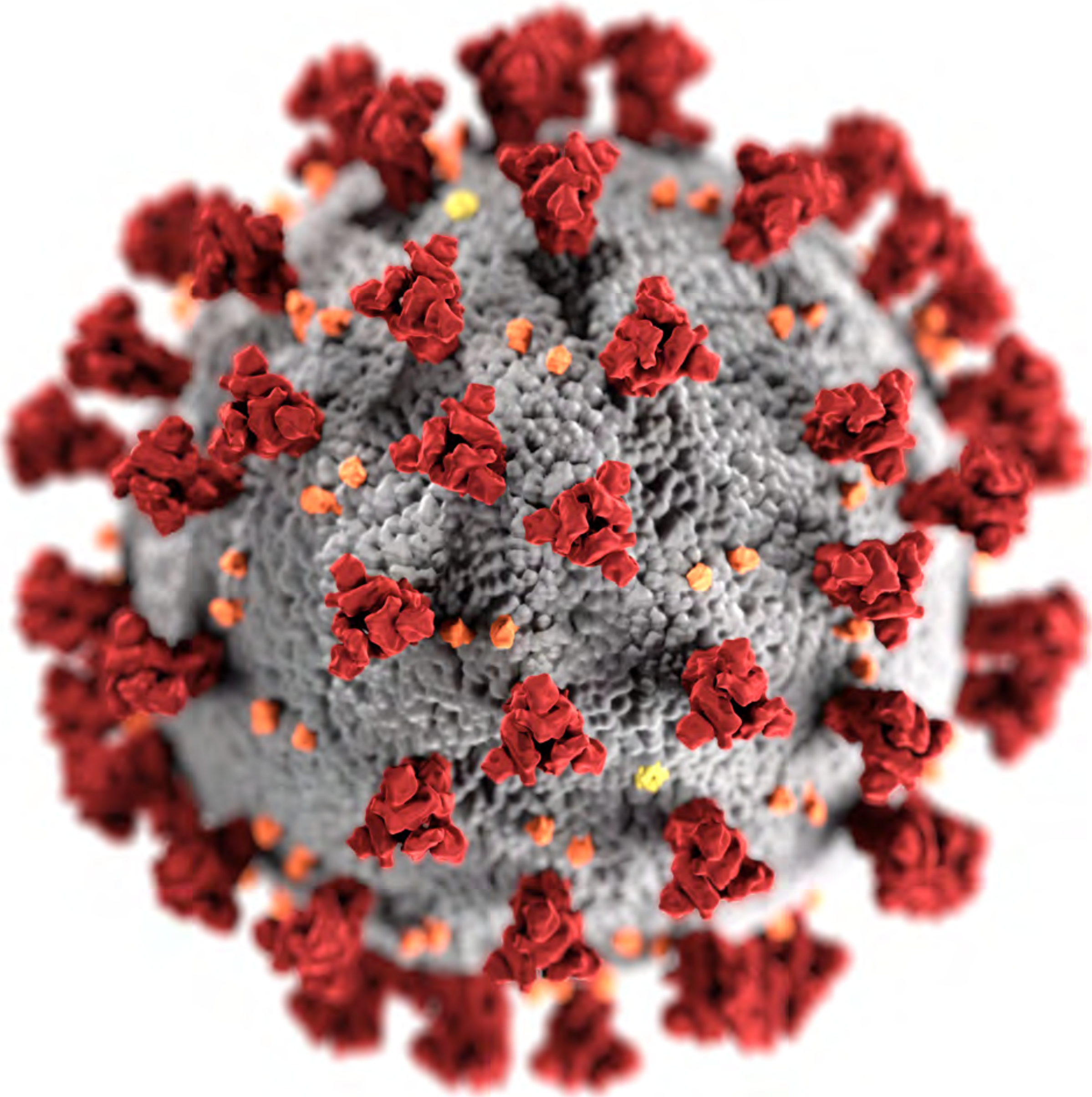
THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE
FALL/L'AUTOMNE 2020

BULLETIN



MECHANICAL ENGINEERS FIGHTING

COVID-19

CONTENT

FALL/L'AUTOMNE 2020

ILLUSTRATION, CREATED AT THE CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC) REVEALS ULTRASTRUCTURAL MORPHOLOGY EXHIBITED BY CORONAVIRUSES. [ID #23312 ALISSA ECKERT, MSMI, DAN HIGGINS, MAMS]

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Editor's Letter

IT IS DIFFICULT TO BELIEVE THAT MORE THAN eight months have passed since many universities shut down their on-campus activities due to the COVID 19 pandemic. The impact on everyone's personal and professional life has been significant. We have learned a lot, specially about how to stay socially distant from each other while remaining connected and still active and productive in what we do. In Ontario, the provincial government just announced that some regions will move back into COVID-19 lockdown on Nov. 23, 2020. Moreover, it seems that the COVID-19 vaccine may not reach the general public till late 2021. Altogether, we must adapt to the new reality, perhaps for a foreseeable future.

Given our situation with the novel coronavirus, and the fact that our community has contributed significantly towards combating this pandemic, we dedicated this CSME Bulletin issue to the Mechanical Engineers (MEs) Fighting COVID-19. Canadian MEs are conducting research and development projects in all areas related to COVID-19, including the diagnostic, prevention, treatment, and tracking the impact of the disease on society and the economy. The current issue aims at providing a few examples of the efforts the mechanical engineering community has done so far to help cope with the COVID-19 pandemic.

An article by Dean **Mary Wells** from the U of Waterloo paints a clear picture of the types of COVID projects being undertaken by MEs across Canadian universities. The *Featured Articles* in this issue are by professors **Bégin-Drolet**, **Gormaly** and **Zou** from U Laval, York U and Memorial U of Newfoundland, respectively. These articles will introduce you to the novel projects being conducted to diagnose COVID-19 using low-cost spectrometry, to model COVID-19 transmission by droplet and aerosol spread in public areas, and to design robots for telenursing to better provide socially distant patient care. The *New Faculty Spotlight* articles are by professors **Wong** (U of Alberta), **Stroberg** (U of Alberta), and **Giles** (U of Victoria), describing their exciting research programs in the areas of energy and flight with biomimetics, in-silico cell biology, and mechatronic devices in orthopaedic surgical planning. One of the *ME News* pieces by our Technical Editor, Prof. **Ryan Willing**, describes the recent study directed by Prof. **Eric Savory** at Western U investigating the far-field airflows resulting from coughs from healthy and influenza-infected subjects. The other news piece is on the support that MEs have received lately from NSERC to perform COVID-19 related research, summing up to almost 10% of all the funded projects. CSME concludes with the very sad news of the loss of Professor **Thomas Anthony Brzustowski** from the U of Waterloo who passed away on June 19, 2020. Quoting John, Marc and Paul Brzustowski: "A great Canadian, a devoted husband, a proud and generous father and "Dziadzio", Tom was loved by many, respected by all, and will be sadly missed and fondly remembered."

The next CSME *Bulletin* issue will be dedicated to advanced materials. We invite all the researchers in this area to watch for our article invitation email in early 2021 and send us abstracts for evaluation by the editorial board. It is your contributions that make the CSME *Bulletin* a publication that CSME community can be proud of. We hope you enjoy reading this issue.

We wish you all health, a fast recovery from COVID-19 impacts, and a happy holidays and new year season. Best wishes for 2021!

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Transactions of the Canadian Society for Mechanical Engineering (TCSME)

I am happy to report on the accomplishments of the *Transactions of the Canadian Society for Mechanical Engineering* (TCSME). The most exciting news last summer was that the 2-year impact factor for TCSME has increased from 0.243 (2018) to 0.573 (2019). This is the first impact factor calculation since the TCSME was moved to Canadian Science Publishing (CSP). Up to now in 2020, based on the Web of Science, articles published either in 2018 or 2019 were cited 56 times this year which is a good indication that the impact factor for 2020 will be even higher. Another exciting news is that CSP has now launched a new website that simplifies searches and sharing of research results. The CSP address is www.cdnsciencepub.com, and the CSME Transactions webpage is www.cdnsciencepub.com/journal/tcsme.

MARIUS PARASCHIVOIU, PhD, FCSME
Editor-in-Chief, TCSME
Professor, Mechanical, Industrial and Aerospace Engineering
Concordia University

PHOTO (REZAI): COURTESY OF THE LASSONDE SCHOOL OF ENGINEERING, YORK UNIVERSITY / PHOTO (GALLART): TABITHA GILLMAN

President's Message

Message du président

Dear CSME Colleagues,

WELCOME BACK AFTER AN EXTREMELY BUSY SUMMER. I AM SURE THAT MANY OF YOU HAD TO rapidly adjust to an online only version of work, and that this required a major effort. I trust that this "conversion" was successful, and I believe that this process will continue for a few years. The COVID-19 pandemic continues and the news of today is that most provinces are in its second wave. It seems that we need to learn how to live with COVID-19 and face masks are only one of the many constraints that we need to accept.

You must be aware of issues related to certain social networks and their role in the dissemination of unreliable information as well as their uncontrolled collection and use of personal information. I expect that the appeal of such networks will eventually diminish, which means that professional networks like those associated with the CSME will grow. I am happy to let you know that our membership is steadily increasing. We are hard at work at building proper processes to provide our student members a smoother transition to full membership upon their graduation. There are about 15,000 ME students in Canada, and this provides an opportunity for building a very strong professional network. One of the benefits that CSME provides is free access to www.engineeringcareers.ca, a niche career/job site dedicated to the engineering community which I am sure many of you will find very useful in these difficult and unusual times.

