of the physics of fracture and localized changes to the ice microstructure (damage), which results in drastic changes to local ice material properties near the contact interface.

"This work has significantly increased our understanding of links between these processes, structural response and associated ice loads. New probabilistic approaches for modelling fracture, as well as estimating local and global design ice pressures have also been developed, which are important in helping link risk-based design methods with the underpinning physics of ice compressive failure."

'Confinement and temperature'

Dr. Taylor and his colleagues are also working to develop an improved understanding of how strength develops in ice ridges, which form when large masses of broken ice (rubble) accumulate in nature due to movement and deformation in the pack ice cover.

"Large-scale experiments carried out as part of past collaborations between CARD and the NRC have provided important insights into the influence of factors such as confinement and temperature on the development of overall strength in ice ridges," explained Dr. Taylor. "The next step is to link the overall strength of these ridges with the physics of the processes by which strength is developed in and between the ice blocks that make up the keel. Understanding and modelling these phenomena are essential in

DR. TAYLOR TAKES A SELFIE WITH TEAMMATES IN THE BACKGROUND (LEFT TO RIGHT: ROB PRITCHETT, DR. GREG CROCKER, DR. ELEANOR BAILEY AND DR. IAN TURNBULL DURING A FIELD PROGRAM ON PISTOLET BAY, NL IN FEBRUARY 2016.

guiding the development of improved methods for modelling loads on structures, ships and subsea facilities that may interact with such ice features when operating in first-year ice environments."

To help verify that findings from desktop and laboratory studies translate to full-scale interactions, carrying out field tests and data collection programs are crucial. Building on past field work in the North Humberland Strait, the Caspian Sea, and the Barents Sea, Dr. Taylor works closely with his colleagues at CARD to collect new field data offshore Labrador and in northern Newfoundland.

"In our current field work, we deploy various types of instrumentation, which provide vital data needed for the development of next generation ice drift forecasting and ice-structure interaction models," explained Dr. Taylor. "This research is also closely linked with the development of improved models of pack ice pressure that we are working on. Pressured ice can occur when converging ice conditions arise due to wind, current and pack stresses. These ice conditions may impede and beset vessels operating in the sea ice, which may also impact the operations they support.

"In addition, field experiments are being conducted to improve our understanding of ice-ice interactions and the failure processes that limit pressures during these interactions. This includes the collection of new ice failure strength data to study the effects of scale and in situ conditions on ice flexural and compressive strength."

Impact of global warming?

When asked about the future of ice mechanics in a warming world, Dr. Taylor replied, "Despite changes to ice regimes around the world, ice will continue to be an essential consideration for ships and structures operating in sub-Arctic and Arctic regions well into the future. The only certainty going forward is uncertainty and it's here that engineering research plays an essential role.

"Our work aims to enhance the safety and economy of design and operations through the reduction of uncertainties in modelling ice-structure interactions and associated risks. An essential part of this is characterizing ice environmental conditions and understanding how evolving ice conditions may translate into changes in the types of ice features present, the nature of interactions and the corresponding risk profiles for structures, vessels and other infrastructure, so as to support effective decision-making. In nature, variability is always present and the key is to appropriately account for these uncertainties and build in sufficient system capacity to ensure safety is achieved." – *Jackey Locke*

ii. Who are the relevant stakeholder groups for each go-to-market option/application combination?
iii. What are the critical barriers to adoption for each go-to-market option/application combination?
iv. What constraints would apply for each go-to-market option?
v. How can the business model or technology form be changed to encourage adoption?

WHAT'S NEXT

Drs. Maxwell and McNamee are now sharing the tools and approaches with University and research organizations globally to provide them with data and case studies to validate this approach. In addition, they are developing versions of this approach to include as credit courses in Masters Degrees in Innovation and Engineering at their respective universities. They invite others to access these tools , and share their experiences at www.innovationcartography.com.

Dr. **ANDREW MAXWELL** *is an Associate Professor, Entrepreneurial Engineering, in the Department of Mechanical Engineering, at Lassonde School of Engineering. He received his Ph.D. in the management of technology from the University of Waterloo in 2011, winning the Academy of Management's Heizer Award for his research on the Business Angel Investment Decision. He is currently MultiMedia Editor for the Journal of Business Venturing and a member of the Editorial Review Board for IEEE Transactions on Engineering Management. His current research is on the link between trust and innovation, and new models for technology commercialization.*

CSME WEB SITE HAS A FRESH NEW LOOK!

CSME is happy to announce the launch of its revamped mobile-friendly website. We trust that you will find it easier to navigate. Please visit us @ **www.csme-scgm.ca**. Look for further enhancements in coming months.

CSME has also created new Twitter feeds **@CSME_SCGM** and a Facebook page at **www.facebook.com/CSMESCGM**

Please provide your comments and also announcements/ pictures etc. that you would like us to broadcast through our social media.

PHOTO TOP LEFT COURTESY OF DR. ROCKY TAYLOR | ILLUSTRATION (BOTTOM LEFT): SHUTTERSTOCK

Q&A

Dr. Gerard Francis McLean

Tell us why you chose to study Systems Design Engineering at University of Waterloo and what led you to selecting an academic career in Mechanical Engineering at University of Victoria in 1989?

