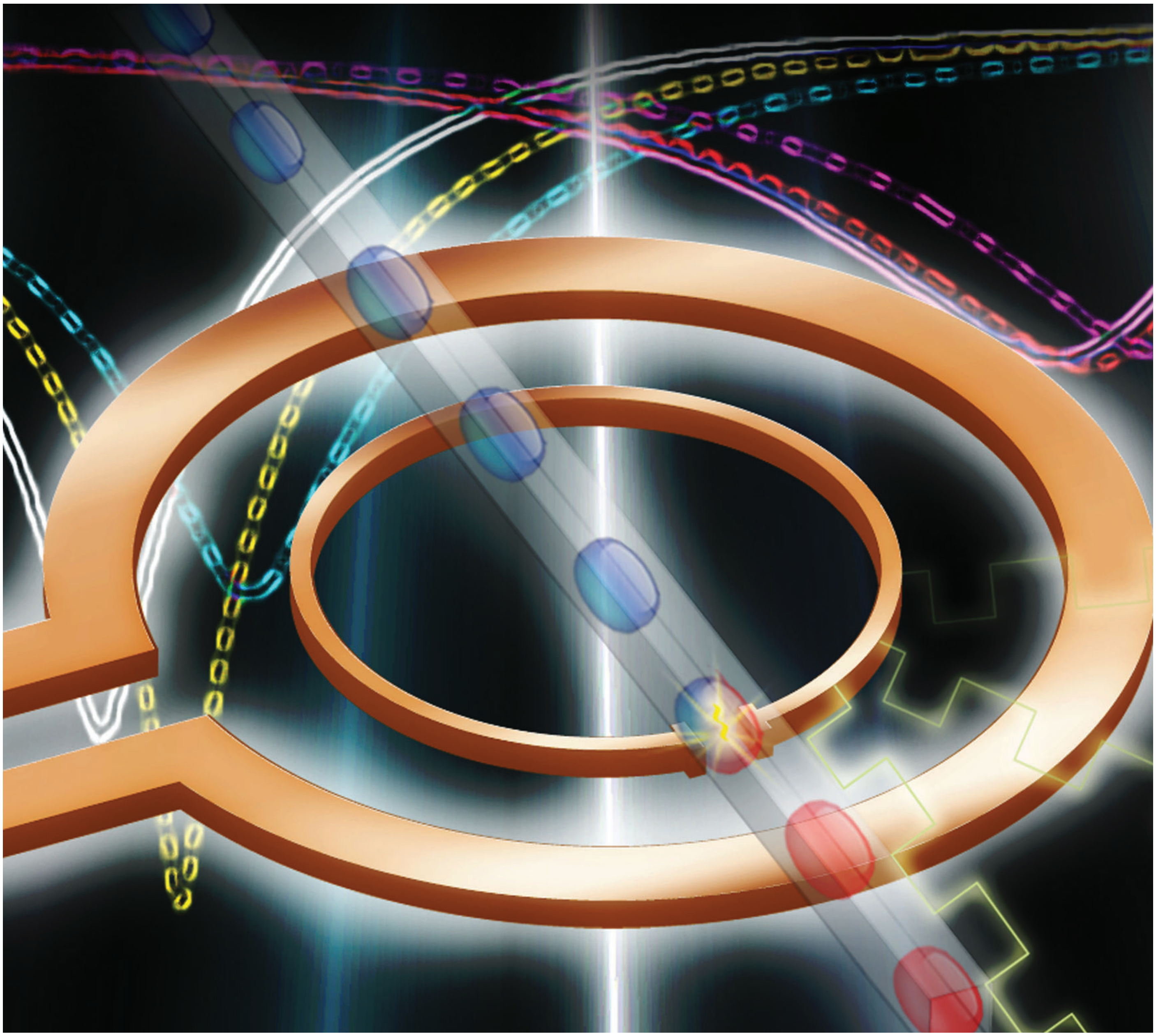
THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE

FALL/L'AUTOMNE 2018

BULLETIN



SPECIAL ISSUE ON

Bioengineering

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Editor's Letter

I AM PLEASED TO HAVE THE OPPORTUNITY to introduce another issue of the CSME *Bulletin*, this time focused on *Bioengineering*. Over the past few decades, mechanical engineering departments across Canada have been developing bioengineering programs and scholars at these institutions have been contributing novel research to this exciting and promising multidisciplinary area of research, helping improve the health of Canadians by developing, for example, novel microfluidic diagnostics tools, improved helmets to avoid head trauma, and a better understanding of osteoarthritis. There is evidence that this scholarly domain is on the verge of introducing ground-breaking technologies into various markets such as health and security. As such, it seems appropriate to dedicate an issue to this subject and let our readers hear some great stories from Canadian researchers in this field of study.

The issue is categorized into standard sections of the CSME *Bulletin*, with some changes to the *Recognitions* section by CSME's new President, Professor **Maciej Floryan**. Henceforth, we would be delighted to recognize and promote the achievements of members of our Society via publication of news pieces in the *Recognitions* section. Please continue to email the Bulletin editors with your exciting news pieces.

In this issue, Professor **George Zhu**, as the new Chair of the Department of Mechanical Engineering at Lassonde School of Engineering, located at York University, will provide some insights into one of the youngest mechanical engineering departments in the country and its recent success in receiving accreditation for its undergraduate program. Four distinguished professors in bioengineering in Canada will present their latest achievements in areas including diagnostic technologies, droplet microfluidics, and biomechanics. The new faculty spotlight section is dedicated to four of our recently hired colleagues in eastern Canada, who are highlighting their work on biofabrication, advanced materials, bio-inspired robots, and interfacial thermo-fluidics. It was a great pleasure having the opportunity to interview one of the most successful female mechanical engineers in Canada, Ms. **Sarah J. Shortreed**, the former Vice President at Blackberry and the current Chief Information Officer (CIO) at Bruce Power. The *News* and *Student Chapter Report* sections contain exciting information about the most recent trends in bioengineering and the manner our students have been engaged in the society.

The CSME *Bulletin* will continue to focus on emerging and demand-driven areas of Mechanical Engineering. We plan to have future issues on artificial intelligence and machine learning, sustainable energy, and advanced materials. We look forward to receiving your comments and feedback on the CSME *Bulletin* as well as your suggestions for improving our future publications. Please enjoy reading this issue on *Bioengineering*.

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PHOTO TOP LEFT: COURTESY OF THE LASSONDE SCHOOL OF ENGINEERING, YORK UNIVERSITY / PHOTO RIGHT: TABITHA GILLMAN

President's Message

Dear CSME Members,

THIS IS MY FIRST LETTER AS PRESIDENT OF THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING (CSME). I took over Presidential responsibilities in June 2018. Shortly after, I was asked to write a letter for the Fall Bulletin, which seemed far away at the time. The summer turned out to be very busy with settling a few organizational issues for the Society and it is hard to believe that it is Fall already. This summer was especially hectic because I was on sabbatical spending three months in Germany and then in Hong Kong since the beginning of August. All my work on CSME issues was carried out through email and skype conversations, which tells you how much our society has changed.

The change is accelerating, and long-established concepts and customs are being challenged. Artificial intelligence is emerging, and deep learning is entering mechanical engineering in technical areas as well as at the interface between social and technical issues. Mechanical engineering is growing everywhere and so is our Society. While it is interesting to witness these changes, I would like to urge you to take an active role in shaping them so that disruptions are productive rather than destructive. Change is coming whether we like it or not, so it is better to be in control of it than at its mercy. If you look at it from a constructive point of view, many interesting challenges and career choices will become available. I encourage you to take advantage of these new opportunities.

Sincerely,

MACIEJ FLORYAN, Ph.D., P.Eng. FCSME, FAPS, FASME, FCAI, FEIC
CSME *President*
Professor, Western University
Department of Mechanical and Materials Engineering

Message du président

Chers collègues,

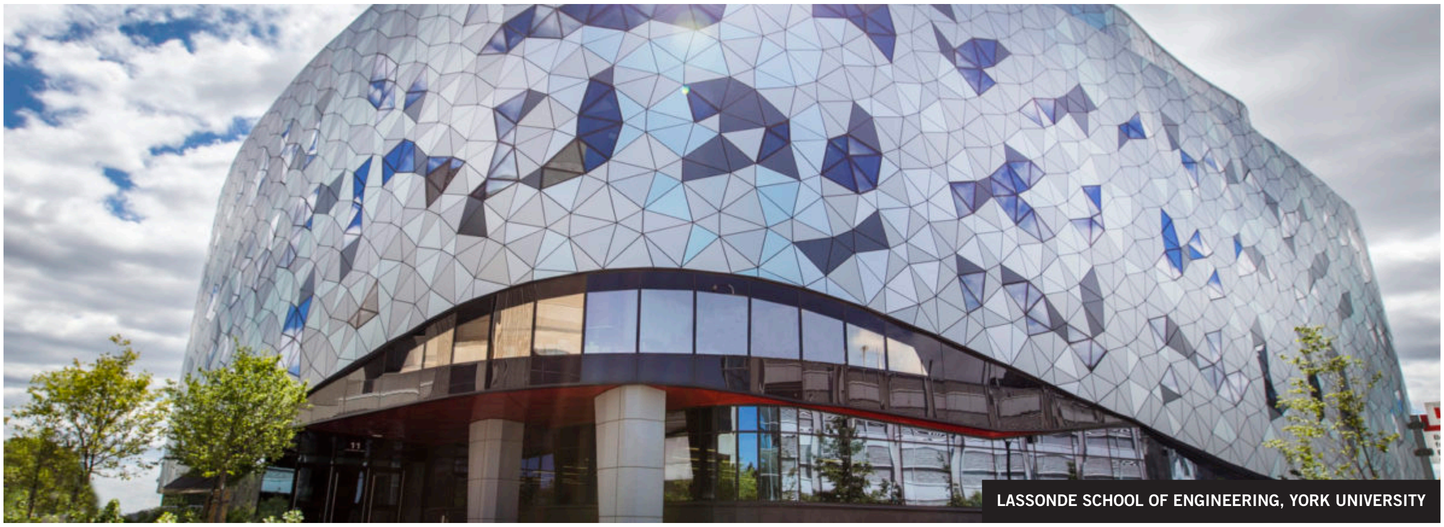
Ceci est ma première lettre en tant que président de la Société canadienne de génie mécanique. J'ai assumé mes fonctions présidentielles en juin 2018. Peu de temps après, on m'a demandé d'écrire une lettre pour le bulletin d'automne, qui semblait très éloigné à l'époque. L'été a été très occupé à régler quelques problèmes d'organisation pour la Société et il est difficile de croire que c'est déjà l'automne. Cet été a été particulièrement agité, car je passais trois mois en congé sabbatique en Allemagne, puis à Hong Kong depuis le début du mois d'août. Tout mon travail sur les questions SCGM a été réalisé par e-mail et par des conversations sur Skype, ce qui vous montre à quel point notre société a changé.

Le changement s'accélère et des concepts et des coutumes établis de longue date sont remis en question. L'intelligence artificielle fait son apparition et l'apprentissage en profondeur fait son entrée dans les domaines techniques de l'ingénierie mécanique, ainsi qu'à l'interface entre les problèmes sociaux et techniques. Le génie mécanique se développe partout, de même que la SCGM. Bien qu'il soit intéressant d'être témoin de ces changements, j'aimerais vous demander de jouer un rôle actif dans leur mise au point afin que les perturbations soient productives plutôt que destructrices. Le changement arrive, que cela nous plaise ou non; il est donc préférable de le contrôler que de se laisser à sa merci. En le regardant d'un point de vue constructif, de nombreux défis et choix de carrière intéressants deviendront disponibles. Je vous encourage à profiter de ces nouvelles opportunités.

Cordialement,

Maciej Floryan
Président

TRAINING ENGINEERS OF THE FUTURE – RENAISSANCE ENGINEERS



LASSONDE SCHOOL OF ENGINEERING, YORK UNIVERSITY

DR. **ZHENGHONG (GEORGE) ZHU**, PhD, P.Eng.

Dr. Zhu is a professor and Tier 1 York Research Chair in Space Technology in the Department of Mechanical Engineering, York University and has been the Department Chair since May 2018. He completed BEng, MEng and PhD degrees in engineering mechanics from Shanghai Jiao Tong University located in Shanghai, China, and then MASc in robot control at the University of Waterloo and PhD in mechanical engineering at the University of Toronto. He held positions of Research Associate at University of Toronto in 1993-1995 and senior stress engineer as well as certified welding engineer at Curtiss-Wright Indal Technologies in 1995-2006. He joined the Department of Earth and Space Science and Engineering at York in 2006 and joined the Department of Mechanical Engineering in 2016. He is the author of more than 230 articles. His research interests include dynamics and control of tethered space system and space robot, nano-enhanced multifunctional materials and computational mechanics. He is the fellow of Engineering Institute of Canada, Associate fellow of AIAA, Fellow of CSME and ASME, and senior member of IEEE.

PHOTO CREDIT: LASSONDE SCHOOL OF ENGINEERING COURTESY OF YORK UNIVERSITY

THE DEPARTMENT OF MECHANICAL ENGINEERING at Lassonde School of Engineering in York University is the youngest mechanical engineering department in Canada. It was launched in 2013, accepted the first enrollment of students in 2014, and it was successfully accredited by the Canadian Engineering Accreditation Board in 2018. This provides us a great opportunity to shape a new mechanical engineering department to train engineers of the future.