Please note that the next AGM meeting will be held on 29 November 2020 when new CSME leadership will be elected. Please mark this day and plan to attend online through Zoom. Details on how to register will soon be announced. The term of the CSME President is limited to two years, so I will be stepping down from the presidency. I would like to thank you for your support over the last two years. Please stay strong and healthy.

Best,

MACIEJ FLORYAN, PhD, P.Eng. FAPS, FASME, FCSME, FCASI, FEIC, FJSPS, FCAE, AFAIAA
CSME *President*
Professor, Western University
Department of Mechanical and Materials Engineering

Chers collègues de la SCGM,

Il me fait plaisir de vous réécrire après un été extrêmement chargé. La plupart d'entre vous avez dû vous adapter rapidement à une version uniquement en ligne au travail ou à l'étude, et cela a nécessité un effort majeur. Je suis convaincu que cette «conversion» a été une réussite et je crois que ce processus se poursuivra pendant quelques années. La pandémie de la Covid-19 se poursuit et la nouvelle d'aujourd'hui est que la plupart des provinces en sont à leurs deuxièmes vagues. Il semble que nous devons apprendre à vivre avec la Covid-19 et que les masques faciaux ne sont que l'une des nombreuses contraintes que nous devons dorénavant accepter.

Vous devez être conscient des problèmes liés à certains réseaux sociaux et de leur rôle dans la diffusion d'informations non fiables ainsi que de la collecte et utilisation incontrôlées d'informations personnelles. Je m'attends à ce que l'attrait de ces réseaux finisse par diminuer, ce qui signifie que les réseaux professionnels comme celui de la SCGM se développeront. Je suis heureux de vous informer que le nombre de nos membres continue d'augmenter régulièrement. Nous travaillons d'arrache-pied à la mise en place de processus appropriés pour offrir à nos membres étudiants une transition plus fluide vers une adhésion professionnelle après l'obtention de leur diplôme. Il y a environ 15 000 étudiants en génie mécanique au Canada, ce qui permet de bâtir un réseau professionnel très solide. L'un des avantages offerts par la SCGM est l'accès gratuit à www.engineeringcareers.ca/?locale=fr_ca, un site de carrière / emploi dédié à la communauté d'ingénierie, ce que beaucoup d'entre vous trouveront très utile en ces temps difficiles et inhabituels.

Veuillez noter que la prochaine rencontre annuelle générale des membres aura lieu le 29 novembre 2020, lorsque les nouveaux dirigeants de la société seront élus. Veuillez noter ce jour et prévoyez d'y assister via ZOOM. Les détails sur la façon de s'y inscrire seront annoncés sur le site web. Le mandat du président de la SCGM est limité à deux ans, et mon terme se terminera donc cette journée-là. Je tiens à vous remercier pour votre soutien au cours des deux dernières années. Veuillez rester fort et en bonne santé.

Cordialement,

Maciej Floryan, PhD, P.Eng. FSCGM
Président

Welcome New CSME members

1 May to 30 September 2020

Dr. Issam Bait Bahadur, *Sultan Qaboos University*, Oman
Mr. Hafiz Liaqat Bashir, *Bombardier Transportation Canada*
Mr. Temitope Duyile, *KPDY International Services*
Mr. Md Imrul Hasan, *Development Design Consultant*, Bangladesh
Mr. Sreenath Kamalon, *KVR Tata Motors*
Mr. Mohammed Khennich, *Université de Moncton*
Prof. Jianyu Li, *McGill University*
Mr. Noah Saber-Freedman, *Evoqua Water Technologies*
Mr. James Skyes, *Mitsubishi Aircraft Corporation*, Japan
Mr. Geofrey Yamomo, *Next Structural Integrity*
Prof. Lexuan Zhong, *University of Alberta*

Mechanical Engineering research efforts are helping in the fight against COVID-19

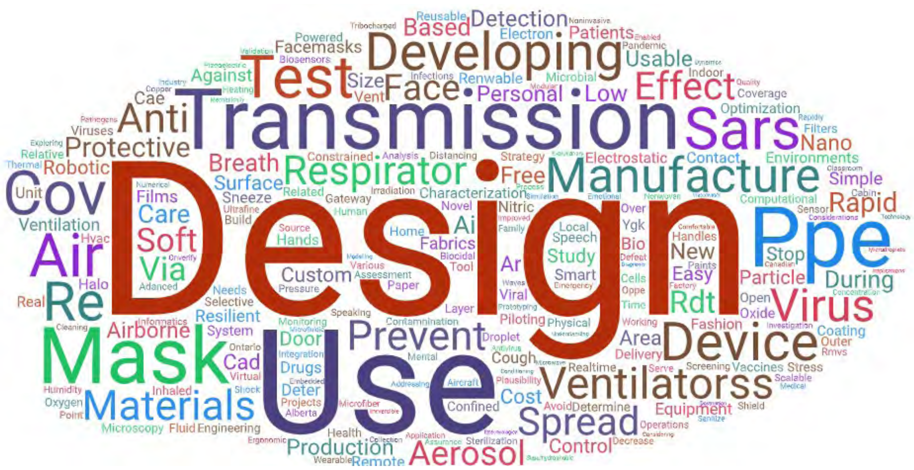


FIG. 1: WORD CLOUD OF THE RESEARCH PROJECT TITLES BEING CONDUCTED BY MECHANICAL ENGINEERS ACROSS CANADIAN UNIVERSITIES (NOTE: THE WORD COVID WAS REMOVED).

ON MARCH 11TH, 2020 THE WORLD HEALTH Organization (WHO) declared the COVID-19 coronavirus a global pandemic. This pandemic is not only a public health crisis, but a crisis that has left its fingerprints on all sectors, from how we interact with each other socially and professionally, to how our students learn, to the near total shutdown of our economy over several months. When the pandemic was announced in mid-March, engineering professors across Canada pivoted their research skills and expertise to find ways to combat this disease directly but also consider the future recovery needed in the wake of this heartbreaking tragedy. To understand how engineering professors were contributing to the fight against COVID-19, Engineering Deans Canada conducted a national survey on engineering research activities to address the current pandemic but also pandemics in the future.

To many people, it is not obvious how engineering research can contribute to the COVID-19 health crisis, but our national survey clearly showcases the contributions it is making to treat, test and track COVID-19 today, and also towards providing solutions to reopen our societies and economies safely in the near term and future. These contributions are being made across all of our engineering disciplines with each discipline focusing their efforts in different ways. The survey results show that mechanical engineering faculty are conducting the highest number of research projects across Canada, representing over 20 per cent of the 280 COVID-19 research projects identified. Figure 1 shows a word cloud using the research project titles in mechanical engineering to show the range of areas impacted and the tools employed. As expected, at the core of the mechanical engineering approach is a focus on design. Referring to Figure 2, the majority (close to 75 per cent) of these projects are focusing on ways to provide and improve treatment for COVID-19 patients. This includes the design and manufacturing of personal protective equipment (PPE) by developing more effective and sustainable masks and face shields. Other research projects are working to meet the need for low-cost ventilators, as well as optimizing mass production of supplies, vaccine modelling, and the application of anti-viral surface coatings. Testing research relates to point-of-care diagnosis of COVID-19 disease which could lead to a significant decrease in infection rates.

Mechanical engineering research related to tracking and spread of COVID-19 include the effects of droplet particle size and air humidity on how long the virus can remain suspended in the air and the potential transport of COVID-19 in municipal sewer systems.

Finally, mechanical engineering research is also helping to find ways for society to better function during the COVID-19 pandemic, as well as to prepare us for the future and an economic recovery after a prolonged shutdown. This is being done through examination of infrastructure and optimizing space in public areas while maintaining social distancing measures, along with measuring cleanliness of air flow in buildings. This survey clearly indicates and provides insight into how mechanical engineering research is making valuable contributions to assist in the global response to this pandemic.

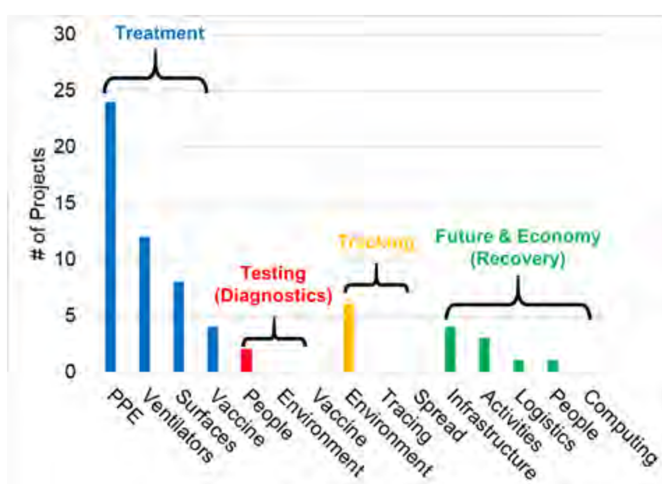


FIG. 2: SURVEY RESULTS SHOWING THE NUMBER OF RESEARCH PROJECTS AND THE IMPACT AREAS BEING UNDERTAKEN BY MECHANICAL ENGINEERS ACROSS CANADIAN UNIVERSITIES.