In a word: Design

Systems Design at Waterloo offered a comprehensive multidisciplinary engineering program with a focus on design methods. I was particularly attracted by the emphasis on synthesizing solutions to problems - most other programs at the time appeared to emphasize analysis. When I was looking for a faculty position, I wanted the opportunity to teach design and to encourage students to think creatively and be innovative. The Mechanical Engineering Department at UVic was quite new at the time and there was a great opportunity to create the design curriculum and to emphasize this as an integral part of the program. Our design program worked out really well during those years - our students were constantly engaged with the local community solving real world problems, mapping these problems onto their more technical courses and winning design competitions with the results.

You founded Integrated Data Acquisition (iDAQ) in 1996 when you were an Associate Professor at University of Victoria. What was the innovative technology behind this spinoff and how was it transformed into a business? What did you learn from your first entrepreneurial venture?

My quest to fully understand the process of design and innovation has always led me to seek partners for my work and to try and take every design project towards regular implementation as far as possible. This emphasis towards design utility led me to establish iDAQ, as it was clear there was significant need for the technology.

The challenge for iDAQ came out of student design activities which identified the need to obtain real world strain data for designing complex structures. Initially, we worked on dynamic strain measurement for racing mountain bikes but later expanded our work to highway bridges and aircraft. There was no system at the time which provided an unobtrusive way of monitoring strain on these dynamic structures. iDAQ developed the 'Stressnet' system which comprised a network of tiny smart sensors distributed around the structure and a wireless telemetry link to transmit the measured data to a recording system. We could monitor dozens of strain points with a sample rate of 1 Khz on a bike with a system weighing under 500 g.

Some of the lessons we learned from this were obtained through dealing with the issues raised due to the technology being at a very early stage to create a viable business model. Our focus was on providing a tool for research, for which there was not a very large market. When we attempted to focus on onboard vehicle diagnostics, we found most customers feared the technology would force their expenses to rise, putting them in a disadvantageous position against their competitors. It was a counterintuitive lesson that better technology does not necessarily make a better system from the customers point of view. Today, we see the emergence of the 'Internet of Things' which has a similar technology base as what we were trying to develop at iDAQ- it will be interesting to see where all that goes.

Why did you decide to leave your academic position and to found Angstrom Power Inc. shortly after becoming a full professor? How has your academic experience in Mechanical Engineering served you to become a successful businessman?

My commitment has been to learn the processes of design and innovation by taking design ideas as far as possible towards implementation. Being a struggling entrepreneur seemed to be more aligned with this commitment than being a frustrated full professor! I have continued to learn about design - through the Angstrom experience - in ways I never imagined.

We had begun fuel cell research at UVic in 1996 when I was invited to provide a creative design perspective to a much larger team of researchers funded by NSERC, British Gas and Ballard Power. After immersing ourselves in the fledgling fuel cell industry for a few years, it was clear that most of the development was around 'big systems' requiring large investments and government support. The concept for Angstrom Power was to focus on micro fuel cell development for portable power applications and to see if we could provide sufficient benefit to consumers that they would 'pull' the technology into the marketplace and lead the way for hydrogen energy at other scales. Our proposals for research activity in the area were not well received as we had no industry partners to validate the work. However, when we took the plan to the Venture Capital community we received rapid and significant support, so we decided to proceed in the private sector, outside of the university.

Tell us about Angstrom Power Inc., its major achievements during your presidency (2002-2011), and the process that led to its acquisition by BIC Inc. in November 2011.

Angstrom Power began by developing a unique micro-structured fuel cell which we believed would offer higher power density at lower cost than 'shrunk' fuel cells of conventional design. After a few years, it became clear we needed to expand the scope of the technology portfolio to complete "Micro Hydrogen" systems, including the fuel cell, balance of plant, onboard hydrogen storage systems and portable hydrogen refuelling because none of these technologies had been developed by partners as we had originally hoped it would. We built a team that peaked at 75 workers - mostly engineering oriented - who worked to perfect 5W planar fuel cells that weighed 4 g and were smaller than a credit card in every dimension, novel planar fluidics (valves, regulators, PRD, TRD, etc.), solid state polymerized metal hydride systems for onboard storage and fast refuelling devices. Apart from working as part of a management team to make Angstrom a commercial success, my job was to nurture a development environment that promoted creative risk taking in the context of hard targets and tough evaluation metrics. It was a privilege to be able to watch the inventions of so many people come together to make the best micro fuel cell systems anywhere - for the first five years we generated roughly one new patent every month, we had development relationships with every major cellphone manufacturer and investments from the largest battery makers in North America and Japan.

The sale to BIC was a straightforward business decision taken by our investors - BIC had both the manufacturing expertise and global distribution necessary to launch such a new technology, and Angstrom had a suite of system components that were an ideal complement to some fuel cartridge technology that BIC had been developing independently. It was a good fit to enable the next steps of development.

You have extensive experience both in academia

and in technology-driven businesses. What are your views on innovation, technology commercialization and entrepreneurship which is the focus of this issue of CSME Bulletin?