Our professors have studied at the best universities in Canada and world-wide. They are active researchers with a social conscience and a sense of global citizenship. Their research programs are cutting-edge with a stunning diversity and scope in the field of mechanical engineering. Currently, there are 17 professors in the department with research interests ranging from nanotechnology to spacecraft technology. Our focus in research is in thermal sciences, energy, transportation technologies, automation and advanced robotics, fluid and colloidal systems, especial emphasis on advanced materials and manufacturing, surface engineering, optomechanical systems and diagnostics, biosystems and bio-sensors, biomechanics and exoskeleton technologies. The solid mechanics, design, and dynamics, together with system level design and optimization are another areas of research focus. The department enjoys the reputation of research excellence in the fields of microfluidics and thermal science, advanced robotics, and space technology. The department's first student design and built CubeSat will be launched in 2019 to demonstrate the space debris removal by electrodynamic tether technology.

Inspired to train engineers of the future, we are striving to create a home for Renaissance Engineering™ to offer students unique learning experiences. Our Renaissance Engineering program is committed to groom engineers not only as problem solvers or functionary builders, but also leaders who consider and communicate how engineering relates to matters of sustainability, health, safety and civil society. The focus of our educational activities is delivery of current and knowledge building courses that are enhanced through self-discovery and out of class learning. The program also offers co-op education that enhances students' experience at Lassonde and beyond to prepare them for the future jobs. Currently, the mechanical engineering program is the most attractive program in the Lassonde School of Engineering with over 400 talented students. In addition to the undergraduate program, the department has established a vibrant graduate program with strong externally funded research programs.

Last but not least, the department is also the home of Bergeron Entrepreneurs in Science & Technology (BEST) program, with a vision to create "Renaissance Engineers" in partnership with the Schulich School of Business and Oscoode Hall Law School at York University. BEST integrates curricular and experiential activities for Lassonde and York University students to become engineering leaders with an entrepreneurial spirit to serve the society with a social conscience and a sense of global citizenship. Students involved in BEST can obtain the BEST certificate, which appears on their degree transcript, and combines academic and experiential requirements. This is another win of our students to differentiate themselves from other mechanical engineering graduates.

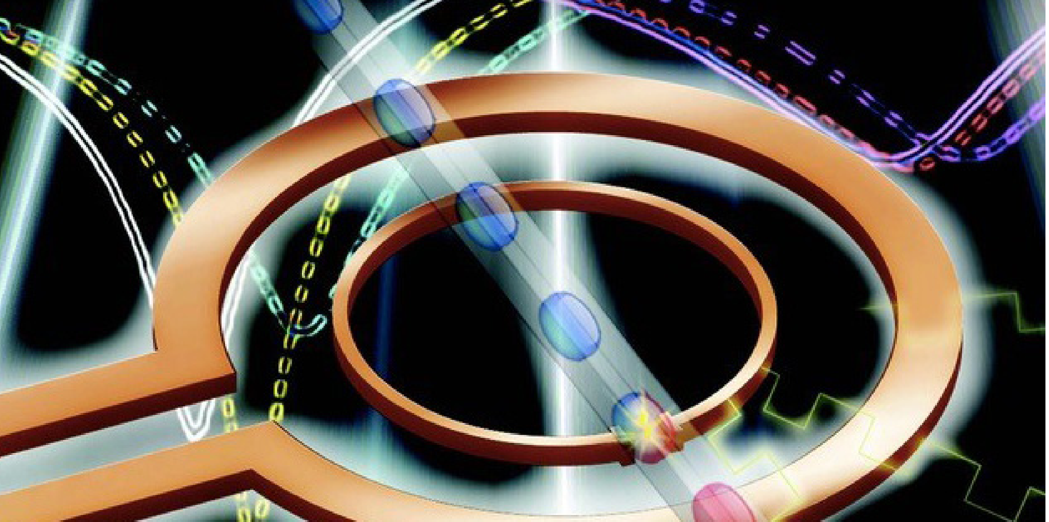


FIGURE SHOWING MICROWAVE SENSING AND HEATING OF DROPLETS (M. S. BOYBAY, A. JIAO, T. GLAWDEL, C. L. REN, "MICROWAVE SENSING AND HEATING OVER INDIVIDUAL DROPLETS IN MICROFLUIDIC DEVICES", *LAB CHIP*, 13 (2013) 3840-3846.)

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DROPLET MICROFLUIDICS

DR. **CAROLYN REN**, PhD, FCSME

Dr. Ren is a professor of Mechanical and Mechatronics Engineering at the University of Waterloo (UW) and holds the Canada Research Chair in Droplet Microfluidics and Lab-on-a-Chip Technology. She is directing Waterloo Microfluidics Laboratory focusing on advancing fundamental knowledge of microfluidics and developing Lab-on-a-Chip technologies which have significant impact on a wide range of applications. Examples of her research applications span from material synthesis, to protein separation, single cell analysis and water quality sensing. Besides the Canada Research Chair, Dr. Ren has also received several awards from the engineering and research community, including: election as a Member of the College of Royal Society of Canada, being recognized as one of 20 leading female innovators in Women of Innovation*, appointment as Fellow of the Canadian Society of Mechanical Engineering, and an Early Research Award from the Ontario Ministry of Research and Innovation.*

BIOENGINEERING IS TRULY INTERDISCIPLINARY, drawing upon knowledge from a wide range of disciplines such as biology, chemistry, physics, medicine and engineering and thus stimulates large networks of collaborations. As a result, the scope of the field has dramatically widened over the past two decades.

Biomedical engineering and bioengineering have been used interchangeably in the past, with bioengineering being more inclusive, because of the advances in both knowledge and technologies beyond medical applications. For instance, biomedical engineering is mainly at the interface between engineering and medicine as defined in the description of undergraduate or graduate programs in many universities, which was largely driven by the motivation to develop sophisticated medical equipment for diagnosis and treatment, to understand how the body works biologically and to train medical and engineering professionals who can collaboratively improve human health and quality of life. Bioengineering however has expanded to involve more disciplines such as agriculture and environmental with the pressure of maintaining a sustainable ecosystem on earth.

Bioengineering has been rapidly growing, as evidenced by many factors such as the number of undergraduate and graduate programs formed in this broad field across the world for education, and the overwhelming interactions between engineering and a broad range of biorelated disciplines. On the one hand, sophisticated engineering systems and tools have largely advanced the knowledge of biological systems and revolutionized the levels of diagnosis and treatment of biological systems. For example, many portable biomedical systems have been developed for rapid diagnosis and treatment of diseases which have helped save lives in resource limited regions such as Africa. This cannot happen without engineering contributions. On the other, the significantly improved understanding of biological systems have raised new challenges and opportunities which have shaped and guided engineering development. It is expected that the scope of bioengineering will be further widened and shaped by this ongoing interaction in the future.

Bioengineering now covers a very wide range of topics. It is challenging to include all the topics considering the rapid growth of the field scope. A good example of a list of these topics is the one listed by an open access Journal of Bioengineering. Briefly, the topics mentioned include bionics and biological cybernetics; bioelectronics including wearable and implantable electronics and bioelectronics devices; bioprocess and biosystems engineering and applications; biomolecular, cellular and tissue engineering and applications; biomedical engineering and applications; biochemical engineering and applications; and translational bioengineering. The boundaries between different branches are being blurred when new disciplines emerge and converge into this broad field.

Although medical devices with many engineering components have been made centuries ago such as the foot prosthetics invented in the mid 1500s, it was fascinating to see the potential to use my knowledge and expertise in mechanical engineering to help advance biomedical and biological areas when I started my PhD in the early 2000s. My PhD research was focusing on understanding the fluid flow, heat and mass transfer in microchannels which are on the order of a few tens to a few hundreds of micrometers. At that time, the major driving force for engineers to work with this field is to help develop miniaturized devices that can shorten analysis time and multiplex the performance of sample (i.e. protein and DNA) separations which were mainly handled in individual capillaries with similar size. In addition, the detection sensitivity and specificity could be increased significantly by dynamically concentrating the samples and enabling different sample processes. Capillary-based separation was one of the major analytical methods used in the field of analytical chemistry. With the advances of the semiconductor industry, miniaturized chips with massive microchannel networks can be fabricated out of glass, silicon and polymer materials such as polydimethylsiloxane (PDMS). The terminology of microfluidics and Lab-on-a-chip emerged with some bench mark studies in early 1990s[1-2]. It was out of the scope of analytical chemists to design microchannel networks involving extensive understanding and control of fluid flow, heat and mass transfer. Therefore it was somewhat a natural progression to engage mechanical engineers in the field. One of the major research activities of my early career centered on developing various chip-based protein separation techniques which also led to a start-up company, Advanced Electrophoresis Solutions, co-founded by Dr. Tiemin Huang and myself in 2010.

Scaling down fluid channels offers different methods for pumping fluids besides commonly used pressure driven flow. For example, surface charges that exist on most microchannel materials such as glass and PDMS cause charge separation in the liquids used for bioapplications, which results in net charges near the channel walls. These net charges can be leveraged to induce fluid flow by applying electrical fields along the channels. Research into this direction also stimulated electrical engineers to develop numerous electrical-based pumping, sample manipulation and detection techniques. With the field further evolving in both fundamentals and applications, many other disciplines such as physics, biology, medicine, materials and environmental started to make contributions to advance this field. The blossoming of the field demanded platforms where interdisciplinary research results can be appreciated and disseminated, which contributed significantly to the introduction of several new journals in the bioengineering field such as Lab on a Chip by Royal Society of Chemistry, its sister journal of Integrative Biology and the journal of Microfluidics and Nanofluidics.

Although the field was explosively growing with numerous fundamental discoveries, advanced technologies and devices developed, the original promise of revolutionizing the levels of biomedical diagnosis, material synthesis and environmental monitoring has not been realized and more and more fundamental and technological challenges are discouraging. Fundamental challenges include slow mixing due to laminar flow nature, cross contamination between different assays because of no compartmentalization of individual assays and low throughput which requires linearly increasing the device footprint to increase throughput. Technological challenges are associated with low robustness of the design and operation and low quality of mass production of chips. These challenges prompted the branch of microfluidics, two-phase Droplet

Enabling Platform Technology for High Throughput Analysis towards Bioengineering

Microfluidics, which employs monodispersed, pico- to nano-liter sized drops that can be generated at kHz rates in microchannels by injecting one fluid (i.e. aqueous solution) into another immiscible fluid (i.e. oil) as mobilized test tubes. These drops are separated from each other by the carrier fluid (i.e. oil) minimizing cross contamination, they enable rapid mixing due to the three-dimensional motion occurring within them while traveling through microchannels and they offer magnitude higher throughput than their traditional single phase microfluidic counterparts. There are new sets of challenges to be overcome to make droplet microfluidics a robust enabling platform for high throughput screening analysis which is highly demanded by almost all the bioapplications such as life science research, drug discovery, tissue engineering, material synthesis and environmental monitoring. For example, to make droplets stable, surfactants are used to reduce the interfacial surface tension between the drops and their carrier fluid. For different pairs of fluids, different surfactants are needed, which draws upon knowledge and expertise from a wide range of disciplines such as biology, chemistry, physics and engineering.

As the director of Waterloo Microfluidics Laboratory, my vision of engineering contribution towards droplet microfluidics would be developing modular systems and tools so that such a promising platform can be widely adopted by users cross disciplines who do not need in-depth understanding of droplet microfluidics. For example, each functional unit for droplet manipulation such as drop generator, splitter, merger and heater can be a standalone functional unit and can be integrated with other units through a simple connection. End users would simply need to choose the desired units for specific application without efforts into developing them. To approach this vision, my lab has been developing fundamental models that allow droplet generators, merges and heaters to be designed and optimized as well as electrical sensing techniques such as capacitance and microwave sensing. The microwave sensing is capable of simultaneous heating of individual droplets which can cool down quickly due to their large surface to volume ratio. This technique finds many applications in bioapplications such as sensing contaminants in water and food and initiating quick reactions. It is expected that droplet microfluidics will enrich the field of bioengineering significantly in the next decade as an enabling technology.

AN ARRAY OF MERGED DROPLETS (TWO WERE MERGED AT ONE MERGER) FOR DRUG SCREENING TOWARDS ALZHEIMER'S DISEASE (X. CHEN, C. L. REN, "A MICROFLUIDIC CHIP INTEGRATED WITH DROPLET GENERATION, PAIRING, TRAPPING, MERGING, MIXING AND RELEASING", *RSC ADV*, 7 (2017) 16738-16750.).