PHOTO: MARTIN SCHWABE / COURTESY OF THE UNIVERSITY OF WATERLOO

DR. MARY WELLS, PhD, PHD, FCAE, FEC, P.Eng.
Dr. Wells is the Dean of Engineering at the University of Waterloo. Prior to becoming Dean of Engineering at Waterloo, she was the Dean of the College of Engineering and Physical Sciences at the University of Guelph for three years and a Professor in the Mechanical and Mechatronics Engineering Department at the University of Waterloo, as well as the Materials Engineering Department at the University of British Columbia. Her research addresses the relationship between processing, structure and properties for advanced metallic alloys used in the transportation sector.

TECHNICAL COMMITTEE REPORTS

Advanced Energy Systems (AES) Technical Division

The main activities of the CSME Advanced Energy Systems (AES) Technical Division over the past year include:

- Organized a special issue focusing on the Advanced Energy Systems in the *International Journal of Green Energy* (IJGE) from a selected pool of quality papers. After review, six papers were accepted, but not sufficient to form a special issue, hence eventually published in regular issues.
- Held a committee meeting, including election for a new Division chair (Prof. **Xili Duan** of Memorial University of Newfoundland).
- Sponsored the CSME International Congress 2020, to be held at the University of Prince Edward Island, by organizing the Symposium on Advanced Energy Systems (eventually cancelled due to the impact of pandemic, but the symposium had already been organized).
- Sponsoring the CSME International Congress 2021, to be held at the University of Prince Edward Island, by organizing the Symposium on Advanced Energy Systems.
- Sponsoring the new CSME Transactions to be published through the Canadian publisher, Canadian Science Publishing (CSP).

— Dr. Xianguo Li

Biomechanics and Biomedical Engineering

The BBETC organized a successful Symposium at CSME2020 with 17 papers/abstracts submitted. Although the Congress was postponed to 2021, many of the submitted papers/abstracts were published in Progress in Canadian Mechanical Engineering, Volume 3. The TC is planning to organize a successful Symposium at CSME2021 in Charlottetown, PE. Current members of the Biomechanics and Biomedical Engineering TC includes Ali Ahmadi (University of Prince Edward Island), Tohid Didar (McMaster University), Dana Grecov (University of British Columbia), Arman Hemmati (University of Alberta), Mohammad Pakanahad (University of Toronto), Pouya Rezai (York University), Dan Romanyk (University of Alberta), Hossein Rouhani (University of Alberta), and Ryan Willing (Western University).

*— Dr. Ali Ahmad*i

Computational Mechanics

The interests of this Committee include development of new algorithms and non-standard applications of existing algorithms. Routine use of software packages for various simulations falls outside its interests. The Committee prepared symposia on "Computational Heat and Fluid Flows" as well as "Artificial Intelligence in Computational Mechanics" for the 2020 CSME Congress. These symposia had been postponed till 2021.

— Dr. J.M. Floryan

Design and Analysis

- Attended/participated - the IUTAM AGM (August 2020)
- Attended/ participated - the CSME/CNC meeting prep for IUTAM AGM (August 2020)
- Member of the Engineers Canada QB sub-committee on Aerospace Eng. syllabus
- Organizing member: the 2020 & 2021 CSME Congress — symposium on Advanced Design and Analysis of Multifunctional Materials and Structures
- Scientific Advisory Board for Design 2020 Technical Committees, The International Conference on Applied Physics and Engineering (ICAPE) 2020, Frankfurt, Germany
- Engagement with the CSME transaction as associate editor

— Dr. Kamran Behdinan

Fluid Mechanics

- 2021 CSME Congress; co-chair the Fluid Mechanics Symposium
- Planning for a meeting at the 2021 Congress

— Dr. Martin Agelin-Chaab

Manufacturing

Oct 2019 - Oct 2020

1. Membership: Alex Czekanski, Chair; Sayyed Ali Hosseini, UOIT; Farbod Khameneifar, Polytechnique Montreal; Tsz Ho Kwok, Concordia University; Abdolhamid Shafaroudi, McGill University; Ahmad Barari, UOIT; Basel Alsayyed, University of Alberta

2. Meetings

Annual meeting was scheduled to take place in UPEI 2020. Unfortunatelly due to COVID restrictions, this meeting was cancelled.

3. TCSME

Several research papers review on Manufacturing was led by TC Manufacturing chair

4. The activities of Manufacturing TC

- Supporting the 2020 Congress by developing Manufacturing symposiums
- Reviewing submitted papers to 2020 CSME Congress.
- Supporting the 2021 Congress by developing Advanced Manufacturing symposiums

5. Next steps

- Contribute to organization of manufacturing symposium at CSME 2021.
- Recruit more members.
- Develop governing process and select vice-chair(s) during CSME 2021.

— Dr. Alex Czekanski

Microtechnology and Nanotechnology

Since starting my position as the chair of the Microtechnology and Nanotechnology committee last year, I recruited Dr. Bhiladvala from the University of Victoria as the vice-chair of the committee. Additionally, I recruited 10 members from 10 universities across Canada. The team consists of members with expertise in microfluidics, Biosensing, 3D bioprinting, Materials Modelling, Tissue engineering, disease modelling, and Microelectroelectromechanical systems (MEMS) and Mechatronics and intelligent systems. The team reviewed 10 abstracts for the Microtechnology and Nanotechnology

Symposium at the 2020 CSME Congress at the University of Prince Edward Island (canceled due to COVID-19). Attracted two sponsors (4M Biotech and *Journal of Micromachines)* to support activities related to the Microtechnology and Nanotechnology TC at the Congress. We also invited four keynote speakers for the Microtechnology and Nanotechnology Symposium. We plan to continue working with the organizers of the 2021 CSME Congress at the University of Prince Edward Island to revisit our plans for organizing the Organize the Microtechnology and Nanotechnology Symposium at 2021 CSME Congress, should the COVID situation resolve.

— Dr. Mohsen Akbari

Transportation Systems

The transportation systems technical committee (TC) and its core members are mainly responsible for selecting peer reviewers for submitted papers on road and rail transportation systems for publication in *Transactions of CSME* (TCSME); based on the comments and concerns from selected reviewers, preliminary recommendations have been made to the chief editor of TCSME. The Chair of the TC attended the online TCSME editorial board meeting on August 25, 2020, and recommendations for improving the quality of the journal were made. The transportation systems TC intended to organize a symposium entitled "Advanced Technologies for Road and Rail Vehicles" during 2021 CSME Congress. The call for papers for the symposium has been sent to all the TC members and associated peer researchers in the relevant communities.

— Dr. Yuping He

Message from the Congress Co-Chairs

DR. ALI AHMADI , PhD, P.Eng.
Associate Professor, Faculty of Sustainable Design Engineering, University of Prince Edward Island
Co-Chair of CSME 2021 Congress

DR. NICK KROUGLICOF, PhD, P.Eng.
Professor, Faculty of Sustainable Design Engineering
University of Prince Edward Island
Co-Chair of CSME 2021 Congress