This is a very hard question to answer in a short note. I don't think any two situations are the same and so prescriptive answers will seem trite. However, the one common thread in everything I've seen and done is the need for a person to be a champion and leader, someone who is willing to take a risk in order to make the business work. Many of my academic colleagues see huge potential for their ideas, but are unwilling to take the risk to advance those ideas beyond academic publications. Universities try hard to create various structures to support commercialization, but in the end it takes the dedication of people to literally carry the technology from the lab into the 'real world'.

I've seen businesses 'buy' or 'license' innovations only to have them go nowhere because nobody in the business understands the technology well enough to be able to see alternatives when problems arise, causing the technology to be abandoned.

Transitioning a technology from the lab into business requires the passion of an inventor - but also requires the inventor to recognize that as the technology matures it is going to take contributions from lots of other non-engineering skill-sets to get to commercial success. It takes a commitment to an idea and a willingness to grow with it as it matures.

What role does research play in initiating a business and nourishing it over the years of its development and expansion? What are the major differences between academic and industrial research? And how can academic-industry research be supported by local, provincial, and national institutions and organizations?

The core value of a technology driven business lies in the fundamental innovation which is creating a competitive advantage in the market compared to incumbent technologies. The academic research world tends to focus on identifying those innovations and demonstrating what the potential might be. The business is tasked with the job of realizing that potential, which includes building the ancillary components necessary to make products, building the supply chain, finding the unique selling proposition for the product, raising the capital and marketing, etc. A very small portion of the activities of the business would ever warrant publication in a scientific journal, yet all those activities are totally essential if the benefit of the technology is ever to be realized.

My favourite example of this, from a purely technical perspective, has been seals in fuel cells - try to find a study of fuel cell sealing in the academic literature and you will not find much, check the patent literature and you will find a bit more; but talk to the engineers working on the fuel cells and you will find a mountain of knowledge and know-how related to materials, structures and processes for keeping the reactants, products and bi-products separated. The academic "innovation" might relate to some electro-chemical aspect of the fuel cell, but sooner or later the developer is going to need that sealing know-how if they are to succeed.

In an ideal world these two sides would work closely together to accelerate the transition of an innovation into a product by re-using the business components and enhancing their development cycle. This implies a long term relationship between a company and a group of researchers so that in time the lag between invention and value creation would be very short. But this is difficult, as the academic community typically works on the timescale of years to complete a project (largely revolving around the cycle time of a graduate student) whereas the company works on the timescale of months (largely revolving around the cycle time of financing rounds). This timing mismatch makes it extremely difficult for startup companies to maintain a long term relationship with a university.

I actually think that our system of support for innovation is pretty good in Canada. NRC-IRAP, in particular, provides very flexible support that is directed right at the interface between the university and early industrial activity. Our SR&ED tax program provides significant funding for bona fide research activities undertaken in an industrial setting. Few countries offer these sorts of programs. NSERC has a tough job of trying to find a way to support the gamut of research activities ranging from fundamental physics to the most applied system demonstration.

What are your views on future of energy systems and particularly fuel cells? What are the major challenges that need research and innovation?

In August 2016, the CO_2 concentration in our atmosphere crossed 400ppm and is unlikely to drop below that value in the next hundred years. We need to do two things if we want to limit temperature increases by managing greenhouse gas concentrations: first we need to stop emitting greenhouse gases, so a zero emission agenda for energy technologies is required. Second, it looks increasingly likely that we will need to actively remove greenhouse gases from the atmosphere if we hope to return GHG concentrations to 20th century levels. There is a massive need for evolving our energy systems towards the zero emission objective (through both design of new technology and design of new policies) and atmospheric remediation will create a new and significant load on the energy system that can be implemented in novel ways as it is not connected with the daily and annual cycles of human activity. Design opportunities abound.

I have never believed that hydrogen and fuel cell technology is 'the answer', but rather view this as an important suite of technologies with the potential to provide options and alternatives for carrying energy. Hydrogen has potential to be a transportation fuel, as well as, an energy carrier that might be more conveniently stored than electrons. However, the technologies required to manipulate hydrogen in our energy system continue to be complex and expensive and we see hydrogen technologies struggling to compete with other technologies in the real world marketplace despite its great potential. The issues for hydrogen energy come back to a point I was making earlier - the potential benefit is well understood and the research community continues to make significant improvements, but the practical details required for implementation make it difficult to realize those benefits in a productized setting.

What is defined as success for a spin-off company and what are the major components that contribute to this success at different stages, such as technology validation, business model development, commercialization, expansion, acquisition and so on?

Every company has a different definition of success and completing each of the stages you mention in the question could be defined as the exit point for a company or a transition to the next stage of development.

A company needs to show that it is creating value for its investors, so really, success is defined as completing a suite of activities to increase value. Note this does not always involve building or manufacturing a product. The hard part for fledgling entrepreneurs is to recognize which activities will create the most value the fastest, and then, to recognize when value creation has started to reach diminishing returns. This is where technology entrepreneurs like

continued on page 20...