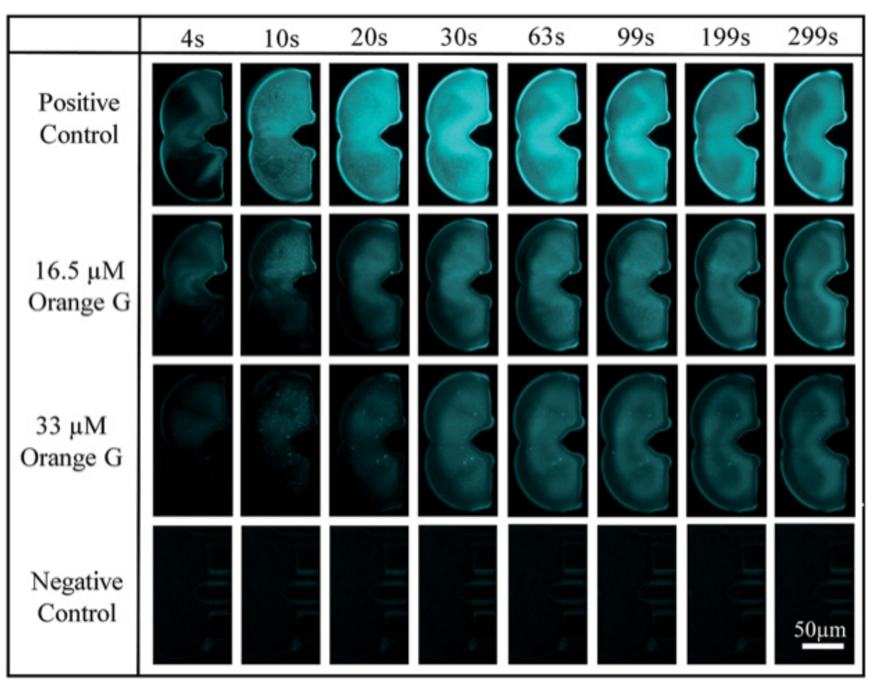
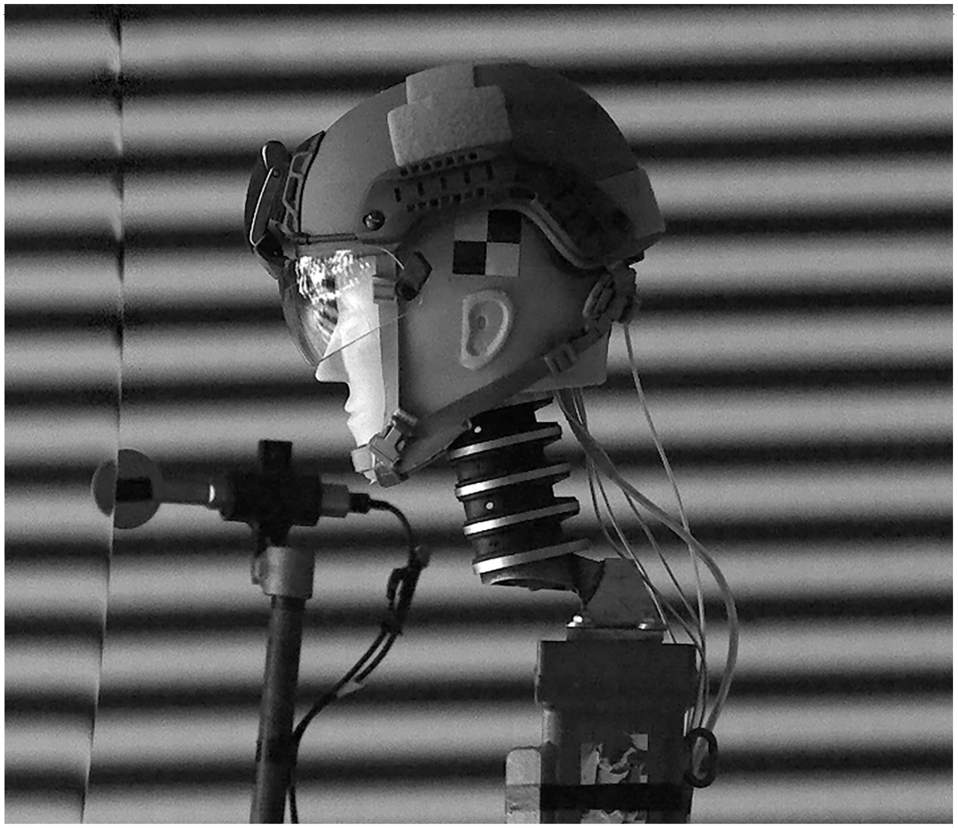


IMAGE COURTESY OF THE RESEARCHER



HIGH-SPEED IMAGE FROM A FULL-SCALE EXPLOSIVE TEST CONDUCTED AT DRDC VALCARTIER RESEARCH CENTRE. THE IMAGE SHOWS THE BIPED SURROGATE BEING DEPLOYED TO EVALUATE THE POTENTIAL OF PROTECTIVE HEADWEAR FOR MITIGATING INJURIES FROM EXPOSURE TO A BLAST WAVE.

BIOMECHANICS

AN INTERDISCIPLINE OF ENGINEERING AND HEALTH SCIENCE

Dr. **CHRIS DENNISON**, PhD

Chris Dennison is an assistant professor of mechanical engineering at the University of Alberta and a professional engineer in the province of Alberta. In 2017, he was appointed to be a Tier 2 Canada Research Chair in Biomedical Instrumentation. His research focuses on development and application of experimental techniques to assess protection devices and also on development of novel instrumentation for application in laboratory and field experiments examining human injury. He is also active in the standards community, focusing on standards applied in certification of protective headgear.

SIMON OUELLET

Simon Ouellet is a senior level defense scientist at Defense Research and Development Canada. He has been conducting research in the field of injury biomechanics, human-based physical models, armour systems and operationally-relevant test methodologies for more than 15 years. In 2016, he was a visiting scientist at Defence Science and technology group in Melbourne, Australia. He has acted as a national expert on different NATO STO technical groups focused on injury assessment and mitigation. He serves as a scientific advisor to the Canadian Armed Forces on specific topics related to personnel survivability and protection.

BIOMECHANICS IS A SUB-DISCIPLINE OF biomedical engineering. It focuses on application of principles of mechanics to study biological systems towards improving and preserving human health and longevity. Because the human body comprises many systems and tissues that can be analyzed, understood and modeled in terms of mechanics, the breadth of areas in which the field of biomechanics can benefit society is vast. For example, in the field of orthopaedic biomechanics, engineers play a vital role in understanding the human musculoskeletal system and in developing devices that can restore its proper function, such as mechanical implants for the knee and hip joints. In the field of injury (or trauma) biomechanics, engineers study how mechanical loads experienced during traumatic events, for example automotive or sport related collisions, lead to structural injuries to bones and other tissues. At the cell level, mechanical loads can influence biochemistry that controls properties of tissues and have direct consequences on cell health and death: topics of central importance in tissue engineering. The suite of approaches and tools that engineers use in these fields is equally vast. They include rigid-body, continuum and statistical mechanics; experimental methods using tissue or tissue simulants, simplified models of human anatomy; and numerical multi-physics simulation techniques including finite element modeling and an array of techniques in computational fluid dynamics.

An eloquent and contemporary example of a contribution that biomechanics makes to society is the engineering of protection devices such as seat belts, airbags, body armour and helmets. These devices are used every day in multiple sectors of society including the general public, industrial workers, law enforcement officers and military personnel. They are designed with the goal of reducing the risk and severity of injury associated with transportation, conduct of work duties or recreational activities. In Canada, unintended injuries have been identified as one of the leading causes of death and disability in young people[1,2] and the financial costs are estimated in $Billions. The design of protection devices requires knowledge of the mechanics of injury – knowledge gained from the field of biomechanics. Once the mechanical parameters that cause the injury are understood, the engineer can design protection devices that alter these parameters in such a way to reduce the severity of, or prevent the injury altogether. To test whether or not the protection device modifies mechanics as intended, engineers rely upon models.

Models for assessing protection devices recreate anatomy of the human that is relevant to the injury of concern and through the use of tailored instrumentation; they measure mechanical parameters that have a causal or correlative relationship with that same

IMAGE CAPTURED BY THE MUNITION EXPERIMENTAL TEST CENTER AND PROVIDED BY SIMON OUELLET injury. Often, biomechanical experiments where post-mortem specimens subjected to an injury-causing event (e.g. a head impact, blast) are conducted in an attempt to recreate the injury that living humans experience. In these experiments, sensors, transducers and high-speed imagery are used to quantify the mechanics that the biological tissue experiences and to image the injury event, respectively. Through an array of statistical approaches, the subset of parameters that are the best predictors of the injury likelihood and severity are established. Once the mechanical response of the tissue to the injury is known, physical models, or surrogates, comprising synthetic materials that have mechanical properties similar to human tissue (sometimes referred to as simulant materials) can be designed. These surrogates can then be used in laboratory experiments where the surrogate is fit with protective gear (e.g. helmets, armour) and subjected to an injury-causing event such as an impact or a blast from an explosion. The mechanical response of the surrogate is quantified to ascertain whether or not the protective gear altered the magnitude of the identified mechanical parameters that correlate with the injury.

In Canada, universities across the country are contributing to the field of biomechanics as it relates to protection devices. Many of these centers focus at least some of their efforts on head injury in sport and are developing experimental and computer-based models for studying human protection. One of the major, nation-wide, themes in sport related head injury is development of new methods to assess sport headgear. Researchers are working on new approaches and methods to configure surrogate models of the human to more realistically simulate head impact in sport, and from these laboratory simulations determine which mechanical parameters could relate to injuries in soft tissues of the brain. The findings from these efforts could be applied in assessment of head protection gear (helmets) for protection against injuries to the brain.

For example, in our laboratory at the University of Alberta, we examine how impact mechanics measured in certification-style drop impact experiments[3,4] can be related to brain tissue strains computed from available numerical models of the head-brain. The overarching idea behind such examinations is to identify whether simple to measure mechanics associated with certification-style impact experiments (e.g. linear or rotational accelerations or velocities, among others) can be shown to correlate with strain: a parameter proposed by many to be linked to injury in brain tissue. If robust correlates are identified they could potentially be used in helmet assessment and act as complements to the measurements and approaches already used in helmet assessment. In related work, we also have efforts underway to develop mechanical surrogates for the neck that, with further development, could offer realistic mechanics in helmeted head impact and serve as complements or replacements to the surrogate neck models that are currently commonplace, but that are taken from test dummies developed not for helmet assessment but instead for automotive crashworthiness testing.

In addition to universities, federal research organisations like Defense Research and Development Canada (DRDC) also focus on developing new approaches to study human protection. At DRDC, the Weapons Effects and Protection section develops tailored approaches to study human protection against military threats. A new surrogate model of the human head was developed for examining head protection against blast from explosions[5]. The model, termed the Blast Injury Protection Evaluation Device (BIPED) comprises simulants of the skin, skull, falx and tentorium cerebelli, cerebrospinal fluid and of the brain itself. Representative anthropomorphic features ensure that helmets can be properly fit on the headform. Its response to blast has been compared to that of post-mortem human specimens[6]. Through the use of external surface transducers, the evolution of the transient pressure field around the head can be quantified. Then, with the help of built-in pressure transducers within the brain, and force transducers distributed on the skull, the transmission of blast energy into the head and modal responses of the head-brain can be estimated[7]. The BIPED is a tailored device enabling the assessment of the relative performance of head protection (e.g. helmets, eye and face shields). It is one of only a small handful of head models under development for blast protection studies and an excellent example of application of biomechanics towards surrogate development for a specific injury, blast induced traumatic brain injury, that statistics show is affecting increasing numbers of people in recent years.

Protecting humans from unintended injury is of paramount importance and biomechanics will continue to play a central role in how we understand and design protection from injury. Since the mid-twentieth century, protection devices have continuously improved to prevent often-fatal injuries. As more people survive injury events, there can be a shift towards different mechanics than those associated with severe or fatal injuries. As a result, ongoing biomechanics research is necessary to understand the new mechanics of less severe injuries, so the human can be further protected. The ongoing need for biomechanics and for engineered protection devices has led to significant investments from the Natural Sciences and Engineering Research Council, Canadian Institutes for Health Research, Canada Research Chairs, Canada Foundation for Innovation and Western Economic Diversification, among other agencies, to establish infrastructure and support of basic and applied research. With a constantly evolving landscape of injury events in all sectors of society, biomechanics and protection devices will continue to be a key area of contribution for mechanical engineers.

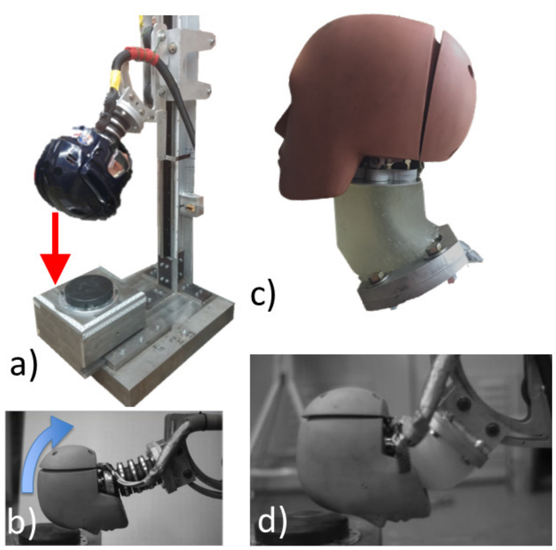


IMAGE SUPPLIED BY THE BIOMEDICAL INSTRUMENTATION LAB, UNIVERSITY OF ALBERTA, MECHANICAL ENGINEERING

MANY OF THE NEW PROPOSALS FOR TESTING HELMETS BORROW HEAD AND NECK SURROGATES DEVELOPED ORIGINALLY FOR CRASH TESTING IN THE AUTOMOTIVE SECTOR. IN PANE A) ONE POSSIBLE EXPERIMENT IS SHOWN WHERE AN AUTOMOTIVE CRASH TEST DUMMY NECK IS USED, FIXED TO A HEAD MODEL, WEARING A HELMET. IN PANE B) THE HEAD (WITHOUT A HELMET) IS SHOWN TO CONVEY THE ROTATION OF THE HEAD AS THE IMPACT EXPERIMENT UNFOLDS. IN PANE C) AND D) EXAMPLES OF NEW SURROGATE NECK MODELS ARE SHOWN. THESE NECKS ARE MEANT TO OFFER REALISTIC NECK MECHANICS IN HEAD IMPACT AND COULD SERVE TO REPLACE THE NECK MODELS BORROWED FROM THE AUTOMOTIVE CRASH TEST DUMMIES.