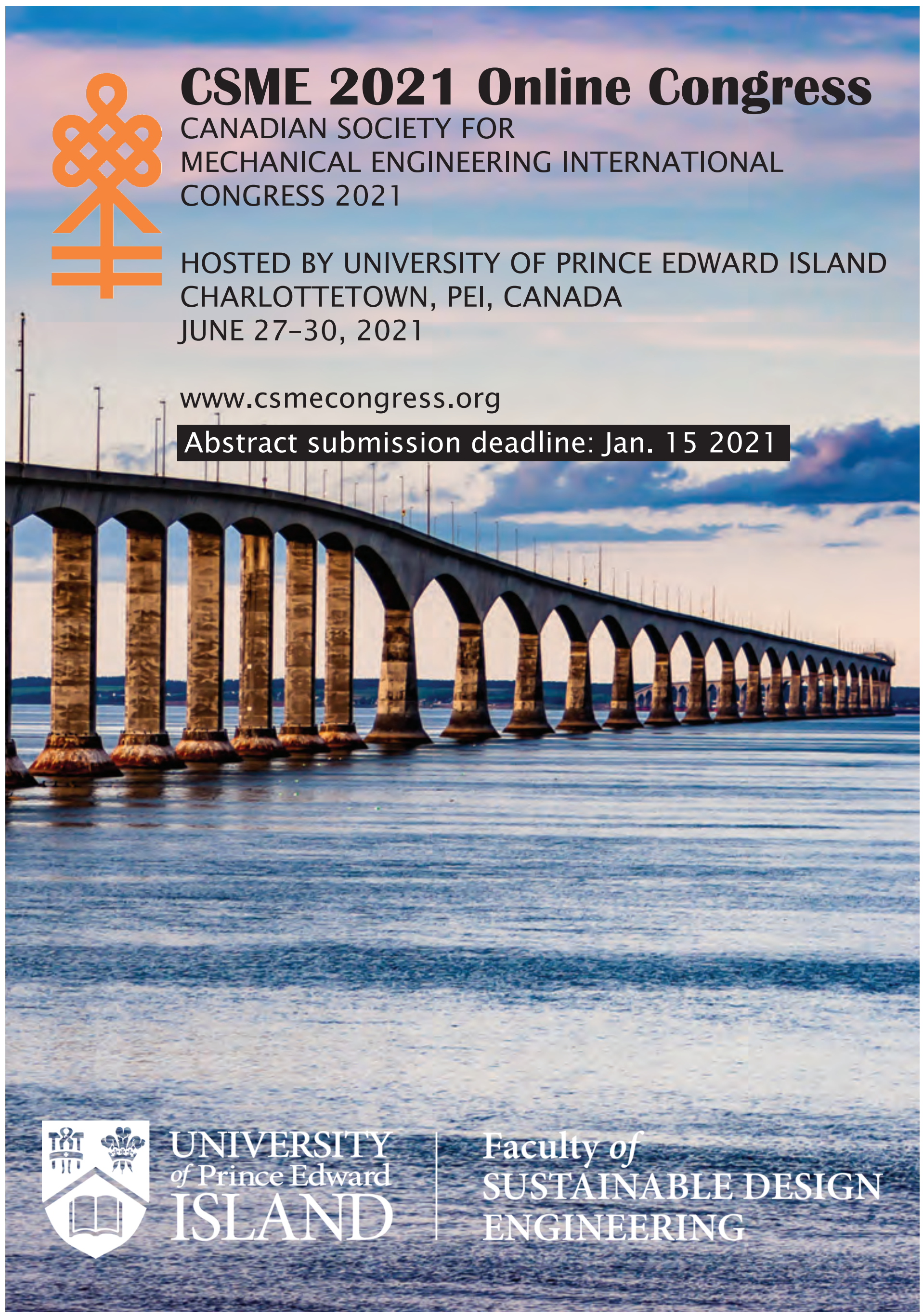
DEAR CSME COMMUNITY,

As many of you are aware, due to the unforeseen circumstances arising from the COVID-19 pandemic, the CSME 2020 Congress that was to be hosted by the Faculty of Sustainable Design Engineering at the University of Prince Edward Island in Charlottetown, PE has been postponed to summer 2021. We were thrilled to receive 260 submissions to CSME 2020, and despite the postponement of the Congress, we published the submitted work in the Progress in Canadian Mechanical Engineering Volume 3. Out of all the submitted work, the authors of 160 papers/abstracts authorized the publication of their work in the *Proceedings*. These *Proceedings* were published by the University of Prince Edward Island library and each paper received a unique DOI number. The papers are available for viewing and downloading at library.upei.ca/csme-2020.

Originally, we had planned to host the CSME 2021 Congress June 27 - 30, 2021 in Charlottetown, PE. While we were looking forward to hosting you all in Charlottetown and to share a plate of fresh lobster and island potatoes, given the current status of the pandemic projections in Canada, we had to make the difficult decision of hosting the 2021 Congress in an online format. So we will just have to find a way to convince Dr. **Hossein Rouhani**, Chair of the CSME 2022 Congress at the University of Alberta, to serve lobster at their banquet instead!

Therefore, we would like to officially announce that the CSME 2021 Congress hosted by the Faculty of Sustainable Design Engineering at the University of Prince Edward Island will be held online during June 27 - 30, 2021. Details of the paper submission, deadlines and paper templates can be found on our new website at www.csmecongress.org. There are two formats for submission of your work, full paper or abstract. All the accepted abstracts and papers will be scheduled for a virtual presentation and all the presented abstracts and papers will be published in the *Progress in Canadian Mechanical Engineering,* Volume 4. We will provide additional updates as they come up.

Although it has been a challenging few months, we are delighted to continue to organize the upcoming CSME 2021 Congress. On behalf of the organizing committee, we hope that all of you and your loved ones stay safe during these difficult times.



CALL FOR PAPERS/ABSTRACTS:

The Canadian Society for Mechanical Engineering (CSME) invites you to submit a paper or an abstract to the 2021 CSME International Congress to be held **online** hosted by the Faculty of Sustainable Design Engineering at the University of Prince Edward Island during June 27-30, 2021.

Congress Co-Chairs: Drs. Ali Ahmadi and Nicholas Krouglicof, University of Prince Ewdard Island

SYMPOSIUMS:

- Advanced Design and Analysis of Multifunctional Materials and Structures
- Advanced Manufacturing
- Advanced Energy Systems
- Biomechanics and Biomedical Systems
- Artificial Intelligence in Computational Mechanics
- Engineering Design
- Environmental and Wind
- Fluid Mechanics
- Heat Transfer
- Machines and Mechanisms
- Materials Engineering
- Mechatronics, Robotics, and Control
- Microtechnology and Nanotechnology
- Solid Mechanics
- Advanced Technologies for Road and Rail Vehicles

SPECIAL SYMPOSIUMS:

- Agriculture and Machinery
- Biotechnology and Bioresources
- Computational Heat and Fluid Flows: Algorithm Development and Non-standard Applications
- CubeSat
- Fisheries and Ocean Technologies
- Renewable Energy

ABSTRACT/PAPER SUBMISSION

The submissions to the Congress are in two formats:

- Abstract: 400-word maximum (no full paper submission will be required*)
- Full-length paper: 6-page maximum

** All accepted papers/abstracts will be scheduled for a vitual presentation. Presented abstracts and full papers will be published in the Conference Proceedings. For paper templates and submission instructions, please visit https://www.csmecongress.org/submissions.*

IMPORTANT DATES

- **January 15, 2021** — Submission of Abstract/Full Paper
- **February 28, 2021** — Notification of Acceptance to Authors
- **March 19, 2021** — Submission of Camera-Ready Papers/Abstracts
- **April 30, 2021** — Early Bird Registration Deadline

For more information, visit ***www.csmecongress.org***, follow ***@csme2021 on Twitter***, or contact ***csme2021@upei.ca***.

Fully automated spectrometer accessory with multiple uses including rapid and low-cost diagnosis of COVID-19

MAXIME JOLY
Maxime Joly is a MSc student in mechanical engineering at Université Laval since 2019. He completed his undergraduate degree with honors in mechanical engineering at Université Laval. He has received many recognitions for his high standard achievements, including the prestigious NSERC Canada Graduate Scholarship and CSME gold medal in 2019.

Prof. ANDRÉ BÉGIN-DROLET, ing., PhD
André Bégin-Drolet is a mechanical engineer and associate professor at Université Laval. He specializes in mechanical design, instrumentation and 3D printing. He is an emerging researcher involved in many multidisciplinary projects. He has established many industrial partnerships, which testifies to his full motivation towards knowledge and technological transfer to end users.

Prof. JESSE GREENER, PhD
Jesse Greener is an associate professor (Dept. Chem., Université Laval), researcher at the Centre de recherche de Québec-Université Laval—Hôpital Saint-François d'Assise and mid-infrared "Beam Team" member at the Canadian Light Source. He holds distinctions and awards including a 2020 NSERC Accelerator grant for microfluidic bioanalytics and a prestigious AUDACE high risk/reward grant for microfluidic studies of "giant viruses". Greener is a formally trained FTIR spectroscopist and one of Canada's leading microfluidic experts with IP in both areas. He is also co-founder and CEO of FlowJEM Microfluidics.

IMAGES COURTESY OF THE RESEARCHERS

INTRODUCTION

While waiting for the arrival of a vaccine against COVID-19, rapid detection of the SARS-CoV-2 virus is essential to reduce its spread in the population. Our research team, composed of mechanical engineers and chemists at the Université Laval, have developed an ATR Spectroscopy Microfluidic Assay Accessory (ASMAA). Already in development before the SARS-CoV-2 virus arrived, the ASMAA is a versatile accessory that allows scientists to do spectrometric mappings of a sample or measure multiple samples in parallel, all in a fully automated way. Since the start of the COVID-19 crisis, our research group has started to adapt this accessory for detecting viruses in saliva and other biofluids.[1] The ASMAA has the potential to offer a fast, low-cost, and portable method for diagnosing COVID-19. In this paper, a brief overview of how viruses such as SARS-CoV-2 are detected in biofluids using spectrometry is first presented. A brief description of the ASMAA, its potential purposes and automation are also included.

COVID-19 detection with infrared spectrometry

Currently, the only viable techniques for early diagnosis of COVID-19 are based on nucleic acid-based technologies (NAT). The ideal NAT would be administered at the point of need (PON), such as a doctor's office or at a mobile testing site. This would avoid remote lab-test delays (e.g., global average is 13h using Abbott Molecular's RealTime SARS-CoV-2 PCR test) and reduce challenges related to labour intensity and use of consumable materials that are expensive or in short supply (e.g., viral transport medium, DNA extraction kits, etc.). In most NAT tests, nucleic materials (RNA, in the case of the virus SARS-CoV-2) are extracted from a protective outer layer consisting of a complex arrangement of protein and lipid molecules (see Figure 1a). Then the RNA is amplified to more easily detectable concentrations using a technique called a polymerase chain reaction (PCR). This is a time consuming process, and counter-intuitively, the amplification process can actually be too sensitive; even trance RNA strands from non-viable viruses can trigger a positive response. This reality is as much a diagnostic dilemma as it is a problem for health policy with ramifications in how to deal with non-symptomatic SARS-CoV-2 positive cases.[2–4] Moreover, as the amplification is not well-controlled it is difficult to have a quantitative measure of the viral load contained in samples. Another approach would

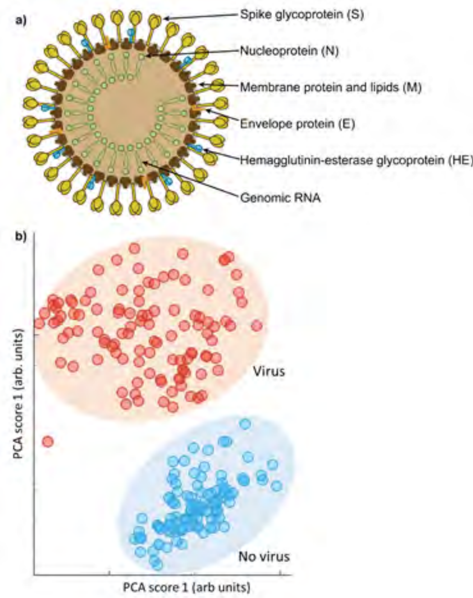


FIG. 1: (A) SCHEMATIC OF A SARS-COV-2 VIRUS WITH ITS PRINCIPAL PROTEIN AND LIPID BLOCKS DETECTED VIA IR SPECTROSCOPY. (B) A PRINCIPLE COMPONENT ANALYSIS SEPARATES SPECTRA CONTAINING A MODEL VIRUS MIXED WITH UNIQUE SALIVA SAMPLES.

be to analyze the entire virus including all proteins and lipids in the protective shell, which constitute most of the viral mass.