IMAGE: SHUTTERSTOCK

Ned Djilali

A FUEL CELL GURU

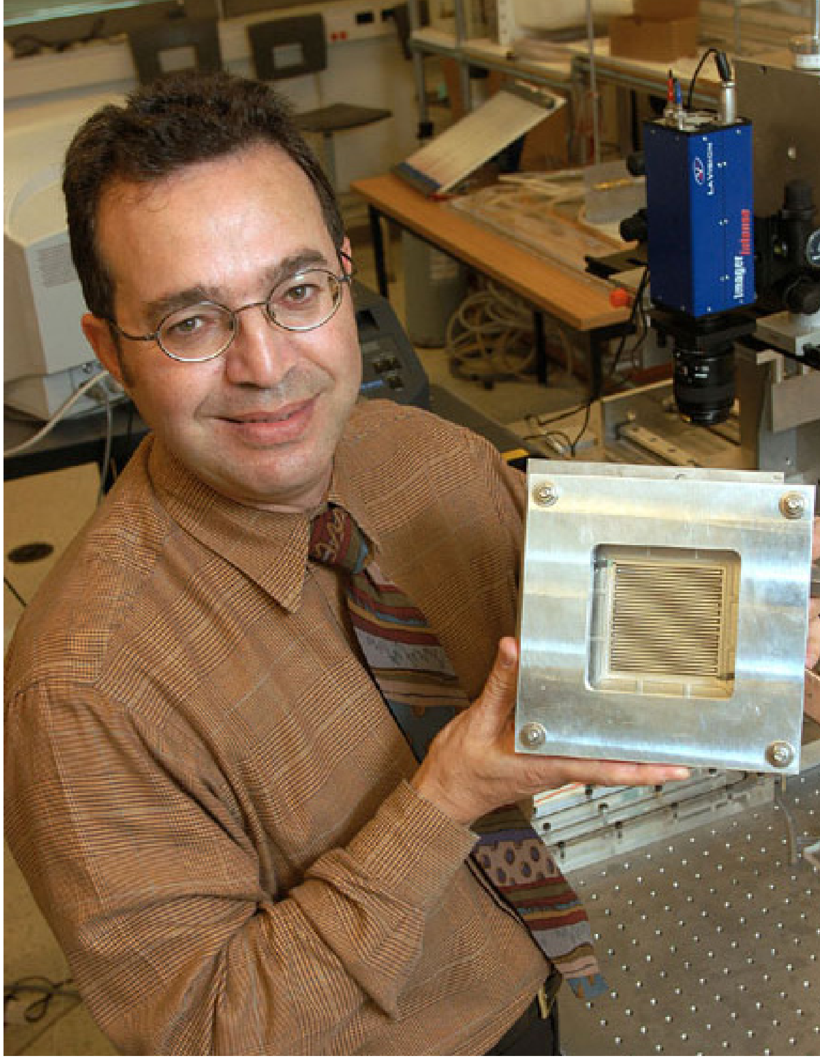
A TRAILBLAZER IN A TRUE SENSE, Ned Djilali, FCSME was born and raised in Algeria in the midst of the war of independence. At the age of 7 he was sent to a summer camp in central France to get some reprieve from childhood asthma. This first flying experience made a big impact on him and changed his career ambitions from being a goldsmith to becoming an airplane designer.

After graduating from high school, he went to England with a scholarship to study Aeronautics, obtaining a Bachelor's at the University of Hertforsdhire and a Master's at Imperial College.

Following military service with the Air Force, he went to UBC to do a PhD in experimental anc computational fluid dynamics, working on complex turbulent flows under the joint guidance of the late Ian Gartshore and Martha Salcudean. He then fulfilled one of his childhood ambitions by joining the Advanced Aerodynamics Department of Bombardier Inc. where he worked on several projects including the wing design of the Canadair Regional Jet.

The University of Victoria lured him back to the west with a position in the budding Mechanical Engineering Department that was founded by one of the gentlemen and scholars of our profession the late Bez Tabarrok (President of CSME 1993-94). The collegiality and energy of the Department allowed Ned to blossom as a teacher and researcher. Within his first three years, he won two teaching awards and initiated research projects in fluid mechanics, transport phenomena in crystal growth of semiconductors (with Sadik Dost) and water desalination (with Geoff Vickers). Work in this area earned him and his collaborators the IMechE Ludwing Mond Prize.

A water shed in Ned's career was the launch of the "Next Generation Fuel Cell Technology", the brainchild of David Scott, who also founded the Institute of Integrated Energy Systems (IESVic) at the University of Victoria. The program which was jointly supported by NSERC, Ballard Power Systems and British Gas had a great influence on Ned's career as he embarked on a fascinating array of interdisciplinary research problems in the budding field of fuel cell technology, and on broader issues of energy sustainability.



Ned Djilali has an uninterrupted record of high impact scholarly research since joining UVic 25 years ago. He has spearheaded a sustainable energy research program that helped position UVic amongst the world's leading institutions in this field. The two unifying themes of his work are energy systems and transport phenomena (i.e. fluid flow, heat, mass and charged species transfer). His contributions include pioneering work in fuel cell science and technology, integration of renewable energy in smart grids, energy systems modelling, and energy-water nexus analysis, as well the analysis and design of thermofluid systems ranging from aerodynamics and water purification to crystal growth of semi-conductors. His scholarly work has had wide scientific impact and earned him the Thompson-Reuters Highly Cited Researcher Distinction, placing him globally amongst the top 200 most influential researchers in Engineering. The application of the work to design has generated a body of patents and significant technology transfer to industrial partners developing clean energy technology. In the course of his UVic career Ned Djilali has also trained, mentored and inspired over 150 graduate students, post-doctoral fellow and undergraduate research students, providing them a stimulating lab environment fostering excellence and opportunities to work at the forefront of energy systems and thermofluid science. Many of his former students have become academic and industry leaders in sustainable energy research and development.