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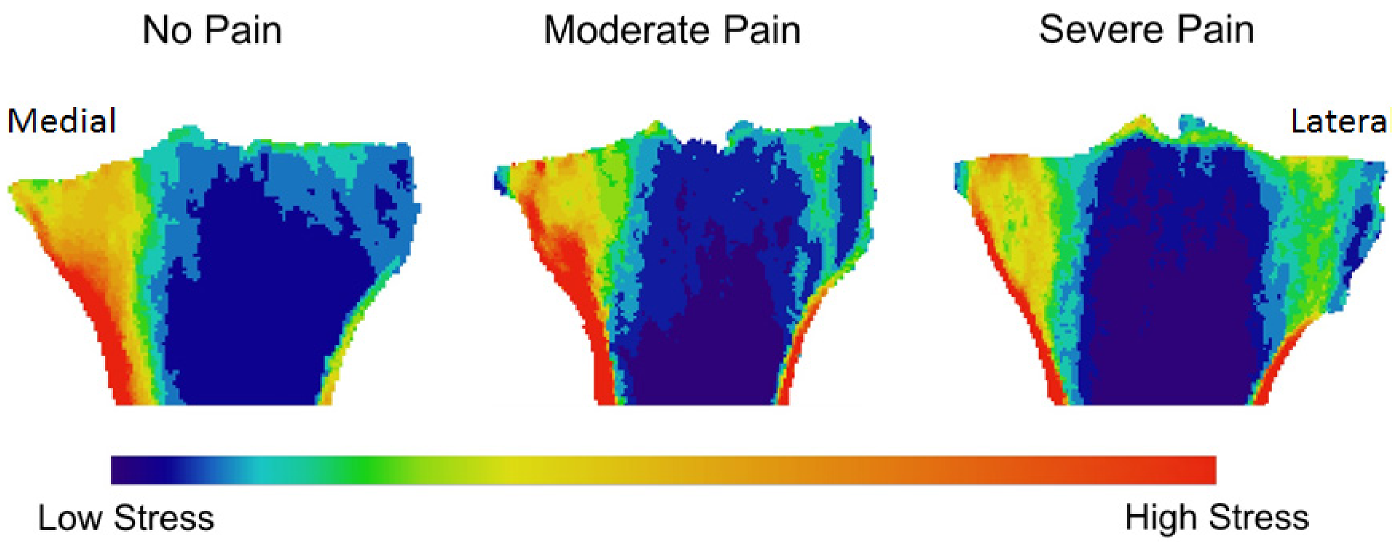

Investigating Bone and Joint Disease Using Individualized Finite Element Modeling

DR. **JAMES (J.D.) JOHNSTON**, PhD

J.D. is a Professor with the Department of Mechanical Engineering at the University of Saskatchewan. J.D. received a BSc from the University of New Brunswick (1999), an MSc from Queen's (2001), and a PhD from the University of British Columbia (2011). Between his MSc and PhD he spent 3 years at the Institute of Orthopedic Research and Education in Houston, Texas as a biomedical research engineer. J.D.'s research interests are in the area of orthopaedic biomechanics, computational modeling and medical imaging.

OSTEOARTHRITIS IS A PAINFUL, DEBILITATING joint disease affecting more than 3 million Canadians. The disease is most notably characterized by cartilage degeneration at joint surfaces. Unfortunately, there is no known cure (apart from joint replacement), and osteoarthritis is usually detected after significant cartilage damage. The exact cause of the disease is unknown, but is thought to be related to malalignment (e.g., bow-legged or knock-kneed) and/or mechanical overloading. Although pain is a dominant symptom, the source of osteoarthritis-related pain is poorly understood. Improved understanding of disease development and contributing biomechanical factors can improve prevention and treatment of this debilitating disease.

In addition to cartilage degeneration, osteoarthritis is also marked by bony changes including bone spur formation along joint edges, voids within bone, as well as altered shape, morphology (thickness, volume) and mechanical properties of underlying subchondral bone. Importantly, bone is filled with nerves and thus may be a plausible source of pain associated with osteoarthritis (cartilage, in contrast, lacks nerves or physical sensation). Of relevance to mechanical engineers, osteoarthritis-related changes to subchondral bone morphology and mechanical properties are thought to increase subchondral bone surface stiffness (i.e., stiffness directly at the subchondral bone surface), which could initiate and accelerate cartilage degeneration. Specifically, a stiffened subchondral bone would be less able to deform under dynamic impact loading (i.e., transfer strain energy), leading to more energy being transferred through the overlying cartilage. This would result in higher internal cartilage stresses, cartilage breakdown, and eventual osteoarthritis. Current theories regarding the role of subchondral bone in osteoarthritis, though, are largely based upon animal or cadaveric studies. Animal studies of disease initiation and progression, however, may not be applicable to the human process. There is also uncertainty regarding the validity of cadaveric studies given that clinical disease stage or pain symptoms are generally unknown. In order to better understand the role of subchondral bone in osteoarthritis, methods are needed to monitor subchondral bone mechanical property variations in people living with the disease.

Subject-specific finite element (FE) modeling offers unique potential to clarify the role of subchondral bone in osteoarthritis initiation and progression. Using non-invasive clinical imaging (e.g., computed tomography, CT, CAT) an individual's specific bone geometry can be acquired. As well, varying tissue elastic moduli within the structure can also be estimated using experimentally-derived relationships linking bone's elastic modulus with CT image intensity. Image-derived geometry and varying material

IMAGES COURTESY OF THE RESEARCHERS

properties can then be used to create a subject-specific FE model, which can be analyzed under varying loading scenarios (e.g., repetitive walking, impact intensive running) to simulate bone and cartilage responses to loading. Importantly, information nearly impossible to measure experimentally (e.g., internal stress and strain distributions in both cartilage and bone) can be acquired using FE modeling to address possible associations with clinical symptoms and osteoarthritis progression. The FE method can also be applied longitudinally to evaluate bone and cartilage structural behavior following osteoarthritis-related morphological and mechanical alterations to these tissues. As well, FE modeling could assist with monitoring treatments aimed at preventing or delaying osteoarthritis onset and progression.

My research group has been and continues to develop subject-specific FE models to non-invasively estimate subchondral bone stiffness and mechanical response to loading. Our first work in this area pertained to the development and validation of a FE model of the tibia (lower bone at knee). For validation, we assessed how accurately FE-based estimates of subchondral bone stiffness matched experimentally-derived stiffness measures from cadaver specimens. In this regard, we evaluated how different published relationships linking bone's elastic modulus with CT image intensity affected stiffness predictions1. We also developed optimized relationships using neural-networks2. One key limitation associated with most subject-specific FE models is that bone is typically modeled as exhibiting isotropic and linear elastic material behavior. Bone, however, is shown to be at least orthotropic in anisotropy. To address this limitation, we evaluated whether low-resolution clinical CT images could be used to quantify the fabric tensor for quantitative characterization of bone orthotropy (here the main direction of bone is derived via fabric eigenvectors; orthotropic elastic properties are then derived via fabric-elasticity equations with fabric eigenvalues and CT imaged intensity as inputs)3. Using the results of this work, we incorporated directional properties of bone into our FE model of the tibia4, which was a first using low-resolution CT images.

With our validated model of the tibia, we applied subject-specific FE modeling to study individuals afflicted with osteoarthritis. In our first preliminary study, we assessed the precision (i.e., repeatability) of mechanical metrics (stiffness, stress, strain) acquired using FE modeling5. This study was important as information about precision errors is needed to ensure that any (statistically significant) difference observed between groups is sufficiently larger than the associated measurement error. To gauge potential application of subject-specific FE modeling, we also assessed whether FE-derived mechanical metrics differentiated people with and without osteoarthritis (7 people per group). Our results indicated that mechanical metrics were precise, with measurement errors less than 6%. Minimum principal stress was, on average, 75% higher in osteoarthritic versus healthy knees. For comparisons, CT imaged intensity, which is used typically to compare osteoarthritic and control groups, showed no difference. In our most recent study, we assessed whether mechanical metrics were associated with osteoarthritis-related knee pain in 42 people scheduled for a total knee replacement6. Our results indicated that minimum principal stress was 50% to 65% higher in participants with severe pain. Rationale regarding why stress is linked to pain may be because stress levels are approaching yield limits of bone. To our knowledge, these are two of the largest subject-specific FE-modeling studies to date (most FE-modeling research is conducted using simplified geometry or with small samples of 1-3 subjects). Overall, study results are important as they indicate that FE-derived bone stress patterns may be important for understanding osteoarthritis development as well as pain initiation, and warrant application in future studies.

In terms of current research directions, our group is furthering development and validation of our FE model of the tibia. We are validating internal bone strain and displacement using a high-precision actuator integrated within a high resolution CT scanner. With this approach, 3D bone deformation is captured by imaging the tibia with increasing levels of loading. Digital volume correction is then applied to the images to acquire internal strain and displacement, which is correlated with FE model predictions. We are also advancing our model of joint soft tissues (cartilage, meniscus) in collaboration with researchers from Calgary and Finland. As well, we aim to apply our FE model with the Multicenter Osteoarthritis Study (MOST), a prospective study of +2000 participants across the United States afflicted with different levels of osteoarthritis.

In closing, I wish to acknowledge the students who completed the bulk of the work summarized here, our collaborators as well as funding agencies. Also, I wish to acknowledge study participants who supported this research through volunteering or bequeathing their bodies to science. Students or researchers interested in being involved in this research are encouraged to contact me at jd.johnston@usask.ca.

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GROUP PHOTO COURTESY OF SAIJA KONTULAINEN

REVOLUTIONIZING Diagnostic Technologies

DR. **AMIR SANATI-NEZHAD**, PhD

Dr. Sanati-Nezhad is an Assistant Professor of Mechanical and Manufacturing Engineering at the University of Calgary and the Canada Research Chair in BioMEMS. He is the Principal Investigator of BioMEMS and Bioinspired Microfluidic Laboratory at the University of Calgary with a joint affiliation with the Centre for Bioengineering Research and Education (CBRE) and Biomedical Engineering Program at the University of Calgary. Dr. Sanati-Nezhad is also the co-lead of "Novel Medical Devices" as one of the six BME strategic plans at the University of Calgary. He is a full member of Hotchkiss Brain Institute, and an associate member of Arnie Charbonneau Cancer Institute and Libin Cardiovascular Institute of Alberta, at the University of Calgary. He received a PhD from Concordia University. He was then a postdoctoral fellow at McGill University and University of Harvard. Dr. Sanati-Nezhad's main research interests are microfluidics, sensors, biomaterials, tissue engineering, lab-on-chip and organ-on-chip. Dr. Sanati-Nezhad is leading significant projects in sensing, biosensing and diagnostic technologies at the University of Calgary. Among them is a $6 million translational initiative to develop new platforms for antibiotic susceptibility testing in Canada, in collaboration with metabolomic facilities and Calgary Laboratory Service in Calgary. His current research is focused on enhancing the biosensing performance for the highly sensitive and selective detection of a variety of different analytes in complex biofluids.

THE CURRENT CLINICAL DIAGNOSIS OF diseases is mainly based on a combination of clinical presentations and the use of molecular methods, including omics-technologies, Northern blot, in situ hybridization, reverse transcription polymerase chain reaction (RT-PCR), and microarrays. These methods are not readily available in many clinical settings due to their high cost, lack of sensitivity, and labour-intensive process. Multiplexed PCRs, in particular, are not yet readily available or in routine use, and are not yet FDA approved for many diseases. The use of real-time PCR is also complicated by the need to collect specimens using sterile techniques. The potential distortion of gene expression in PCR methods have also limited its selectivity. Enzyme-linked immunosorbent assays (ELISA) have recently become the benchmark for high-volume clinical testing of biomarkers. However, the timeline for the current detection approaches and their sensitivity limit are still a constraint for the detection which limit the application of these detection systems for routine monitoring of biomarkers in biofluids.

Alternatively, electrochemical biosensors have recently found reputation for clinical implementation due to their highly sensitive and selective performance, rapid, label-free, simple, and ease of automation in the detection of biomarkers in biofluids. Several electrochemical biosensors with different surface functionalization protocols have been developed for the detection of different diseases. However, most of these techniques still require labelling or enrichment, and need several pre-processing operations. Further advances on label-free hybridization-based electrochemical sensors enabled rapid, selective, and sensitive detection of biomarkers and demonstrated that label-free electrochemical techniques can be a clinical alternative to the existing detection techniques. However, the sensitivity, selectivity, and detection limit of most biomarkers (proteins, miRNAs, DNAs and cells) using direct electrochemical sensing is still a challenge given the very low abundance and small size of these molecules in biofluids. Electrochemical nano-biosensors have recently combined the advantages of electrochemical biosensing with conductive nanocomposites, nanoparticles, nanotubes, magnetic beads and/or quantum dots with enhanced surface area and catalytic properties to generate a new class of ultrasensitive diagnostics, reliable sensing, and easy-to-use assays. However, most of these studies generated electrodes that are still expensive and less available, and their modification is costly and time-consuming. Future nano-biosensors are expected to address the unmet needs of clinical diagnostics for highly sensitive and selective detection of markers in clinical biofluids with a low-cost, rapid, and automated sensing performance.

Through the support of several local, provincial and national collaborations and partnerships, our team in BioMEMS laboratories at the University of Calgary, has developed highly sensitive, selective, low-cost and automated sensing platforms for the detection of several different diseases, with the focus on cancer, brain injuries and infection. Our research is working toward quickly and efficiently analyzing several aspects of a biofluid sample for speeding up the diagnostic and treatment of patients. Our technology is much faster, lower cost and sensitive than many of existing sensing technologies, being translated to five spin-off companies, and will create new jobs in Alberta.