Infrared (IR) spectroscopy is a well-known analytical chemistry technique which can be applied to proteins, nucleic acids, lipids and other bio-macromolecules.[5,6] Since viruses, such as the SARS-CoV-2, are composed of these basic building blocks, IR can be exploited to obtain a unique spectral fingerprint as the basis of a new diagnostics approach. As such, IR spectroscopy has already been used for viral detection in unpurified liquid blood samples[7,8] and even live infected cells.[9,10] Thus, the new paradigm we call "live viral spectroscopy" (LVS) opens opportunities for entire viruses or subcomponents to be studied holistically and passively by IR spectroscopy, supposing that the proper instruments are available. Our short-term objective is to adapt the ASMAA for LVS and apply it to COVID-19 diagnosis. A portable system to carry this out in an efficient and parallel manner can revolutionize virus detection for both the current and future pandemics. Figure 1b shows preliminary data collected using FTIR analysis of over 100 saliva samples, divided into groups which were positive and negative for model viral signature.

Mechanical description

The ASMAA, coupled with a Fourier transform infrared spectrometer (FTIR), uses a low cost multi-point single-bounce attenuated total reflection (ATR) crystal (IRUBIS GmbH, Munich, Germany). The sample is placed on the top of the 7 x 9 mm detection area of the crystal. When a standard crystal holder is used, the IR light of the spectrometer illuminates all the crystal and the entirety of the sample is measured.

In contrast, the ASMAA, presented schematically in Figure 2a, allows for selecting parts of the sample to measure individually, thanks to a motorized aperture plate (5) sliding under the crystal (1). The aperture plate blocks part of the light emitted by the spectrometer. Light passing through the aperture refracts into the crystal, reflects against the sample surface and returns to the spectrometer detector (see Figure 2b-c). The aperture plate, connected via a crank-slider four bar mechanism (6) to a servomotor (4), allows precise selection of the measured region of the sample placed on the crystal. A 1024 counts per turn encoder coupled with the servomotor allows a resolution of the aperture displacements on the order of 10 microns. With his simple mechanism, the ASMAA can accommodate microscale sample compartments, offering a multitude of options for complex spectrometric measurements.

Sample configuration

The ASMAA is very versatile and can be used for two main purposes. First, it can be used to do a linear mapping of measures of a single sample placed on top of the crystal. For instance, the sample could be a flow of liquid in a microchannel, and the ASMAA could be used to monitor the chemical composition of the liquid in relation to the position in the flow. Secondly, and most pertinent to the current application, the accessory can acquire measurements of multiple samples housed in different microfluidic sample compartments in contact with the ATR crystal. Because all samples are on the crystal at the same time, they are submitted to the same ambient conditions and comparison between them is better. In both cases, multiple measurement cycles can be taken to monitor the chemical composition of the samples over time.

Automation

From a user's point of view, the main advantage of the ASMAA is that it offers new ways to do complex spectrometric measurements easily. Obviously, it needs to be fully automated to help users optimize their measurements and limit the manipulations required. To this end, a graphical user interface (GUI) has been developed in LabVIEW. In the program, the user enters the parameters required for the measurements. These parameters are the number of measurements, the position for each measurement, the number of measurement cycles and the waiting time between each cycle. Then, the program automatically controls the aperture displacements while the spectrometer is synchronized to make measurements. For the displacements, the program sends requests via serial communication to a microcontroller connected to the motor. For the measurements, the program sends request to the spectrometer software to take a measure using dynamic data exchange communication protocol. When the measurement is finished, the results are saved and the program is ready for the next measurement.

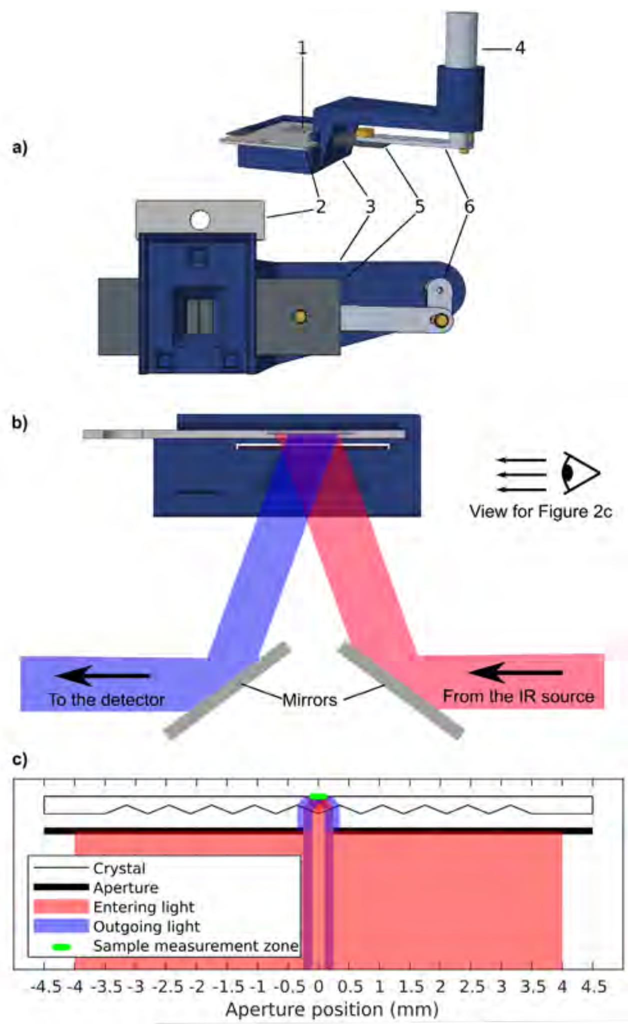


FIG. 2: (A) SCHEMATIC OF THE ASMAA ASSEMBLY INCLUDING THE IRUBIS CRYSTAL (1), THE CRYSTAL PLATE (2), THE 3D PRINTED HOLDER (3), THE SERVOMOTOR (4), THE SLIDING APERTURE PLATE (5) AND THE SLIDER-CRANK MECHANISM (6). (B) SECTIONAL VIEW OF THE ASMAA WITH THE IR LIGHT COMING FROM THE SOURCE AND GOING TO THE DETECTOR. THE RIDGES OF THE CRYSTAL AND THE APERTURE ARE PARALLEL TO THIS VIEW. (C) ZOOMED VIEW PERPENDICULAR FROM FIGURE 2A OF THE IR LIGHT GOING THROUGH THE CRYSTAL WITH THE SAMPLE MEASUREMENT ZONE GIVEN BY THE APERTURE POSITION.

Conclusion

The ASMAA is a versatile and compact accessory that can be used for multiple applications, enabled by its movable aperture allowing for selection of the area of the sample to measure. Since the start of the COVID-19 crisis, our research team has started to adapt the accessory for detecting SARS-CoV-2 viruses in saliva samples. Following promising results using a model viral detection, the next step is to test real infected saliva samples, in partnership with a local hospital. If the tests are successful, the ASMAA will soon offer a fast, low cost, portable and reusable way to diagnose COVID-19.

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Modeling droplet and aerosol spread for minimizing airborne transmission of COVID-19 and other diseases in public spaces

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IMAGES COURTESY OF THE RESEARCHER

BACKGROUND AND EVIDENCE OF AIRBORNE TRANSMISSION

The on-going COVID-19 pandemic has disrupted the global population, and many researchers are working to develop methods to minimize the effects and transmission of the virus (SARS-CoV-2). The virus is known to be highly contagious, spreading through several routes: direct contact, droplet transmission, indirect contact and short-range airborne routes.[1] For airborne transmission, both droplets and aerosols contribute to transmission routes, however they differ among several factors which include particle diameter, range of transmission, viral stability in various environmental conditions, as well as virulence and infectivity. The defining factors for droplets versus aerosols are ambiguous in the scientific literature. The World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) define particles with a diameter below 5 µm to be aerosols (that tend to suspend in the air for longer periods of time) while particles above 5 µm are recognized as droplets, which will deposit before surpassing a distance of 2 m.[2] In contrast, several studies reviewed by Bahl et al. show that droplets as large as 50 µm can remain suspended (travelling horizontal distances beyond 2 m) and droplets above 5 µm can travel horizontal distances up to 8 m.[3] A moderately accepted definition in literature is that droplet transmission occurs with short-range (essentially face-to-face) interactions where expiratory droplets deposit on to a host's mucous membranes; while aerosol transmission occurs when aerosols spread expansively within indoor environments where they are generated through expiration, speaking, coughing or through the evaporation of droplets (forming what is known as droplet nuclei).[1]