Together with students and collaborators he has also devised new experimental procedures and elegant analytic models to unravel fundamental questions related to liquid water transport and heat transfer in porous fuel cell electrodes.

A notable aspect of Ned Djilali's research has been his ability to translate advances in fundamental knowledge to the invention of novel fuel cell architectures that exploit microscale transport.

In the area of Energy Systems, Dr. Djilali has in recent years made unique contributions to the integration of renewable power generation. He led the development of a laboratory scale integrated renewable energy experiment (IRENE) which allowed for the first time investigation of the dynamics of a system coupling wind and solar energy to a regenerative electrolyser/fuel cell/battery system to guide the design and integration of residential-scale renewable–regenerative system. In order to help address the issue of intermittency that limits the penetration of renewable energy, Dr. Djilali and his students have explored novel "Demand Response" (DR) strategies in conjunction with smart grid technology. As part of this work a new thermostat that can respond appropriately to transactive electricity price signals was invented.

Ned's exceptional scientific and engineering contributions are complemented by outstanding research leadership and service. As Director of the internationally recognized Institute for Integrated Energy Systems (2001-07), he spearheaded a significant expansion of IESVic membership and sustainable energy research activities. His efforts led to over a dozen new industrial partnerships; engagement and commitment of faculty from several disciplines (engineering, chemistry, economics, environmental studies) and facilitation of interdisciplinary collaboration in sustainable energy research. Dr. Djilali also extended his efforts into the realm of policy. He was a member of the task force that developed the "BC Hydrogen & Fuel Cell Industry Strategy" and co-authored a report for the Premier's Technology Council; he served on the NRC Fuel Cell Program Advisory Board and on the Hydrogen Highway Steering Committee; he has testified in front of a standing committee of the Senate of Canada and was invited to lecture members of Parliament (RSC-PAGSE Lecture) on sustainable energy systems. He also played a lead role (as Theme Leader) in the successful proposal of the Wind Energy Strategic Network (WESNET), and of the NSERC Hydrogen Canada (H2CAN) Strategic Research Network. As Interim Director (2009) and Chair of the Program Committee, he led the Pacific Institute for Climate Solutions (PICS) during its inception phase and continued subsequently to play an active role in promoting interdisciplinary research across science, technology, economics and social sciences to inform policy development. Dr. Djilali has also served on professional organization, national and international committees and editorial boards; he served as President of the CFD Society of Canada, chaired the NSERC Grant Selection committee (Mech. Eng.), and served on the NSERC Joint Prizes Committee. He continues to be engaged in policy research through the analysis of climate-water-energy nexus and its long term planning implications for BC and other parts of the world such as the water stressed Middle East.

Ned's greatest satisfaction since joining UVic in 1991, stems from engaging, training and mentorship of over 150 stellar students and post-doctoral fellows. As a young engineer and professor, Ned benefitted from the mentorship of wonderful colleagues and he has tried to pass this on by enthusiastically mentoring a number of younger colleagues and engaging them in clean energy research.

In his spare time Ned likes to hit the trails running or hiking. In 2012 he took his first long break in over 20 years to walk the Camino de Santiago in Spain. — *Sushanta Mitra*

myself really need to partner with people that have a strong business orientation to identify what success looks like and develop a path to get there. Value creation is not necessarily the same as product sales.

You hold more than 60 issued patents and over 20 patent applications under review. Tell us about the importance and the role that intellectual property plays in technology-based businesses in the 21st century. Do you foresee any changes that might happen in the future with regards to how small businesses protect their intellectual properties?

For Angstrom Power, the IP portfolio was hugely important. It created a tangible base of assets which could be valued by investors and proved to the broader community that our technological capability went well beyond clever know-how. We were able to continue to attract private capital investments, to sell licenses to our technology and eventually to sell all the assets of the company, largely because we had developed a comprehensive IP portfolio. For us, it was part of our value creation strategy.

In general, though, IP protection can be a mixed bag. Having a patent is no proxy for having a commercially valuable technology and sometimes an over protective attitude towards inventions can really stifle the development of a technology. I regularly wonder about alternative methods of protecting ownership while sharing ideas; but, for early stage companies the IP is often the only real asset they have to offer to the investment community.

What is your favorite development/device/product so far and why?