The technology relies on electrochemical sensing, nanomaterials, and autonomous microfluidics. We have incorporated several different nanomaterials and nanocomposites into electrodes in controlled architectures to significantly enhance the biosensing performance. Moreover, for the first time, we developed new manufacturing techniques for automating the generation of multilayer nanocomposite layers over electrodes within microfluidic systems which enabled the mass-production of nano-biosensors with high capability in reproducibility and scalability. These nano-biosensors are being used for the next generation of rapid and highly sensitive detection of biomarkers in biofluids. In partnership with several laboratories and companies in Canada, we are developing

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DR. AMIR SANATI-NEZHAD AND MEMBERS OF THE BioMEMS AND BIOINSPIRED MICROFLUIDIC LABORATORY AT THE UNIVERSITY OF CALGARY

"We have incorporated several different nanomaterials and nanocomposites into electrodes in controlled architectures to significantly enhance the biosensing performance."

selective capturing molecules to detect target biomarkers. Also, we have combined nano-biosensors with both centrifugal and capillary microfluidic platforms for making autonomous diagnostic assays to enable rapid and low-cost detection of different analytes, including cells, bacteria, metabolites, proteins, DNAs, RNAs and microvesicles.

The challenge for Canada's diagnostic industry is to stay competitive for rapid, low-cost and sensitive detection of different biomarkers in biofluids. Particularly, rapid detection of pathogens and their response to drugs are crucial for Canadian healthcare. The existing clinical diagnostic technology for the detection of pathogens and antibiotics takes 2-4 days to analyze samples. This delay directly contributes to the patients' death. Our team through collaboration with the Metabolomic Centre at the University of Calgary and partnership with the Calgary Laboratory Service has developed advanced microfluidic and sensing technologies for rapid and highly sensitive isolation, purification and detection of bacteria from whole blood of infected patients and for automated antibiotic susceptibility testing. This technology can be used for rapid diagnosis of pathogens from the whole blood within 6 hours. Also, the microfluidic devices work with extremely small samples, so instead of needing 15 to 20 millilitres of blood we can work with just 2 to 3 millilitres. The predictive value of the new technology is being validated in clinical trials. The success of this novel microscale metabolomics device has the potential to transform medical microbiology testing and may significantly alter the $14 billion worldwide market in clinical microbiology testing.

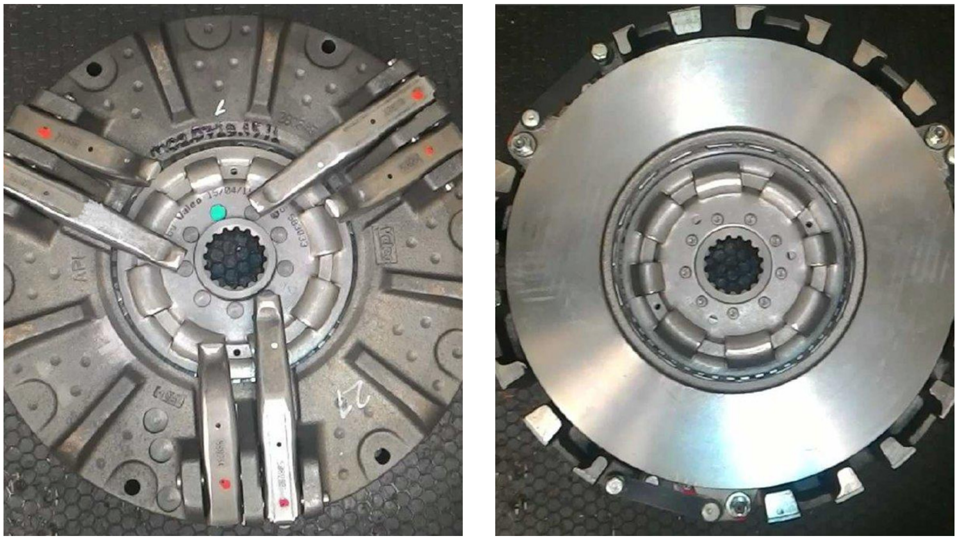
Our BioMEMS centre is also the first in Canada to develop microfluidic-based biosensors for the diagnosis and management of brain injuries and concussion. This work is being done at the Calgary Centre for Innovative Technology (CCIT) in the main campus of the University of Calgary, in partnership with concussion clinicians at the Foothill Hospital in Calgary. The long diagnostic time, complicated workflow, and labour-intensive nature of sport-related brain injuries testing make the service to patients expensive. The high costs of diagnosis and treatment, and public health concerns related to brain injuries and concussion have driven clinicians to critically review the emerging technologies for the diagnosis and management of brain injuries. Any significant improvement in the process would have an immediate impact on global health. To address this concern in Canada, our team of engineers and clinicians in Alberta has manufactured biosensors that integrate the sensing of different analytes from the blood and urine into a single sensing platform. In partnership with biotechnology companies in Canada and Germany, we have significantly improved the performance of these nano-biosensors to enable the detection of top-ranked brain injury potential biomarkers down to femtogram/mL concentration in less than 45 min. The levels of these proteins in the blood and urine after brain injury or concussion can help to predict the severity of injury to the brain and determine which patients may have intracranial lesions visible by CT scan and which won't. This device is also expected to help in predicting the recovery of concussed patients; reduce operational costs of diagnosis and management of sport-related brain injuries, and save the Canadian healthcare system up to hundreds of million annually.

Our BioMEMS centre is also the first-of-kind in Canada for developing noncontact and non-intrusive sensors made of integrated microfluidic-microelectronic platforms. Based on the concept of "Wireless Fluidics", we developed this technology in partnership with other research laboratories in Alberta and British Columbia, and we are supplying several laboratories and companies worldwide with our noncontact sensors for different applications including drug delivery, flow monitoring, and tissue screening. In particular, out team has generated the new generation of non-contact microwave sensors integrated into microfluidic organ-on-chip platforms for the long-term and real-time detection of tissue microenvironment and function. Parameters such as the concentration of particles, flow rate, flow pressure, shear stress, pH, oxygen, cellular barrier resistance, cell proliferation and differentiation, and cytotoxicity, are among the important parameters measured by non-invasive and non-contact sensors. The integration of these sensors to tissue engineering platforms in high-throughput systems will open avenues up for commercializing the sensory-integrated drug discovery platform, with the applications in drug testing, disease modelling, and biological systems modelling.

The contribution of our team's research to the current research landscape in Canada for BioMEMS, biosensors, lab-on-chip and organ-on-chip, will contribute to the Canada's reputation as a leader in biomedical research. Our colleagues, clinicians and partners have access to our BioMEMS laboratories and sensors experts, which has enabled us to leverage funding through national and international agencies. Several other groups have shown the interest to use our sensing and diagnostic technologies for disease detection and management, and willing to be part of our multidisciplinary team. We are welcoming new initiatives and inventions and explore hiring of bright minds from across Canada to our group. Scholars, students and entrepreneurs interested in our multidisciplinary sensing technologies, high-caliber research or translational initiatives at the University of Calgary, can consult our website (wcm.ucalgary.ca/sanati-nezhad) to explore research and partnership opportunities.

ME NEWS & RESEARCH

HIGHLIGHTS



FRONT AND REAR OF NEWLY DESIGNED TRACTOR CLUTCH USED IN FIELD TESTS

Engineering an Improved Tractor

CSME *Transactions* — *Journal Editor's Choice*

Tractors are a critical component in the food production ecosystem. An aspect to ensure long-term robust operation of the tractor is a properly designed clutch. In a recent article in the Transactions of the CSME, a team lead by Dr. **Fatih Karpat** at Uludağ University in Turkey examined the current design and developed an optimized version of a tractor clutch. They first examined the motor rotational speed, clutch temperature, and frequency of clutch usage in field tractors with embedded instrumentation. Based on the results of the field evaluation, the clutch was redesigned. The redesigned clutch has been field tested and shown to easily withstand at least 1 million rotations under the examined usage conditions. These concepts have the potential to make impacts on industrial clutch designs, such as with research partner Valeo.
— *Technical Editor, Professor Amy Bilton*

F. KARPAT, C. YUCE, O. DOGAN, M. O. GENÇ, AND N. KAYA, "DESIGN AND DEVELOPMENT OF A TRACTOR CLUTCH USING COMBINED FIELD TESTS AND EXPERIMENTS," *TRANSACTIONS OF THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING*, MAY 2018.

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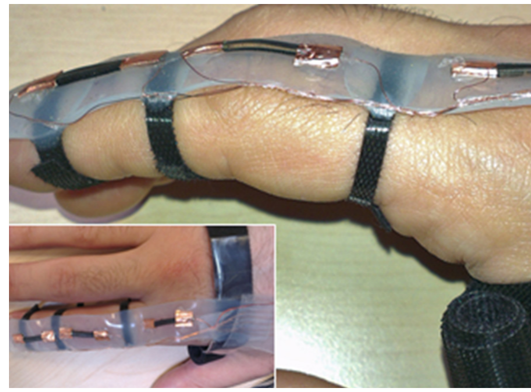

SAMPLE SENSOR DEVELOPED FOR MEASUREMENT OF HUMAN MOTION

NEW ULTRA-STRETCHABLE SENSORS FOR WEARABLE TECHNOLOGY

Interactive wearable devices, such as fitness trackers, smart watches, or smart glasses, are consistently growing in our everyday lives. However, one of the main limitations in current wearables is their inability to have sensors which can be seamlessly worn to measure bio-signals and human motion. A team at the University of British Columbia – Okanagan, led by Dr. **Homayoun Najjaran**, have recently developed a new, ultra-stretchable strain sensor which can conform to the human body to enable these types of applications. Using a new fabrication method, based on infusing graphene nano-flakes into a rubber-like adhesive, sensors for measuring the human heartbeat and tracking body motion were fabricated. The resulting sensors were shown to measure strains up to 350% and were able to withstand more than 10,000 cycles. The research team is currently looking at further applications into wearable technology. – *Technical Editor, Professor Amy Bilton*

S. R. LARIMI, H. R. NEJAD, M. OYATSI, A. O'BRIAN, M. HOORFAR, AND H. NAJJARAN, "LOW-COST ULTRA-STRETCHABLE STRAIN SENSORS FOR MONITORING HUMAN MOTION AND BIO-SIGNALS," *SENSORS AND ACTUATORS A: PHYSICAL*, VOL 271, MARCH 2018, PP 182-191.

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Q&A

Ms. **SARAH J. SHORTREED**, Bruce Power

Sarah is the Chief Information Officer (CIO) at Bruce Power. She has global experience in many industries and executive roles spanning business consulting, complex multi-stakeholder program management, operations, P&L, sales, customer relationship management and product management. Before joining Bruce Power in 2013, Sarah was a VP at BlackBerry, responsible for strategy, planning, procurement, process improvement and business continuity across four of RIM's operating units. Sarah also spent over a decade with IBM in leadership roles such as project and program management; outsourcing; business transformation / process re-engineering; and strategy consulting. Sarah began her career with Union Gas where she held a variety of engineering and management roles in the areas of regional operations and pipeline construction. She holds a Bachelor of Engineering Science degree, Mechanical, from the University of Western Ontario. Sarah sits on the Board of Governors for the University of Western Ontario, the Digital Advisory Board to the CIO Branch of the Treasury Board of Canada, and is the Chair of the CIO Committee at the Conference Board of Canada. Sarah recently completed a term on the Board of the Natural Sciences and Engineering Research Council (NSERC).

You are one of Canada's most successful female engineers. Tell us about yourself and your professional journey as a Mechanical Engineer in Canada.

While I began my career in the pipeline construction and operations field, I've had several other roles on my journey to my current role as a Chief Information Officer. Much of my career has been a story of being open to opportunity. When I work in new industries and disciplines, I learn as much as I can, and try to develop skills that will translate to other roles and opportunities. In this model, I've been in the right place at the right time to explore the airline, smartphone, and healthcare industries as I've moved through my various roles. I've learned that at the end of the day the core skills of a mechanical engineer allow us to define a problem, break it down to its parts, and solve that problem using organizational and project management skills.

I have learned along the way that my personal interests lie in the creation and sustainment of critical infrastructure in society. Bruce Power is currently delivering one of the largest Private Public Partnerships in Canada as we refurbish 6 CANDU reactors to extend the life of the facility which provides 6400 MW of stable baseload clean power in Ontario. I joined Bruce Power because I saw this commitment to critical infrastructure as a way to bring my love of engineering and IT together in an environment that brings benefit to the community I live in.

In addition, one of the biggest trends we have in the industrial space right now is the convergence of IT systems and Industrial Controls and Operational Technologies. I'm excited to be in a company that is leading the global nuclear industry in this area. We have been able to form strong partnership between engineers and IT staff to solve the challenges of this convergence. Issues such as lifecycle management, patching, and cyber are all solvable when you bring the right team together in an interdisciplinary cooperation.

When and why did you decide to move into managerial and leadership roles?

Even as a summer student, working as the Survey Crew Chief in a consulting engineering company, I realized that engineers are inherently the leaders of others. We may lead a cross-functional team in a non-hierarchical way, or we may be given direct reports in the hierarchy, but we are always a technical leader with a point of view! I enjoy what is often called "general management". This means that regardless of the industry or the technology, I enjoy the business aspect of creating organizational capability to achieve the outcomes of the corporation.

You have worked for IBM and RIM, two of the largest companies in Canada. What roles do mechanical engineers play in these and similar other industries?

While both firms employ engineers in many roles, they are often folks like myself who are not actively designing the physical product. IBM for instance has the bulk of its revenue generated from the Services business, not Hardware. Many engineers work in the areas of business transformation, business process optimization, outsourcing of IT services, etc. While at IBM I worked in several areas including consulting to clients on process improvements, building applications, or the services needed to maintain those applications and data centers. At BlackBerry, I managed several teams including Risk Management, Project Management, Procurement, and Strategy.

What emerging technologies are dominating your business today?