Aerosol transmission has been a recent focus due to research gaps surrounding aerosol transport phenomena within indoor environments, as well as the need to evaluate the SARS-CoV-2 virus' infectivity via airborne routes.[3,4] Current research in the Freire-Gormaly Lab is being conducted in collaboration with Dr. **Faizul Mohee**, Director of Research at TMBNExtrados Inc. and supported by a York VPRI-COVID-19 funding grant to explore aerosol transmission of COVID-19 and its implications for HVAC design. Evidence from recent viral outbreaks and experimental studies provide a compelling case for airborne transmission as a viable route of transmission. A restaurant in Guangzhou, with an index patient (in table A) infected customers within their two neighbouring tables (B and C) but did not infect any of the waiters or 68 other customers in the restaurant. No evidence of close contact had occurred between the families during the lunch. The airflow from an air conditioner is hypothesized to have catalyzed the spread of viral particles from the index patient, as the airflow created a "contaminated recirculation envelope".[5] In another instance, a Skagit Valley choir rehearsal with 61 choir members where only one member (index patient) appeared to have cold-like symptoms resulted in 53 members contracting the SARS-CoV-2 virus. The virus is suspected to have transmitted through respiratory aerosols because the choir rehearsal was held indoors in an inadequately ventilated space. Social distancing precautions were followed in the choir rehearsal so the index patient could not have possibly come into close contact with all 53 attendees.[6] In an experimental study, Santarpia et al. 2020 sampled thirteen COVID-19 infected patient rooms with surface samples of commonly touched items, the floors, windowsills, and air samples. The results showed

FIG. 1: PARTICLE TRACKING RESULTS FOR A 0.5 SECOND COUGH AT VELOCITY OF 6 M/S IN A 3 M X 2 M (L X H) ROOM. THE CHART INDICATES THE DIAMETERS OF THE DISTRIBUTED COUGH PARTICLES IN THE RANGE OF 1 MM TO 2 MM.

63.2% of in-room air samples tested positive for RT-PCR (for a mean concentration of 2.42 copies/L of air.[7] Based on a scientific brief released on the 27th of March, WHO argued that PCR positive results do not indicate viral transmissibility, even though certain surface samples with PCR positive results showed growth of the SARS-CoV-2 virus after 3 days of cell culture.[4] The viral replication in cell cultures indicate the transmissible nature of the viral samples.[7] In an experimental study conducted by van Doremalen et al. (2020), a three-jet Collison nebulizer was used to generate SARS-CoV-1 and SARS-CoV-2 viral aerosols (with diameters of less than 5 μm) to explore the viral stability. They quantified the viral stability by analyzing both air samples and surface samples of these viral aerosols. The results showed a viral stability (for both viruses) of 3 hours suspended in air and longer on surfaces.[8] WHO's March 27, 2020 scientific brief stated that the artificial aerosolization process contributes to higher than normal survivability of viral particles.[4] However, there is substantial existing and growing evidence that SARS-CoV-1 transmits via the airborne route[9] which shows alignment with the experimental evidence by van Doremalen et al. (2020).

Numerical Analysis

Recognizing the research gaps that exist for aerosol transmission, there is an urgent need to understand transport physics of airborne transmission in common indoor environments. Simulating the ventilation and airflow within common indoor public spaces and analyzing the potential for viral outbreaks (assuming an index patient in the space) will provide a predictive method for improving ventilation and to prevent outbreaks caused by poor indoor air quality. Currently, a 2-dimensional 3 m x 2 m (L x H) room with a viral source has been simulated and a 3-dimensional elevator with two hosts (one being the index patient) is in the process of simulation. The 2-dimensional modelling is intended as a simplified preliminary simulation to visualize cough particles spreading with a chosen range of assumptions and boundary conditions. The numerical model is further applied in three dimensions to enhance modelling accuracy, as well as to compare and validate results with experimental literature. From results presented in the figures, 2 seconds of total simulation time for the 2-dimensional simulation, caused the particles to spread horizontally halfway across the room, while dispersion also occurred vertically. 0.5 seconds of total simulation time within the 3-dimensional simulation allowed cough particles to disperse moderately across the elevator, with higher concentrations surrounding the viral source, the air inlet, and exhaust. The elevator simulated a scenario where both hosts were not wearing masks, the dispersion results are subject to change with mask usage and varying air exhaust rates. The goal is to determine common spread patterns, the distance of aerosol travel, and the implications for HVAC design to improve the safety of indoor environment.

In terms of the 2-dimensional simulation, the viral source is simulated as a particle and fluid (air) inlet with an initial velocity of 2 m/s for air, to simulate breathing, and 6 m/s for the particle droplets. The particles were injected for a duration of 0.5 s, while breathing continues for the entire duration of the simulation. The injection is modelled as a group injection with 20 streams, and the particle sizes are determined using a Rosin-Rammler diameter distribution, with a mean diameter of 1.5 μm, maximum diameter of 2 μm and minimum diameter of 1 μm. The ambient air is still in absence of the viral source. For the 3-dimensional case, droplet expiration is modelled without including breathing, where 1 μm diameter particles are expelled at a velocity of 8 m/s, through a solid cone injection. The air flow in the 3-dimensional elevator is controlled with an air supply inlet and a pressure exhaust. Modelling viral-laden aerosol flow within air is recognized as a particle-laden flow, therefore a Euler-Lagrange approach is preferred.[10] The approach allows the ambient fluid continuum to be solved by the Navier-Stokes equations, while the discrete aerosol particles are tracked using the Lagrangian particle tracking algorithm. The aerosol particles trajectories are defined by the following forces: drag force by spherical drag law, gravitational forces, and acceleratory forces. Brownian and thermophoretic forces may be considered in the future depending on the range of particle sizes and heat flux. The high initial velocity from expiratory events leads to a turbulent flow. The turbulence is modelled with a k-ε RNG turbulence model, which has been recommended for indoor ambient airflows.[10] For current simulations, the evaporation, breakup, hygroscopicity and coalescence are not considered, and solid droplet nuclei with a density of 1900 kg/m^3 are assumed.

Future work will focus on including diverse ventilation and airflow models, considering the evaporative effects of droplets manifesting into aerosols, heat flux effects on the dynamics of droplets and aerosols, and validating the numerical analyses with experimental literature. These research studies to understand, predict and minimize the effects of the COVID-19 virus are relevant now and will continue to be relevant for possible future infectious disease outbreaks. Hence researchers, scientists and HVAC engineers around the world are collaborating and further investigating aerosol transmission to minimize the risk of COVID-19 infection in indoor environments.

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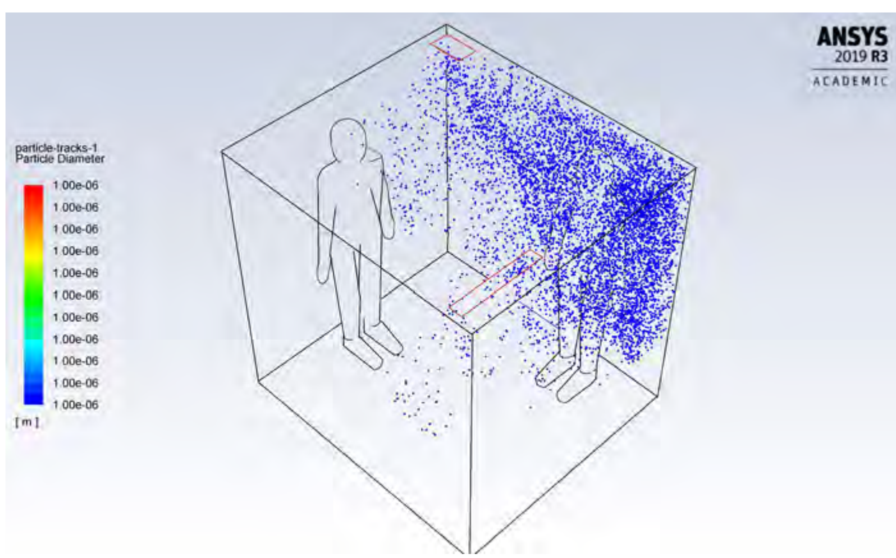

FIG. 2: PARTICLE TRACKING RESULTS FOR A 0.4 SECOND COUGH AT VELOCITY OF 8 M/S IN A 2 M X 1.8 M X 2 M (L X W X H) **ELEVATOR SETTING. THE SCALE INDICATES THE DIAMETER OF THE COUGH PARTICLES (1 MM).**

Design of a remotely-controlled haptic robot for telenursing to combat COVID-19

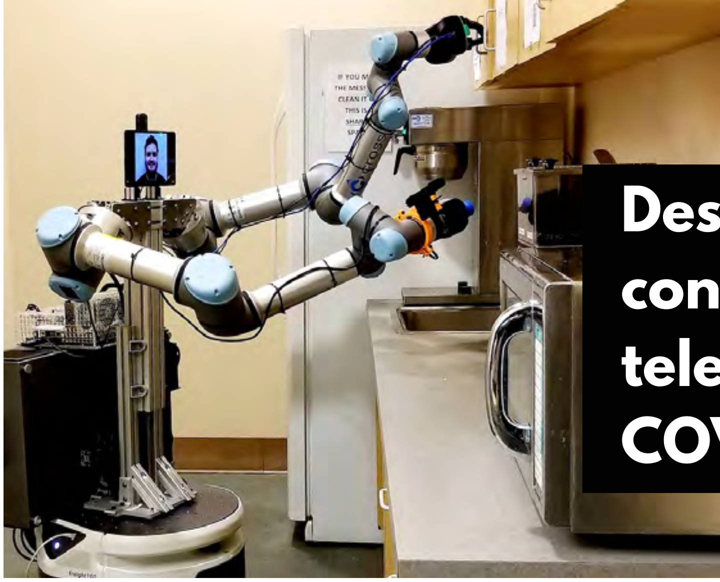

FIG. 1: TRINA 2.0, DEVELOPED BY UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, IS EQUIPPED WITH A MOBILE PLATFORM TO TRAVEL THROUGH CONFINED SPACES. THE COLLABORATIVE ROBOT OF TRINA IS DESIGNED TO CARRY OUT HUMAN LIKE MANIPULATIONS SUCH AS GRABBING THINGS AND DELIVERING MEDICINE. PHOTO SOURCE: IEEE SPECTRUM, AVAILABLE AT SPECTRUM.IEEE.ORG/AUTOMATON/ROBOTICS/MEDICALROBOTS/MEDICAL-ROBOTS-FUTURE-OUTBREAK-RESPONSE

INTRODUCTION

The Canadian healthcare system is under tremendous pressure due to hospitalization among positively tested, highly infectious population during the second-wave of COVID-19. Healthcare providers are in a difficult situation where they are devoted to provide clinical services to patients while trying to stay uninfected in an environment full of COVID-19 virus. This is extremely challenging and robotics can make significant contributions to address such issues.