When engineers began their new job at Angstrom, I would give them their first few weeks to get oriented, understand the company objectives and invent something new and amazing. Often this would result in not much beyond a well-oriented engineer; but on a few occasions, people hit the jackpot. My favourite invention is the product of a brilliant young engineer named Joerg Zimmermann who joined Angstrom to work on fueling. He came up with the idea of binding metal hydrides to highly elastic polymers to create a rock like solid capable of storing hydrogen without some of the common challenges of decrepitation and settling that face the design of metal hydride storage systems and require metal hydrides to be packaged in cylindrical pressure vessels. In three weeks, he had proven the concept, for which he led the further development over the next several years. Angstrom was able to create prismatic metal hydride storage systems as small as 10 cc, with both gravimetric and volumetric energy densities roughly twice that of the best lithium battery. This is easily my favourite of Angstrom's inventions - it created huge value for Angstrom Power and was the product of a fairly 'out there' approach for nurturing innovation.

Do you have any advice for students who want to pursue an entrepreneurial career path after their graduation? How can post-secondary education help these students achieve their goal?

I would encourage students to think big and take risks with their research. Doing risky research might lead to a big innovation, but more importantly it will help students learn the processes of treading new ground and managing the absolute uncertainty that comes with risk taking.

In a practical way, graduate-level education might provide the opportunity to get out of the engineering lab and learn about all those other disciplines and skills that will be required to make a successful company.

VERONICA MARIN, PhD IN MECHANICAL ENGINEERING
AUTONOMOUS SYSTEMS AND BIOMECHATRONICS LAB
UNIVERSITY OF TORONTO

PHOTO: ROBERTA BAKER / UNIVERSITY OF TORONTO ENGINEERING

Tenure-track position in the area of Solid Mechanics

Department of Mechanical and Industrial Engineering

Concordia University's Faculty of Engineering and Computer Science hosts over 7500 undergraduate/graduate students and prepares the next generation of technical leaders and entrepreneurs to address complex real-world problems. We offer a multi-disciplinary and research-engaged environment dedicated to incubating innovation, excellence and success. Our teaching and research is daring and transformative and contributes significantly to the sustainable intellectual and economic development of our community. We connect ideas with people and we are redefining the university experience.

The Department of Mechanical and Industrial Engineering has a faculty complement of 50 professors active in various areas of mechanical, industrial and aerospace engineering and its strength has grown in recent years. The department offers PhDs, master's and bachelor's degrees in mechanical, aerospace and industrial engineering. Enrolments are strong at both the undergraduate and graduate levels. More information on the Department is available at:
http://www.concordia.ca/mie

The Department of Mechanical and Industrial Engineering seeks an outstanding candidate for a tenure-track position in the area of Solid Mechanics, with research interests which could include, but are not limited to, vibrations, stress analysis, deformation and fracture mechanics. The appointment will be at the rank of Assistant Professor, but exceptional candidates at the Associate Professor level may also be considered.

Applicants must possess a PhD degree in mechanical engineering or a related discipline. The successful candidate is expected to demonstrate a strong commitment to the supervision of MASc and PhD students and to excellence in teaching at both the graduate and undergraduate levels. She/he will conduct independent scholarly research, attract external funding and be able to demonstrate industrial applications of their research activities. Eligibility for certification as a Professional Engineer (preferably in Quebec) is essential. The language of instruction at Concordia is English; however, knowledge of French is an asset. Applications must include a cover letter, detailed curriculum vitae, teaching and research statements and the names of four referees in their application that shall be accepted in electronic form (PDF). Applications will be reviewed on an ongoing basis until a suitable candidate has been identified, but should be submitted by December 15, 2016. Only short-listed applicants will be notified. The appointment is expected to commence in August 2017.

Kindly forward your electronic applications to Ms. Sophie Merineau (assistant-to-chair@mie.concordia.ca)

Dr. Martin Pugh, FCSME
Chair – Mechanical and Industrial Engineering
Concordia University
1455 de Maisonneuve Blvd. West
Montreal, Quebec H3G 1M8 CANADA

All qualified candidates are encouraged to apply; however, Canadians and Permanent Residents will be given priority. Concordia is strongly committed to employment equity within its community and to recruiting a diverse faculty and staff. The University encourages applications from all qualified candidates, including women, members of visible minorities, Aboriginal persons, members of sexual minorities, persons with disabilities, and others who may contribute to diversification.

CSME Student Affairs Committee Chair

RECENT SURVEYS FROM THE YOUNGER generation indicate that they are more focused on starting their own business. Corporate jobs and their prestige have become less appealing for the younger generation unlike the past generation who developed their career by moving up the corporate ladder. To address this demand of young generation of engineers, some possible start-up opportunities in the field of the mechanical engineering are briefly reviewed in this article.

In the first look, the mechanical engineering students see few start-up business opportunities in their filed in comparison with their counterparts in other fields such as computer science, computer engineering, and information technology. This observation is to some extent true since the computer or IT industries are fast growing fields. The business ideas in these industries are also more advertised in the main stream media which helps the students in those fields to see the possibilities. However, by taking a closer look to new advancement in the field of mechanical engineering, students can see there are so many different opportunities available for them in this field. This article focuses on two new emerging advancements: Embedded systems and 3D printing which can potentially create lots of opportunity for individuals with entrepreneurial skills.