We are pursuing research and projects in several emerging technologies including Artificial Intelligence, Robotic Process Automation, Biometrics, and BlockChain. Not all of these may end up with specific solutions in our day to day business, but we need to explore how best they can support the business we operate. One of the challenges when you run an operational environment, is to carve out the time and the sandbox environments to run proof of concept activities, so this is a key area of focus for me. In addition, with the recent announcement of the Nuclear Innovation Institute that is being launched in Bruce County, I am actively working with researchers and other industrial partners on defining some interesting projects to co-locate in the Institute.

...continued on page 22

NEW FACULTY SPOTLIGHT SERIES:

FOCUS ON ATLANTIC CANADA

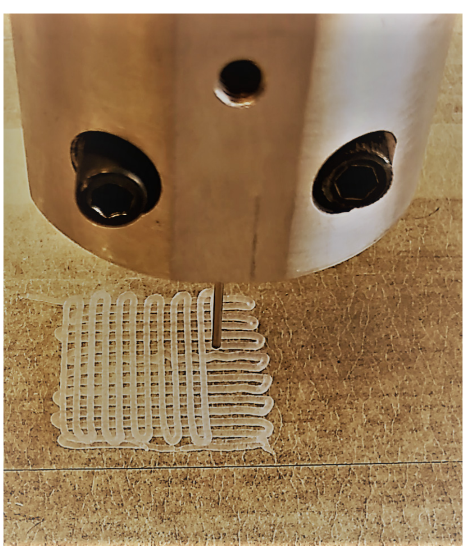
This series highlights new Canadian ME faculty members by region.
In this issue, we return to Atlantic Canada with research highlights from:

Dr. Ali Ahmadi, University of Prince Edward Island
Dr. Ting Zou and Dr. Xili Duan, Memorial University of Newfoundland
and Dr. Clodualdo Aranas Jr., University of New Brunswick

University of Prince Edward Island
Dr. **Ali Ahmadi**

UPEI BioFab Lab: A surf and turf approach to biofabrication

Dr. **ALI AHMADI**, PhD, MCSME
Dr. Ahmadi is an Assistant Professor in the Faculty of Sustainable Design Engineering at the University of Prince Edward Island (UPEI) in Charlottetown, Prince Edward Island, Canada. Before joining UPEI in 2016, he was a postdoctoral research fellow and research associate at the University of British Columbia (UBC). He received his Ph.D. degree in Mechanical Engineering from UBC in 2011, and his M.Sc and B.Sc. degrees from the University of Tehran, Iran in 2007 and 2004, respectively. His research interests include biofabrication and microfluidics. Dr. Ahmadi currently serves as the Chair of the Biomechanics and Biomedical Engineering Technical Committee of the CSME and is an Associate Editor for the Transactions of the Canadian Society for Mechanical Engineering (TCSME).



BIOFABRICATED TISSUE ENGINEERING SCAFFOLD FROM CHITIN-BASED AND STARCH-BASED POLYMERS.

Biofabrication is the development of complex living and non-living biological constructs from materials including living cells, extracellular matrices, and biomaterials. In the short term, biofabrication technology is essential for developing highly predictive living tissue-based technologies for drug discovery, and complex in vitro models of human diseases. In the long term, biofabrication can potentially contribute to the development of novel biotechnologies for organ transplants, gene therapy, smart drug delivery systems and biomimetic devices. Consequently, the wide range of potential applications of biofabrication strongly suggests that this emerging technology will become a new paradigm for 21st century manufacturing and biotechnology.

Given the importance of this emerging field, the Atlantic Biofabrication Laboratory at the University of Prince Edward Island (UPEI) led by Dr. Ahmadi focuses on the development of novel biofabrication techniques for tissue engineering, drug delivery and drug discovery. Particularly, Ahmadi focuses on the development of high performance bioinks for 3D and 4D bioprinting as well as the development of processes for 4D bioprinting of stimuli-responsive biomaterials. A bioink is comprised of a suspension of living cells and the mechanical and physiological support of biomaterials (or “scaffold”) that are essential for the fidelity of the tissue; bioinks typically contain a higher viscosity scaffold material with complex rheological properties. The development of bioinks is a challenging facet of bioprinting applications and processes. It is crucial that the bioink is able to be deposited in such a way as to be a self-supporting filament so that it may maintain its structural integrity following deposition. As such, the bioink must possess a relatively high viscosity. On the other hand, living cells cannot survive in high-viscosity bioinks during bioprinting as the large shear forces that develop during the deposition cause the cells to lyse and the fragile gel base might easily fracture.

Ahmadi’s group performs rheological analyses of biomaterials to develop and characterize high performance bioinks that may be efficiently used for 3D bioprinting. His group focuses on determining the relationships between the printing parameters as well as fundamentally important bioink parameters such as viscosity, shear rates, and thixotropy. Particularly, Ahmadi is interested in developing high performance bioinks from chitin-based and starch-based polymers. The impact of this work is two-fold. First, in collaboration with Dr. Andrew Tasker at the Atlantic Veterinary College at UPEI, Ahmadi is currently developing these bioinks for 3D bioprinting of neural tissues to develop a model for studying neurodegenerative diseases. Second, this work converts agricultural and fishery waste products from Prince Edward Island (such as starch from potato waste water and chitin from lobster shells) into value-added bioinks for bioprinting.

Ahmadi’s group also works on the development of bioinks for 4D bioprinting. In 4D bioprinting, the addition of “time” (as the fourth dimension) to the tissue construct references the ability of the printed structure to transform its shape and dynamically respond to a selected variety of stimuli over time following printing. To improve the biocompatibility of the printed 4D structure, in collaboration with Dr. Bishnu Acharya at UPEI, Ahmadi is investigating the use of modified nanocrystalline cellulose (NCC) isolated from tunicates (which are an invasive species to Prince Edward Island) for printing pH-responsive structures. These pH-responsive constructs are used for drug delivery, specifically for gastrointestinal applications.

Ahmadi’s other projects include the use of microfluidics in natural product discovery from marine species. Please visit, *www.atlanticbiofabrication.com* for more information.

IMAGES COURTESY OF THE RESEARCHERS

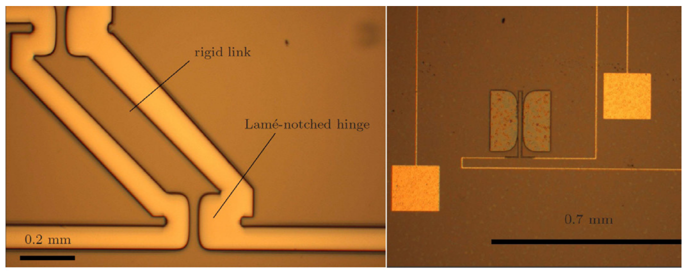
Memorial University of Newfoundland
Dr. **Ting Zou**

Mechanism Design & Control of Bio-inspired Robots for Inspection

Dr. **TING ZOU**, PhD

Dr. Ting Zou is an Assistant Professor in the Department of Mechanical Engineering at Memorial University of Newfoundland. She received her Master's degree in automation from Xi'an Jiaotong University, China, in 2008. Then, she obtained her PhD degree from McGill University in 2013 where she proposed bi-axial accelerometer design based on microelectromechanical (MEMS) techniques and its strapdowns, to improve current pose-and-twist estimation. Afterwards, she joined the Centre for Intelligent Machines at McGill University as a postdoctoral fellow, working on optimum design of the next-generation transmissions for electric vehicles and trajectory tracking & motion control of autonomous tracked vehicles for mining blasthole drilling rigs.

FIG. 2: MICROPHOTOGRAPHS OF MEMS MECHANICAL STRUCTURE AND MEASUREMENT CIRCUIT



Today, remotely operated robots are increasingly used in industry for inspection of mechanical structures, e.g., aircrafts and marine ships. The confined areas of some mechanical systems however bring challenges for industrial robots to perform inspections considering efficiency and manoeuvrability. Bio-inspired robots, mimicking not only the kinematics of animals in nature, but also the structure at the component level, provide solutions to some of these issues

Dr. Zou's current research aims at addressing the hurdles of bio-inspired robots for inspection: low efficiency and limited working areas. A typical example is the inspection of some complicated structures of aircrafts with confined areas using the recent snake-like robots. Snake-like robots have made significant progress in extending the inspection areas of aircraft and pipeline. However, improvements are required to achieve higher inspection efficiency, easier manoeuvrability and precision. Dr. Zou is working on the mechanism design and control of novel bio-inspired robots, for the inspection of mechanical structures with confined areas and obstacles, including aircrafts, marine vessels and oil pipelines.

The mechanism includes innovative actuator designs based on compliant mechanisms to realize smooth locomotion and jumping in confined spaces, intending to extend the working areas of current bio-inspired robots by passing complicated mechanical structures fast and avoiding obstacles. Coordinate control and navigation of autonomous robots for inspection is another important aspect in the current research of Dr. Zou. Design of both hardware and software is conducted to realize automatic control. The hardware includes the sensing system to yield the velocity, angular velocity and acceleration information, based on Microelectromechanical systems (MEMS) techniques. The software are the control and estimation algorithms.

Dr. Zou's research also includes design and testing of the MEMS-based accelerometer strapdown which improves the current pose-and-twist estimation of rigid bodies moving on ground, in air and underwater. The research aims to extend the applications of accelerometer strapdowns by improving the design and estimation algorithm.

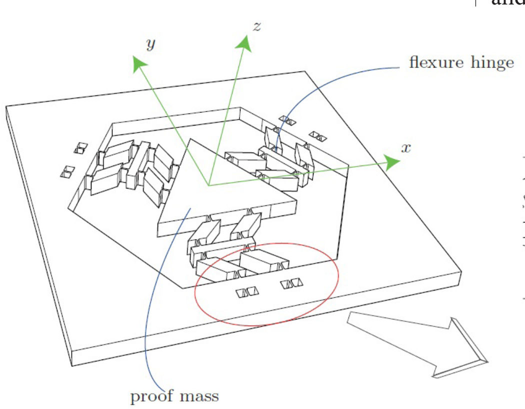


FIG. 3: DESIGN AND SENSING SYSTEM OF THE BIAXIAL ACCELEROMETER

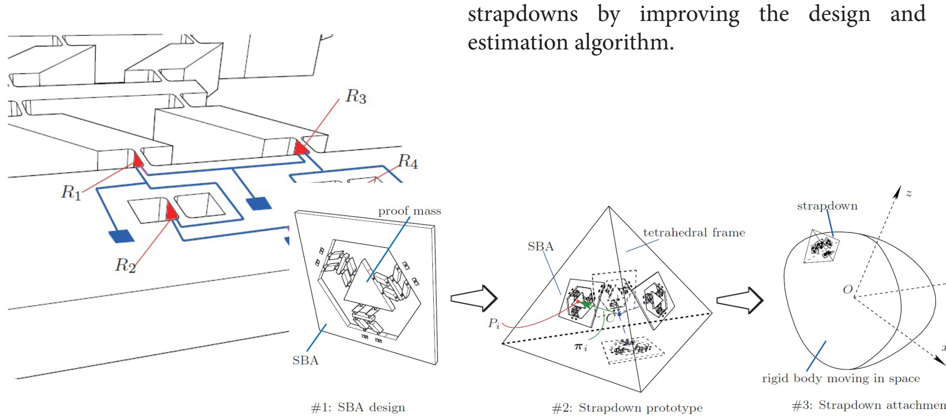


FIG. 3: ACCELEROMETER TETRAHEDRAL STRAPDOWN DESIGN

Memorial University of Newfoundland
Dr. **Xili Duan**

Interfacial Thermal-fluids Research for Energy and Harsh Environment Applications

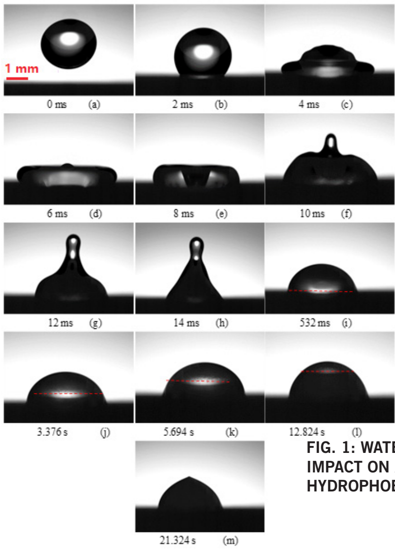
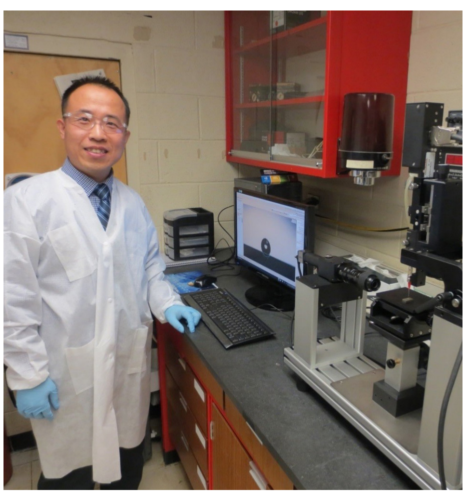


FIG. 1: WATER DROPLET IMPACT ON A HYDROPHOBIC SURFACE

Interfacial thermal-fluids problems involve the fluid dynamics and heat transfer at solid-liquid-gas interfaces. These phenomena happen in many engineering systems, such as fluid flow in a pipe, boiling water in a thermal power plant and ice on a vehicle's windshield or on marine vessels. Dr. Xili Duan is a mechanical engineering professor in Memorial University's Faculty of Engineering and Applied Science. His research aims to develop a better understanding of the interfacial thermal-fluids problems and advanced technologies to improve the efficiency and reliability of many energy systems. Dr. Duan's research involves the following two long-term research programs.