Over the past few years, we have witnessed a boom in the development of robotics technology, leading to expansive applications in combating epidemics. TRINA—the Tele-Robotic Intelligent Nursing Assistant—as shown in Fig. 1 is a typical paradigm. During the 2015 Ebola outbreak, TRINA was developed under the sponsorship of the National Science Foundation to help healthcare providers to perform a set of routine tasks, like food and medicine delivery, cleaning, and communication with patients.[1] Since the COVID-19 outbreak, researchers have been continuously working to explore the application of robots in five main areas: telenursing that relies on robotics to provide remote medical and nursing services without direct contact between healthcare providers and patients; temperature measurement in public areas to quickly detect potential risk of infection; delivery of food and medicine for logistics purposes; health condition monitoring for chronic disease patients at home due to the temporary closure of some non-COVID medical services; and mental caring for increased mental problems due to long-periods of self quarantine.

Telenursing includes a wide range of clinical actions like symptom diagnosis, patient communication and care, and disease treatment. The initial diagnostic testing for COVID-19 is by collecting and testing oropharyngeal or nasopharyngeal swabs, where robot-assisted automatic swabbing technology has the potential to alleviate a substantial workload of qualified healthcare workers, significantly reduce infection risk, and increase collecting and testing efficiency.[2] Robot-based automatic blood sample collection for further lab testing is being developed by researchers, which can reduce healthcare provider exposures to the virus. In the future, this process could be done at home, followed by an autonomous blood sample transfer to the test lab using unmanned aerial vehicles. Statistics show that 20% of infections are severe, accompanied by an aggressive response with the release of a substantial amount of pro-inflammatory cytokines — the so-called "cytokine storm". One typical clinical symptom of the cytokine storm is severely damaged lungs with abundant inflammatory infiltrate that can be observed by computerized tomography (CT).[3] In such cases, automatic CT screening technology without human intervention could speed up the process and thus decrease mortality rates. The array of telenursing robotic technologies also involve ultrasound imaging for automated venepuncture, and autonomous disinfection in hospitals.

Our research team is proposing the design of a brand-new robotic system integrating state-of-the-art haptic teleoperation technology, robotic hand, and artificial intelligence (AI) algorithms to assist healthcare providers to provide clinical services without face-to-face contact with patients. This research can contribute towards protecting Canadian healthcare workers, accelerating testing, and exploring new approaches of robot-assisted solutions to combat pandemics like COVID-19.

Prof. TING ZOU, PhD, MCSME

Dr. Zou is an Assistant Professor, in the Department of Mechanical Engineering, at Memorial University of Newfoundland. She received her PhD in the design of a novel bi-axial accelerometer for rigid-body pose and twist estimation, from McGill University in 2013. She is currently a Guest Editor for the journal of Special Issue on Underwater Robots in Ocean and Coastal Applications, Applied Science, MPRI. Her current research is on the development of biologically inspired robots, and intelligent robotic systems for complex structural inspection and telenursing.

Design of a Remotely Controlled Robot for Telenursing

Despite the significant improvement in robotic telenursing, technical limitations exist, including clumsy movement, low level of human-machine interaction, and an inability to test fluids. In order to address those challenges, our research team is working on a novel design of a telenursing robot that allows healthcare providers to operate the device in a remote site to provide many different routine clinical services to patients. The significance of this approach is three fold: firstly, it will protect healthcare providers from direct exposure to infectious patients; secondly, it will avoid the tragedy that in some cases, COVID-19 can be spread from healthcare providers who have silent symptoms to non-COVID patients having similar symptoms, e.g., coughing due to normal flu; finally, it will speed up the collecting and testing process by allowing one staff to operate multiple robots at the same time.

Figure 2 illustrates the proposed system in a ROS (Robot Operating System) simulation environment. The proposed system is designed to integrate a 7-DOF dual-arm collaborative cobot, a newly-developed robotic hand specifically designed for telenursing routine tasks, and a robust control algorithm allowing healthcare providers to operate the robot remotely. The 7-DOF dual-arm cobot has distinguished features of providing human-like collaborative motions between the two arms in a smooth and accurate way. A new robotic hand is being designed specifically for clinical operations. Current robots for telenursing adopt a conventional form of rigid robotic hand which is unable to perform routine tasks such as sputum collecting and testing swabbing, auscultating, and something alike that require soft contact with patients. Unfortunately, the state-of-the-art soft robotic hands on the market pose challenges for operations that have high requirements for accuracy, like blood sample collecting and packaging. We are working on designing a brand new robotic hand that includes a rigid inner core like human hand bone, and a soft exterior like hand muscle. By means of the mature tendon-driven technique, the inner rigid robotic hand can be actuated by a servo motor in an accurate and smooth manner, which meets the requirements for robotic telenursing. Another challenge we have to deal with is the difficulty of haptic control. The input/output mapping between the remote operation and robot manipulation will never match one-to-one, due to an apparent accompanying delay between 0.5 to 3 seconds. Since the robot will perform a set of routine clinical tasks, an AI algorithm will be developed to train the robot to detect types of routine tasks, and carry out operations in advance a bit to counteract the delay of haptic device. We also have a challenge ahead of us—the difficulty of scanning the irregular shape of the human body and estimating the pose for further collecting and testing operations to ensure that no injury is caused to the patient. We will develop a point cloud segmentation methodology to obtain an accurate contour of individually varied shapes of patients by means of cutting-edge computer vision techniques. By doing this, the robot will be able to perform tasks like swabbing based on a precise information of the pose and shape of a patient's nasal cavity. We will also integrate the cobot with a small size AGV (automated guided vehicle) to navigate in different testing labs to improve efficiency.

Discussion and Future Work

The proposed research is in the conceptual design phase. At this moment, the research team is working on kinematic analyses to obtain the working space of the cobot and the design of the robotic hand. Future versions of such telenursing robots are expected to include: a highly intelligent module that enables the robot to learn the operations of a human operator beyond just routine tasks, an improved human-machine interface that enables the robot to communicate with patients to take corresponding actions based on the big data of clinical operations, and a networking of medical records to share with doctors to have a better tracking of the health conditions. Given the urgent need for such telenursing robot to combat COVID-19, the short term objective is to propose a robot that is haptic controlled, with a robotic hand installed on a 7-DOF robotic arm to carry out some fundamental routine clinical tasks like auscultating and temperature measurement. The long-term objective will be the design of an intelligent robot that can perform clinical tasks with minimum human intervention not only for epidemics, but also for some other clinic and long-term caring tasks.

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FIG. 2: SIMULATION OF THE PROPOSED REMOTELY CONTROLLED ROBOT USING ROS

ME NEWS & RESEARCH

HIGHLIGHTS

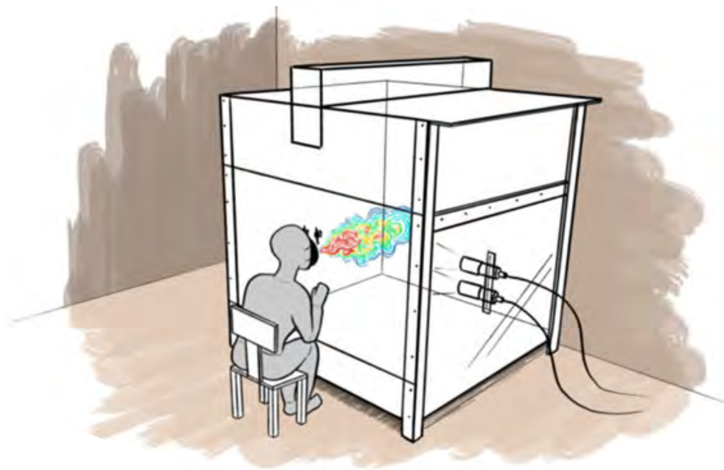


FIG. 1: THE COUGH CHAMBER IS A 2 M ENCLOSED CUBE WITH AN OPENING AND CHIN REST IN THE FRONT, WHICH IS USED AS AN ACCESS POINT FOR STUDY PARTICIPANTS TO COUGH. WITHIN THE CHAMBER, PIV AND HWA MEASUREMENTS ARE USED TO DETERMINE THE VELOCITY OF THE EXPELLED DROPLETS FROM THE COUGH.

IMAGE COURTESY OF THE RESEARCHER

How Far Does a Cough Travel?