Electronics and embedded systems are transforming the traditional mechanical engineering industry. It is hard to imagine a recent car without electronics and embedded systems. Many electrical components are integrated in the modern cars. Major functionalities of automobiles are controlled through the embedded electronic systems including electronic fuel injection system, anti-lock braking system, and airbag control system. Developing smart cars and making the driverless cars a reality is the future of the car industry. This goal cannot be achieved without introduction of more electronic components. These technologies are also widely used in the aerospace industry. Traditional manual flight controls of an aircraft are replaced by Fly-by-Wire systems. All modern gas turbine engines are equipped with Electronic Engine Control. The presence of the embedded system is not only limited to the automobile industry and the aerospace industry. Mechanical engineers have a key role in this industry transformation. All these electronic components interact with the mechanical systems. Integration of the electronics cannot be achieved without in-depth knowledge of the mechanical systems. Transforming the traditional mechanical engineering industry will introduce so many new job opportunities and business ideas for the current and the future generation of the mechanical engineers.

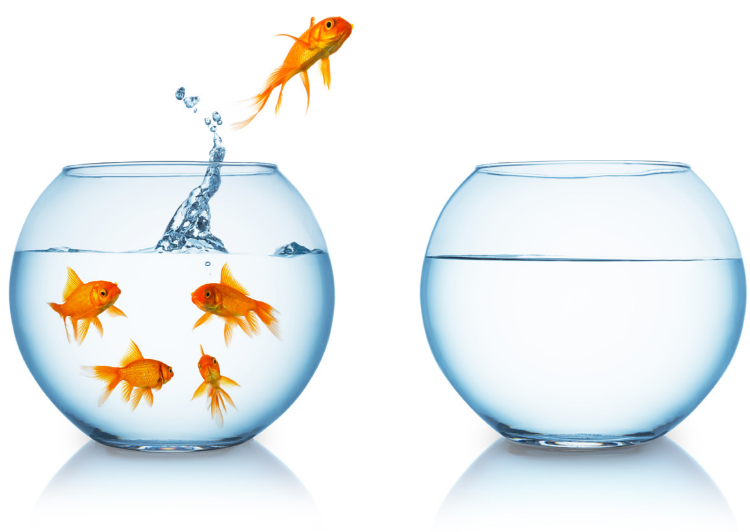


IMAGE: SHUTTERSTOCK

Likewise, three dimensional printing or additive manufacturing has a potential to set an industrial revolution in the manufacturing industry. Three dimensional printing is made by adding a layer upon layer of an additive material such as plastics or metals to form an object designed in the CAD software. A digital object in the CAD software can be turned into reality with the 3D printing technology. The rapid Prototyping of new parts and products is now possible with this technology. The emergence of low cost printers will make it possible for small or start-up businesses to design and prototype new products with much lower costs. The fact that 3D printing is an emerging industry will introduce so many new opportunities for students who are interested to design and create the new parts. Manufacturing methods are not limiting the ambitious designers anymore since the more complex design structure is possible with 3D printing.

Finally, introducing the new advancements in the mechanical engineering filed to students through conferences, lecture series and workshops is one of the CSME mandates. Designing student contests related to these new technologies will be a good option to encourage and engage students in these fields. The 2017 CSME National Design Competition challenges the students from universities and technical colleges across Canada to design and build a 3D printer. Educational institution must register their team by November 30th, 2016. You can visit CSME website for further details.

Hearing back from students that they are interested in learning entrepreneurial skills, CSME can also consider hosting a series of events about these respective topics. CSME Student Affairs wants to understand the demand of the future mechanical engineers in Canada and works towards it.

It is worthy to mention that at its October meeting, the CSME board of Directors will be presented with a motion to allow students registered in a mechanical engineering or related programs to join the society for free starting 2017 membership year. CSME also financially supports the events that are organized by CSME student chapters. E**ach chapter may apply for up to $300 worth of annual grants**. Details may be found at CSME websites.

CSME Student Affairs would love to know the students' views on these topics. This will be a great help for us to tailor our activities towards your needs. At the end, we wish all the students good fortune in Fall 2016 and Winter 2017 semesters. – *Reza Pedrami, MCSME*

CSME EXECUTIVE & STAFF / OFFICIERS ET PERSONNEL SCGM

BOARD OF DIRECTORS / CONSEIL D'ADMINISTRATION

President / Président	Sushanta Mitra, FCSME	mitras@yorku.ca
Sr. Vice President / Premier vice-président	Maciej Floryan, FCSME	floryan@uwo.ca
Past President / Président sortant	Ali Dolatabadi, FCSME	ali.dolatabadi@concordia.ca
Honorary Treasurer / Trésorier honoraire	John Hayes, FCSME	jhayes@mae.carleton.ca
Honorary Secretary / Secrétaire honoraire	David Weaver, FCSME	weaverds@mcmaster.ca

REGIONAL VICE PRESIDENTS / VICE-PRÉSIDENTS RÉGIONAUX

Western Region / Région de l'Ouest	Homayoun Najjaran, FCSME	homayoun.najjaran@ubc.ca
Ontario Region / Région de l'Ontario	Payam Rahimi, FCSME	prahimi@ualberta.ca
Quebec Region / Région du Québec	Baktash Hamzehloo	baktash.hamzehloo@aviyatech.com
Atlantic Region / Région de l'Atlantique	Dominic Groulx, FCSME	dominic.groulx@dal.ca