Dr. **XILI DUAN**, PhD

Dr. Xili Duan is an Asistant Professor in Mechanical Engineering in Memorial University's Faculty of Engineering and Applied Science. Before joining Memorial, Dr. Duan worked with Siemens Energy as a gas turbine combustion testing and design engineer for three years. He received his PhD degree from the University of Manitoba and completed postdoctoral work at the Massachusetts Institute of Technology (MIT). Dr. Duan's current research interests include phase-change heat-transfer, flow-drag reduction and developing surfaces with special wettability for energy applications. He has published one book, one book chapter and over 60 journal and conference papers.

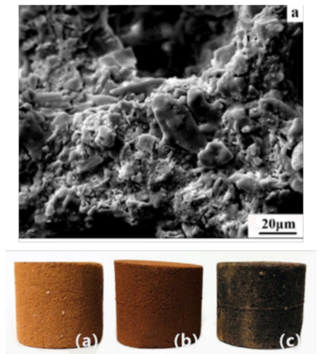


FIG. 2: NANOPARTICLE ENHANCED COMPOSITE PHASE CHANGE MATERIALS (NCPCM)

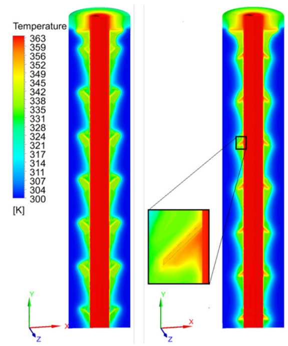


FIG. 3 TEMPERATURE FIELD IN A THERMAL ENERGY STORAGE UNIT WITH PCM

Phase change heat transfer and materials for energy storage, conversion and thermal management applications

Dr. Duan develops enhanced heat-transfer techniques in solid-liquid phase change and two-phase flow convection by combining macroscale enhancement elements, such as fins, with nanoparticles dispersed in the fluid or phase change materials (PCMs).

His research team studies the preparation, stability and thermal properties of the enhanced materials, such as nanofluids and nano-enhanced phase change materials (NePCMs), through experiments and numerical simulations. The team then develops the NCPCM, which is an advanced composite PCM with nanoparticles and paraffin wax in a ceramic porous medium fabricated from iron ore tailings. The NCPCM was tested and showed outstanding stability, thermal conductivity and energy storage capacity.

For applications, prototype thermal energy storage units have been built and tested in the lab for solar thermal storage and waste heat recovery. A hybrid thermal insulation technology with PCM and aerogel was developed for flow assurance in subsea pipelines. Most recently, Dr. Duan filed an invention disclosure for a technology that will directly convert wind to thermal energy.

This research program is supported by several grants including a Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant, an NSERC Engage Grant and research funds from Memorial University.

Repellent Surfaces for harsh environment applications

This research program involves the development of repellent surfaces, hydrophobic and/or icephobic, for asset integrity and engineering safety in harsh marine environments. The research team aims to develop surfaces that can mitigate problems such as corrosion of subsea and floating equipment or icing on offshore platforms. The research outcome from this program has tremendous potential of applications in energy exploration, ocean transportation, power transmission, among others, in the Arctic and offshore regions.

Hydrophobic and super-hydrophobic surfaces are being developed for realistic engineering materials, such as stainless steels, by incorporating micro/nanoscale roughness with low-energy coatings. The team investigated various mechanical and electrochemical methods to fabricate metal surfaces with microscale and submicron texturing and used low energy coatings to further improve the liquid repellency of these surfaces. Surface wettability was characterized by measuring the static and dynamic contact angles, as well as liquid drop sliding and adhesion on inclined surfaces. Corrosion resistance of the materials was tested in harsh environments with variable temperatures and water salinities. The group developed several metal surfaces that have almost perfect water repellency. They also developed new methods to characterize surface wettability and useful correlations between surface wettability and water icing time.

This program received major research fund from Petroleum the Research Newfoundland & Labrador (PRNL) and the Newfound provincial government.

University of New Brunswick Dr. **Clodualdo Aranas** Jr.

Materials of the future: Design and development of next generation advanced high-strength materials

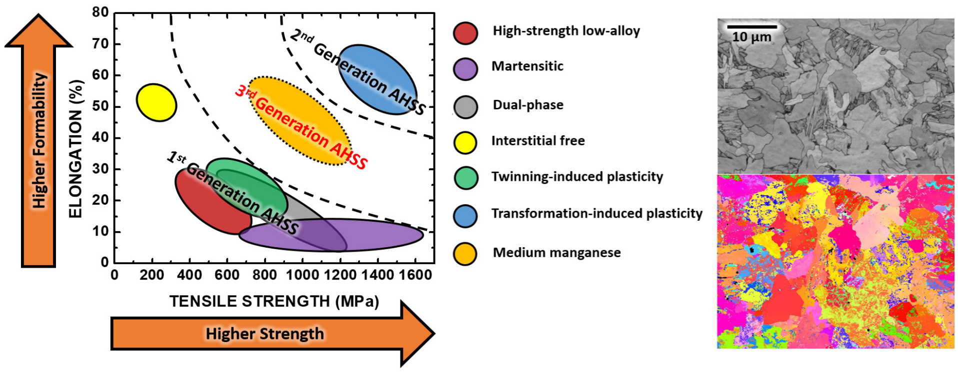


FIG. THE TENSILE STRENGTHS AND ELONGATIONS OF VARIOUS STEEL GRADES ARE SHOWN ABOVE. THE PRESENT RESEARCH INTEREST IS THE DEVELOPMENT OF 3RD GENERATION ADVANCED HIGH-STRENGTH STEELS WITH MEDIUM MANGANESE CONTENT. THESE ALLOYS HAVE A PERFECT COMBINATION OF ECONOMY, STRENGTH AND DUCTILITY.

PORTRAIT PHOTO: JESSA ANDREA CANAVERAL / RESEARCH IMAGE COURTESY OF THE RESEARCHERS

Dr. **CLODUALDO ARANAS JR.**, PhD, P.Eng.
Dr. Aranas is an Assistant Professor in the Department of Mechanical Engineering at the University of New Brunswick (UNB). He received his PhD in Materials Engineering from McGill University in Montreal, Quebec, Canada. His major research contribution is in the understanding of the dynamic phase transformation in steels during thermomechanical processing. He developed a thermodynamic model to understand and predict the high-temperature mechanical behavior of steels. Prior to joining UNB, he was a postdoctoral research scientist at CanmetMATERIALS, Natural Resources Canada and McGill University. His current research interests include alloy development, high-speed deformation and thermomechanical processing of both ferrous and non-ferrous alloys. He is presently designing and developing the next generation and energy-efficient advanced high-strength materials at UNB.

In metal alloys such as steels, it is essential to precisely understand the various strengthening mechanisms to obtain a strategic and well-designed alloy. As an example, the occurrence of transformation-induced plasticity (TRIP) and twinning-induced plasticity (TWIP) is related to the stacking-fault energy (SFE) of the material, a composition-dependent parameter which can be estimated using thermodynamic quantities available in the literature. However, the SFE values may not provide the exact behavior of the material since these strengthening mechanisms may also be affected by the material's grain size and residual stresses. Another example of strengthening mechanism is precipitation hardening, which can be utilized by small additions of microalloying elements such as V, Mo and Nb. Formation of precipitates is well-known to significantly boost the strength of the material. The strength and ductility of materials are also strongly affected by the type of microstructure, which is a processing-dependent property.

In the past five years, Dr. Aranas has been heavily involved in identifying the processing-microstructure-property relationships in materials, which includes his major contribution in the understanding of the dynamic transformation of austenite to ferrite in steels above the transus temperature. In addition, he studied various static and dynamic metallurgical phenomenon on numerous types of steels such as but not limited to high-strength low-alloy, niobium-microalloyed, vanadium-microalloyed, pipeline, electrical, stainless, copper-containing and medium manganese. The development of green and energy-efficient materials is the primary focus of Dr. Aranas' research group at UNB.

In the automotive industry, the combination of strength, economy and recyclability makes steel as the primary choice of material for the body-in-white assemblies. The composition of steel for these parts is continuously evolving due to the ever-changing needs of the world. Presently, the challenge is to produce a 'lightweight steel' that has a comparable (or better) mechanical properties than the previous one. This target can be achieved by altering the chemical composition of the material, however, each alloying element should be properly selected to maximize the potential of the material. In the past several years, manufacturing industries have developed new set of steels for future applications. For example, the *first-generation* advanced high-strength steels (with 3 wt% Mn) were initially developed; however, they exhibited a limited elongation of 25% once the tensile strength was above 600 MPa. This material was therefore not ideal for parts with complex geometries. *Second-generation* advanced high-strength steels (with 15-25 wt% Mn) were established to address the concerns of limited formability. Incredibly, these materials can easily attain tensile strengths of more than 1200 MPa and elongations of 40-50%. However, since this type of steel is heavily-alloyed, the production cost is high, which makes them unattractive to the manufacturing industries. For this reason, the so-called *third-generation* advanced high-strength steels (with 3-12 wt% Mn) are currently being explored. These materials have a perfect balance between strength and ductility by combining the effects of TRIP and TWIP.

Dr. Aranas' research group at UNB focuses on developing third-generation generation advanced high-steels with tensile strengths of more than 1000 MPa and elongation of 30-40% by using unconventional alloying concepts. He believes that by identifying and performing key experiments, and analyzing individual quantitative effects of various parameters, game-changing alloys will emerge which will mark the beginning of a revolutionary approach to alloy database and design. Dr. Aranas plans to develop the next generation advanced high-strength materials at UNB.

Women are underrepresented in the Board of Directors of most Canadian organizations (www.cbc.ca/news/opinion/women-on-boards-1.4566959)**. As someone who has been in the Board of Directors of several not-for-profit companies, why do you think this has been traditionally the case? What do you think should change?**

As your question points out, our society has undervalued the contributions of women for quite some time. The Catalyst organization is tracking the participation of women in Boards and Senior Management for all companies on the Toronto Stock Exchange. Many countries such as Sweden and Australia have set and met targets in these areas. In Canada, there are a number of organizations who publish profiles of qualified women Directors. The current best practice for Board with vacancies is to use a formal Search process to ensure they are attracting the most qualified candidates.

I believe executive leadership by Boards and CEO's can solve the issue in a short period of time if they act with urgency, but like the author of the article you reference above, I am not encouraged by the current pace of change.

As a successful woman in the field of mechanical engineering, you are a role model to many other women who are in the field and aspiration to the ones considering to study mechanical engineering. What is your opinion about gender imbalance in mechanical engineering education and do you have any suggestions to address this issue?

We need more women to participate in all STEM fields including the Trades and Engineering. STEM fields provide high paying and rewarding careers for everyone including women, indigenous peoples, and other minorities. I have spent time over the last 30 years working with grass-roots organization to ensure young women have the information they need to make informed career decisions. However, studies show that the influence of a father is often a key success factor, so I would ask your readers to consider the last encouragement they gave to their daughters, and whether or not they actively supported participation in the pre-requisites for these careers.

You have recently completed a term as a board member of the Natural Sciences and Engineering Research Council (NSERC). What is your opinion about research funding in mechanical engineering in Canada? How can we improve the support for fundamental and applied research in this field?

My term on NSERC was very educational, and I think that they are delivering a valuable service to all Canadians. I believe it is critical that Industry and Academia partner to advance Innovation in Canada and continue to build our leadership position on the world stage.

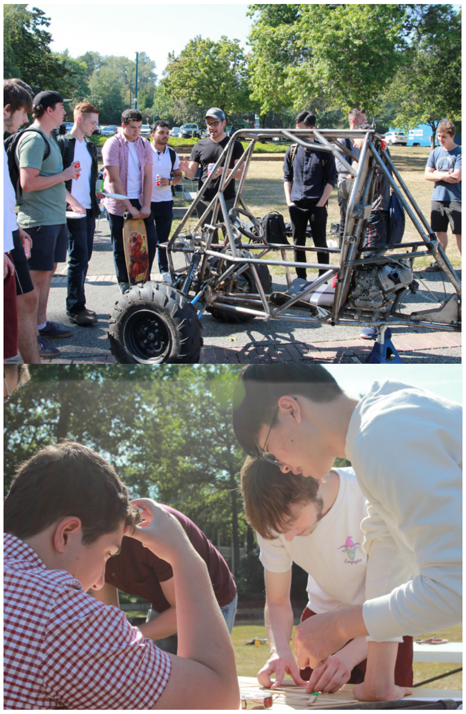
IN MEMORIAM
Dr. Peter Nikiforuk (1930 - 2018)

Dr. Peter Nikiforuk, Professor of Mechanical Engineering, and Dean Emeritus of College of Engineering, University of Saskatchewan, passed away peacefully on July 19, 2018 after a long battle with Alzheimer.

Peter N. Nikiforuk was Dean Emeritus, college of Engineering, at the University of Saskatchewan, Canada. He was Dean of Engineering for 23 years, Head of Mechanical Engineering for 7 years and Chair of the Division of Control Engineering for 5 years. Prior to this he worked in the defence industry in Canada and USA. He served as the chair member of five Councils in Canada, was recipient of seven fellowships in Canada and England and seven other honors, and member of several boards. Dr. Nikiforuk had a wonderful and excellent personality. Rest in Peace Peter.