STANDING COMMITTEES / COMITÉS PERMANENTS

Membership	Sushanta Mitra, FCSME	mitras@yorku.ca
Student Affairs / Affaire étudiantes	Reza Pedrami	r.pedrami.csme@gmail.com
Student Design Competition / Concours de design des étudiants	Alex Czekanski, MCSME	alex.czekanski@lassonde.yorku.ca
Student Paper Competiton/ Concours de publication des étudiants	Mina Hoorfar, MCSME	mina.hoorfar@ubc.ca

TECHNICAL COMMITTEES / COMITÉS TECHNIQUES

Advanced Energy Systems / Systèmes avancés d'énergie	Xianguo Li, FCSME	x6li@uwaterloo.ca
Biomechanics/Biomécanique	Ali Ahmadi, MCSME	ali.ahmadi@ubc.ca
Codes and Standards / Codes et normes	Babak Owlan, MCSME	babak.owlam@csagroup.org
CCToMM Mechanics, Machines, Mechatronics and Robotics Mécanique, machines, mécatroniques et robotiques	Eric Lanteigne, MCSME	eric.lanteigne@uottawa.ca
Engineering Analysis & Design / Conception et analyse en ingénierie	Kamran Behdinan, FCSME	behdinan@mie.utoronto.ca
Environmental Engineering / Génie de l'environnement	Horia Hangan, FCSME	hmh@blwtl.uwo.ca
Manufacturing/ Fabrication	Jack Jeswiet, FCSME	jeswiet@me.queensu.ca
Materials Technology / Technologie des matériaux	Chul Park, FCSME	park@mie.utoronto.ca
Mechatronics and Mems / Mécatronique	*Vacant*	
MEMS/Nanotechnology	Carlos Escobedo, MCSME	carlos.escobedo@chee.queensu.ca
Thermo-Fluids Engineering/ Génie thermique	Kamran Siddiqui, FCSME	k.siddiqui@eng.uwo.ca
Transportation Systems / Systèmes de transport	Ebrahim Esmailzadeh, FCSME	ebrahim.esmailzadeh@uoit.ca

PUBLICATIONS

Editor, **Bulletin** / Rédacteur, Bulletin	Cécile Devaud, MCSME	cdevaud@uwaterloo.ca
Associate Editor	Pouya Rezai, MCSME	pouya.rezai@lassonde.yorku.ca
Art Director / Directrice artistique et de la publication	Nina Haikara	bulletin@csme-scgm.ca
Technical Editors, Bulletin / Rédacteur technique, Bulletin	Amy Bilton, MCSME	bilton@mie.utoronto.ca
	Brendan MacDonald, MCSME	brendan.macdonald@uoit.ca
Editor, **Transactions** / Rédacteur, Transactions	Paul Zsombor-Murray, FCSME	paul@cim.mcgill.ca
Managing Editor / Rédacteur administrateur	Ilian Bonev, FCSME	ilian.bonev@etsmtl.ca
CSME Webmaster	Amr Nagaty	a.k.nagaty@gmail.com

SPECIAL COMMITTEES / COMITÉS SPÉCIAUX

History / Histoire	John Hayes, FCSME	jhayes@mae.carleton.ca
Corporate Membership / Membres corporatifs	*Vacant*	
Honours and Awards / Prix honorifiques	Ali Dolatabadi, FCSME	ali.dolatabadi@concordia.ca

CSME OFFICE / BUREAU SCGM

Executive Director /Directeur exécutif	Guy Gosselin, FEIC, FCSCE	gosselin.eic@gmail.com
Administrative Officer / Agent administratif	Mohammud Emamally	admin.officer@csme-scgm.ca

CSME Address / Adresse de la SCGM

P.O. Box 40140, Ottawa, ON, K1V 0W8

Phone / Téléphone 613.400.1786 Email: admin.officer@csme-scgm.ca www.csme-scgm.ca

Publications Mail Agreement: 42977524 Registration: 7313893
Return undeliverable Canadian addresses to:
CSME
P.O. Box 40140
Ottawa, ON
K1V 0W8

The CSME warmly welcomes BCIT and UPEI as new Sustaining Members.
La société est heureuse d'annoncer l'ajout de BCIT et l'Université de PEI en tant que membres bienfaiteurs

The CSME would like to acknowledge the support from the following ME Departments:
La SCGM tient à remercier les départements de génie mécanique suivants pour leur aide:

University of Alberta
BCIT
Schulich School of Engineering, University of Calgary
Carleton University
Université Concordia University
Dalhousie University
Laurentian University / Université Laurentienne – Bharti School of Engineering / École de génie
Université Laval
University of Manitoba
McMaster University Engineering
McGill
Memorial University
Université de Moncton, Campus de Moncton – Faculté d'ingénierie, Génie mécanique
Polytechnique Montréal
Queen's University
RMC CMR
Ryerson University
The University of British Columbia – Faculty of Applied Science
The University of British Columbia – School of Engineering, Okanagan Campus
UNB Faculty of Engineering – Department of Mechanical Engineering
uOttawa
University of Saskatchewan
Mechanical & Industrial Engineering, University of Toronto
University of Victoria Mechanical Engineering
University of Waterloo
Lassonde School of Engineering – York Université University
Western University Canada