Academic life: contribution to the advancement of Science and Engineering: Dr. Nikiforuk has worked for the advancement of engineering in Canada since 1951 through practice, teaching, research, administration and service on numerous provincial and national councils, boards, associations and committees. Given his range of activities, it is difficult to identify a single or even several of his 'greatest' achievements. He is internationally known for his research in control systems. Some of this dates back as far as his work as a graduate student on nonlinear control systems, which has been referred to in English and other language textbooks. Later, his research in this field led to him receiving the degree of D.Sc. from Manchester University in 1970. As well, throughout his stay at the University of Saskatchewan he was the recipient of one of the largest (and often the largest) research grants in mechanical engineering in Canada, initially from the National Research Council and later from the Natural Sciences and Engineering Research Council. Another indicator of his international reputation is his long and close association with other researchers in this field at 8 Japanese Universities, including the Japan Defence Academy. Still another indicator of his reputation is his many, many years of service on federal and provincial councils, boards, associations and committees dealing with matters pertaining to science and engineering. He was a founding member of the Canadian Academy of Engineering and a Vice-President of the Canadian Society for Mechanical Engineering during its founding. The clear proof of his stature, both nationally and internationally, is in his election to Fellowship in seven science and engineering societies and the receipt of seven awards and medals. Dr. Nikiforuk has been the author or coauthor of over 250 papers which have been published in prestigious scientific journals such as *Transactions of IEEE* (Institute of Electrical and Electronics Engineers), *Transactions of ASME* (American Society of Mechanical Engineers), *Automatica*, etc, and another 230 papers in technical conferences. If asked, however, Dr. Nikiforuk would most probably say that his greatest contribution has been in the education and training of both undergraduate and graduate students and their successes. – *Reza Fotouhi, PhD, P.Eng., FEC, Professor of Mechanical Engineering, University of Saskatchewan*

CSME STUDENT CHAPTER REPORT



CSME BCIT STUDENT CHAPTER:
BCIT RACING AND BCIT MECHANICAL ENGINEERING ROBOTICS CLUB (MERC) EVENT

CSME STUDENT CHAPTERS ACROSS THE country have been gearing up for a new year of organizing events to engage current undergraduate students in industry networking events, design competitions and industry guest lectures. A couple of chapters held some early fall events.

At the CSME BCIT chapter, they kicked-off the year with a 2nd Annual Welcome BBQ for first year students. On Tuesday, September 4th, CSME BCIT collaborated with BCIT Racing and BCIT Mechanical Engineering Robotics Club (MERC), to provide free food and activities for the students. They also held a bridge building contest between four teams comprised of all first-year students. The purpose of this event was to help students become familiar with the program and their new classmates. "We were very happy with the result of the event as students were able to mingle eating burgers and competing in the competition" said Brett Choi, President of CSME BCIT. They are also looking forward to upcoming events including a pub night with Women in Engineering, BCIT Racing, and BCIT Enactus, and their annual Industry Night.

We are also encouraging CSME student members to participate in the CSME National Design competition. During the spring, several teams competed at the CSME Congress. A few teams from the CSME uOttawa chapter also competed. CSME uOttawa students who participated include Hallie Arnott, Clara Phillips, Andrew Zavorotny, and Matt Sehri. CSME uOttawa student members Hallie Arnott and Clara Phillips won the best poster prize.

We are now seeking to increase student participation through the FREE Student CSME membership (csme-scgm.ca/application). The Engineering Careers site (www.engineeringcareers.ca) also provides students an opportunity to plan for their careers. We are also working towards deploying a CSME internship program to further engage students with industry opportunities.

Thank you to all the student chapter executives, volunteers and faculty mentors for your hard work! We look forward to supporting and hearing about your next chapter activities! The CSME student chapters include: BCIT, UBC Okanagan, Concordia, Manitoba, Memorial, Ottawa, UNB-Fredericton, Lakehead, Guelph, Ryerson, Western, and Carleton and a few that are currently being established.

CSME uOTTAWA STUDENT CHAPTER: CSME NATIONAL DESIGN COMPETITION (CLOCKWISE TOP LEFT TO RIGHT): HALLIE ARNOTT AND CLARA PHILLIPS, MATT SEHRI AND ANDREW ZAVOROTNY

If you're interested in leading and founding a CSME student chapter at your campus, let us know. Contact me at m.freire.gormaly@utoronto.ca, or the CSME directly, we will walk you through the process. We're also looking to expand the CSME Student Affairs Committee. If you're interested in helping lead activities at the national level, please reach out.

Forming a CSME Student Chapter is quite simple, you need a team and a short chapter constitution stipulating aims/objectives and modus operandi for elections and membership. Chapter members should be registered CSME Student members (national membership is free). Students can benefit from CSME student membership by participating in networking opportunities, the national design competition, volunteering at CSME Congresses, and access to job boards and scholarships. As well, each CSME student chapter can be funded up to $300 from CSME to fund chapter-related activities and initiatives.

Do you have a great idea, story or proposal to improve the CSME student programming? Please feel free to reach out with your feedback!

DR. **MARINA FREIRE-GORMALY,** PhD, EIT, SCMSE
Chair of CSME Student Affairs
Marina is currently a post-doctoral fellow at the University of Toronto. She is currently teaching 'Mechanical and Thermal Energy Conversion Processes', a 3rd year course at U of T. She completed her PhD at U of T in the Department of Mechanical and Industrial Engineering on the Experimental Characterization and Design of Solar Powered Water Treatment Systems. Marina is passionate about research, teaching and student engagement to tackle society's most pressing energy and water challenges.

DR. **FAIZUL M. MOHEE**, PhD, P.Eng., PMP
Vice Chair of CSME Student Affairs
Faizul is the lead structural engineer at TMBN Extrados Inc. He completed his PhD at the University of Waterloo on composite materials. He also did a master's at the University of Toronto. He taught the Materials Science course at U of T in the Department of Mechanical and Industrial Engineering. He also previously worked at Hatch and WSP. He has been working in the nuclear and mining industries. He looks forward to bringing this experience to the student affairs committee.

STUDENT FOCUSED

Engineering professor receives Atlantic Canadian Distinguished Teaching Award

DR. GEOFF RIDEOUT IS PRESENTED THE ATLANTIC CANADIAN DISTINGUISHED TEACHING AWARD BY DR. MARY BLUECHARDT, PRESIDENT AND VICE-CHANCELLOR, MOUNT SAINT VINCENT UNIVERSITY, AND INCOMING LIAISON TO THE AAU COUNCIL.

DR. GEOFF RIDEOUT

THE SECRET TO DR. GEOFF RIDEOUT'S teaching success is rooted in his passion for his students, their success, and his unique ability to view the curriculum he teaches from his students' perspective.

While wearing inline skates, Dr. Rideout, a mechanical engineering professor in Memorial's Faculty of Engineering and Applied Science, throws a bag of cement to demonstrate how conservation of momentum will propel him backwards. He demonstrates shaft whirl by using a foam pool noodle and a cordless drill. He asks students to predict how far ice will be thrown from the blades of a wind turbine and to verify the police report concerning the speed of a vehicle in a traffic accident in which he was involved.

It is because of his hands-on approach to teaching that Dr. Rideout was presented with the 2018 Association of Atlantic Universities (AAU) Distinguished Teaching Award on September 20.

The AAU is made up of the 16 universities in the Atlantic region and in the West Indies. It presents up to two awards annually in recognition of excellence in university teaching over a number of years, primarily at the undergraduate level.

For Dr. Rideout, the award is reassurance that his teaching techniques are effective and more reason for him to continue to improve.

"It's good to hear from the outside world that I'm doing some things that appear effective, innovative and impactful," he said. "It has energized me to keep taking some risks, and to experiment with new methods of teaching and assessing."

While he uses his personal experiences as an individual and as a professor in his teaching, Dr. Rideout recalls a tutoring experience when he was in graduate school that taught him that everyone has a different learning style and that his students will have different challenges than he did.

"Sometimes it's not that students can't learn the material, but they just need to attach meaning to it," said Dr. Rideout. "I was explaining things in a way that would work for me, but the student wasn't making progress."

"One day we were having a seemingly unrelated conversation where he wanted me to tell him how a real-life engineering system worked. I became concerned as my explanation touched on material from more advanced courses. To my surprise, he became energized and motivated because he made a big-picture connection that worked for him."

Dr. Rideout says that the student did well in the course, and was almost in tears as he expressed his gratitude.

When it comes to the impact he's been having on his students, Dr. Rideout's response is humble.

"A firefighter knows that once they've put the fire out, they've made a difference," he said.

"As a university teacher, I can only try to give my students some base knowledge, connect that knowledge to things that are meaningful to them and hope it combines with all their other experiences to make them better practitioners and people. I have to take it on faith that I'm making an impact."

Dr. Greg Naterer, dean, Faculty of Engineering and Applied Science, is proud of professors like Dr. Rideout.

"Congratulations to Dr. Rideout on receiving this teaching excellence award," he said.

"This award is well-deserved. It is with efforts and dedication to teaching like Dr. Rideout's that give Memorial's engineering programs such a high reputation across Canada. His exceptional passion and priorities on quality student learning are inspirations to all of us as educators."

Dr. Rideout has received numerous teaching awards throughout his career, including the Professional Engineering and Geoscientists Newfoundland and Labrador (PEGNL) Teaching Award in 2015; the President's Award for Outstanding Teaching in 2014; and the Dean's Award for Distinguished Teaching, Faculty of Engineering and Applied Science in 2013. – *Jackey Locke with files from AAU*

PHOTO TOP RIGHT: ASSOCIATION OF ATLANTIC UNIVERSITIES (AAU) / PHOTO OF DR. RIDEOUT BY CHRIS HAMMOND

CSME Fellow Distinguished University Professor Hoda ElMaraghy elected Fellow of the Royal Society of Canada

HAILING HER AS A "WORLD LEADER IN manufacturing systems", the Royal Society of Canada (RSC) announced on 11 September 2018 her election to the class of 2018 Fellows.

"Distinguished scholars and artists are elected to the Fellowship of the Royal Society of Canada on the basis of their exceptional contributions to Canadian intellectual life," said the society's president, Chad Gaffield. "Your election is a telling recognition of your remarkable accomplishments and an invitation to further the leadership you have already shown in advancing knowledge and scholarship in Canada."

The RSC cited her pioneering research and publications in naming her the "pre-eminent scholar of manufacturing systems research" in Canada and internationally. "Her inspiring research opened up new research fields in Co-Evolution and Co-Development of Products and Manufacturing Systems using principles of Natural Evolution," the citation reads. "Her vast contributions to modern manufacturing systems paradigms, flexibility and changeability changed the way they are designed and operated."

Hoda ElMaraghy will be inducted in a ceremony on November 16 in Halifax during the society's Celebration of Excellence and Engagement. She said she is pleased by her election to the Applied Sciences and Engineering Division of the Academy of Science and delighted to join this distinguished group of scholars and looks forward to contributing to the important work of the RSC Academy.

Dr. ElMaraghy, PEng, Distinguished University Professor in Department of Mechanical, Automotive and Materials Engineering, University of Windsor and founding director of its Intelligent Manufacturing Systems Centre held Tier I Canada Research Chair (CRC) in Manufacturing Systems for 14 years since 2002. She received her Master and PhD in Mechanical Engineering from McMaster University and was a Professor in that department until becoming the first woman Dean of Engineering in Canada at the University of Windsor. She is recipient of the Order of Ontario, and is Fellow of the Royal Swedish Academy of Engineering Sciences (IVA), the International Academy of Production Research (CIRP), the Canadian Academy of Engineering (CAE) and the Society of Manufacturing Engineers (SME).

PROFESSOR HODA ELMARAGHY

PHOTO OF PROFESSOR HODA ELMARAGHY COURTESY OF ORDER OF ONTARIO

CSME Fellow Professor Waguih ElMaraghy honoured by ASME as DTM (Design Theory and Methodology) Founder

ENGINEERING PROFESSOR WAGUIH ELMARAGHY was honoured, as Design Theory and Methodology founder, by the American Society of Mechanical Engineers (ASME) at its International Design Engineering Technical Conferences & Computers and Information in Engineering (IDETC/CIE) Conference in Quebec City, August 26-29, 2018. Professor ElMaraghy also received a pin recognizing his 30 years of involvement with DTM.

The Design Theory and Methodology conference promotes research, dissemination of knowledge, and debate in topics including scientific theories of design, creativity and innovation.

The first DTM conference that was held in Montreal, Quebec, Canada, September 17-21, 1989, sponsored by the Design Engineering Division, ASME was co-chaired, and the Proceedings were edited by W.H. ElMaraghy, W.P. Seering, D.G. Ullman. At the first conference about half of the 30 plus papers submitted were accepted. This acceptance rate of about 50% has been consistent over the following years. David G. Ullman, now Emeritus Professor at Oregon State University, stated: "It is heartening that DTM has maintained the goals of the founders and continues to be successful and relevant. The first conference was so successful, and the demand for more papers so high, that in 1990, there were 45 papers accepted. This size felt about right and all conferences since have had about the same number of papers."

Dr. Waguih ElMaraghy is a professor in the Department of Mechanical, Automotive, and Materials Engineering at the University of Windsor, he is also a founding Director of the Intelligent Manufacturing Systems Centre at the University and is a Professional Engineer in Ontario (P.Eng.) and is a Fellow of The Canadian Society for Mechanical Engineering (CSME), the American Society of Mechanical Engineers (ASME), the International Academy of Production Research (CIRP), the Canadian Academy of Engineering (CAE), Engineers Canada (FEC) and the Society of Manufacturing Engineers (SME).

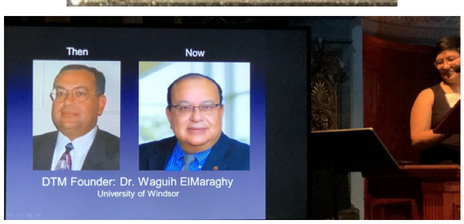


PHOTO ABOVE AND BELOW: **PROFESSOR WAGUIH ELMARAGHY ACCEPTS CONGRATULATIONS FROM PROFESSOR KATE FU, VICE-CHAIR OF THE ASME DESIGN THEORY AND METHODOLOGY (DTM) AT THE 30TH ANNIVERSARY CELEBRATION IN QUEBEC CITY.**

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