Respiratory activities, such as coughing, sneezing, breathing, and talking, generate and disperse pathogen-bearing droplets and aerosols, which is a major vector for transmission of COVID-19. One of the recommendations for reducing your likelihood of contracting COVID-19 is to practice physical distancing, which generally means keeping a distance of approximately 2 m between yourself and others. But is 2 m far enough? A recent study directed by Prof. **Eric Savory** at Western University investigated the far-field airflows resulting from coughs from healthy and influenza-infected subjects sought to answer this question.[1] This study employed a specially-designed "cough chamber", equipped with particle image velocimetry (PIV) and hot-wire anemometry (HWA) capabilities, to analyze airflows 1 m away from 58 subjects' mouths. The resulting airflows were approximately 1.2 m/s at this distance, a finding which was supported by predictions made using computational fluid dynamics (CFD) models. Their conclusion, which received international media attention earlier this year, was that droplets would still be travelling through the air at distances well beyond 2 m. Prof. Savory's ongoing work, funded by NSERC and Roche, includes the development of a cough simulator which will be employed in BSL-2 and 3 facilities to study the transport, deposition and viability of aerosols containing COVID-19 on different surfaces. Future studies will include full-scale experiments using mannequins capable of coughing, sneezing and breathing to quantify person-to-person transmission of COVID-19 and the effectiveness of PPE at different separation distances. — *Technical Editor, Prof. Ryan Willing*

Dudalski N, Mohamed A, Mubareka S, Bi R, Zhang C, Savory E. Experimental investigation of far-field human cough airflows from healthy and influenza-infected subjects. *Indoor Air*, 30, pp. 966-977, (2020).

NSERC Supports Mechanical Engineers in COVID-19 Research

The COVID-19 pandemic has left an indelible mark on all aspects of industry and academia, with many businesses forced to roll-back operations, classes forced online and research programs coming to a near halt. However, many Mechanical Engineers at Universities and Colleges in Canada have successfully pivoted their research programs to adapt to the new normal, and many have joined the fight against the virus. This is evidenced by the large number of successful COVID-19 research grants submitted to NSERC. A list of 29 funded projects lead by Mechanical Engineers was provided by NSERC, each receiving approximately $50,000 and accounting for approximately 10% of the funded projects. Research topics included the development of new tools and techniques for detecting the virus (7 projects), innovations related to PPE (7 projects), and surface treatments to prevent the spread of COVID-19 (5 projects). Development and optimization of therapeutics, patient monitoring, public policy and modelling were among the remaining research project topics. Furthermore, each of these projects involve collaborations outside of academia, including partnerships with consulting firms, product developers, utilities, and companies in chemical, textile, manufacturing, life sciences, air/water quality and aerospace industries (to name a few). We should note that the list provided by NSERC was limited to grants categorized within Mechanical Engineering and might miss important contributions of Mechanical Engineers to other NSERC-funded COVID-19 projects. We would like to extend a special thanks to all Mechanical Engineers contributing to the fight against COVID-19, our partners in industry and supporters at NSERC.
— *Technical Editor, Prof. Ryan Willing*

NSERC CRSNG

University of Alberta
Dr. Jamie G. Wong

Interdisciplinary Innovation in Energy and Flight with Biomimetics

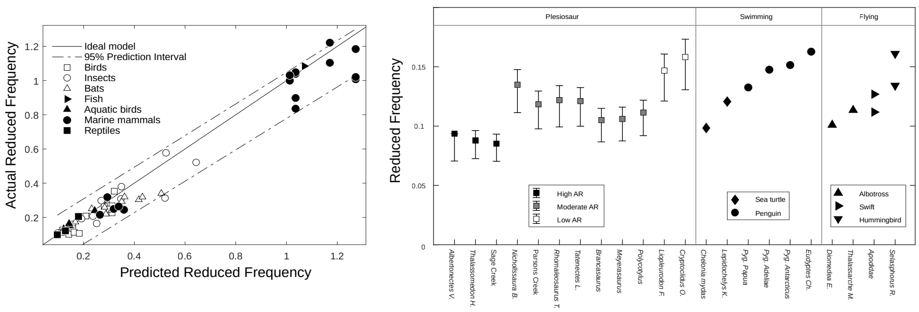


FIG. 1: (LEFT) THE SCALING OF KINEMATIC PROPERTIES OF ANIMAL SWIMMING AND FLYING ACROSS MANY SPECIES CAN BE PREDICTED ROBUSTLY WITH UNIVERSAL VORTEX SCALING LAWS. (RIGHT) THESE PREDICTIONS ALLOW US TO ESTIMATE THE KINEMATICS OF EXTINCT SPECIES FOR WHOM MANY PARAMETERS ARE UNKNOWN, PROVIDING NEW INSIGHT INTO THEIR ECOLOGY.

The first heavier-than-air flying machines built more than a century ago were inspired by – and often direct copies of – the flight of soaring birds. As mechanical flight surpassed what nature could manage in terms of both velocity and altitude, the use of bio-inspired design in aerodynamics lost its utility. But at the slowest speeds and smallest scales, nature's flyers still out-perform anything

Dr. JAIME G. WONG, *PhD*

Dr. Wong has been an Assistant Professor in the Department of Mechanical Engineering at the University of Alberta since January of 2018, following his PhD studies at Queen's University in Kingston, completed in 2017. His research interests include biomimetic fluid mechanics, vortex flows, and optical flow metrology. Outside of research, Dr. Wong is committed to outreach to and inclusion of under-represented groups in STEM, and general interest in aerodynamics and aviation among youth, both through university-led initiatives, and through the Alberta Aviation Museum, where he is a director.

engineers can design. Dr. Wong and his students are working to catch up from this hundred-million-year head start. While a century ago the transfer of knowledge was very one-way, from biology to engineering, they are finding that today biological research often finds insights from aerodynamics in unexpected ways.

How, for instance, does the hydrodynamics of your resting heart help paleontologists working in the badlands of Alberta? Millions of years ago, the Western Interior Seaway linked the Gulf of Mexico to the Arctic Ocean, passing right over Alberta, where four-flippered plesiosaurs swam and (we think) hunted. Alberta institutions lead the world in the paleontology of these swimmers but we cannot determine, from their compressed ocean-floor fossils alone, how fast the animals swam or how well they maneuvered – critical knowledge for understanding their ecology. In collaboration with the Royal Tyrrell Museum, Dr. Wong's group found that scaling rules, originally developed to describe vortices formed in jets

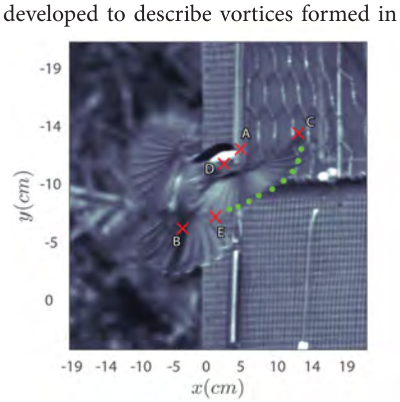


FIG. 2: MULTI-CAMERA HIGH-SPEED IMAGING OF PERCHING BIRDS IS USED TO INVESTIGATE THE RAPID CHANGES IN AREA AND SHAPE EXPLOITED BY SMALL ANIMALS. THE USE OF DEFORMING SURFACES IN ENGINEERED FLYING MACHINES HAS ONLY RECENTLY BECOME POSSIBLE WITH ADVANCES IN MATERIALS AND CONTROL SYSTEMS, BUT IS UBIQUITOUS AMONG NATURAL ONES.

(describing, for instance, the difference between a healthy and unhealthy heart), could be modified into a robust predictor of wing and flipper kinematics across birds, fish, swimming and flying mammals, swimming reptiles, and insects. With this knowledge, it was possible to fill in the unknowns of swimming speed and flapping frequency in order to place different species – both living and fossil – onto a spectrum from most efficient to most nimble.

Such insights are only possible due to the common governing physics of flow separation and vortex growth, which follow the same rules for the vortex forming in flow passing through a heart valve as it does in the oscillations of a flipper. Thus, while the first applications that come to mind in the study of flying in nature may be analogous engineered vehicles – micro-aerial vehicles and autonomous underwater vehicles – insights are transferable to numerous vortex-dominated flows. Dr. Wong's group continues to collaborate with biologists, for example, attempting to couple the aerodynamic and ecological descriptions of the energy state of perching birds (e.g. the aerodynamic cost of a manoeuvre versus food availability or predation risk), but also takes these concepts back to the lab. The manoeuvres observed by him and his group in nature are abstracted in a towing-tank facility at the University of Alberta, where an aerodynamic model can be pulled through water while pitching or flapping to be observed by optical diagnostics. Using a combination of particle image velocimetry – which estimates flow velocities on a plane – and more advanced, volumetric measurements like 'shake-the-box' particle tracking, the full, three-dimensional behavior of the vortex wake behind these objects can be characterized. This information can be used to develop new models for vortex growth and evolution, which define the forces acting on the body, such as their ongoing work developing a point-vortex transport model. Such a model would permit reasonable estimates of forces and energy costs of a bird in flight from images or video alone.

Evolution's head start of hundreds-of-millions of years may never be caught up completely. However, we can continue to close the gap by uncovering the fundamental flow physics of flight.

IMAGES COURESTY OF THE RESEARCHER

University of Victoria Dr. Joshua W. Giles

Designing mechatronic devices and using computational modeling to advance orthopaedic surgical planning

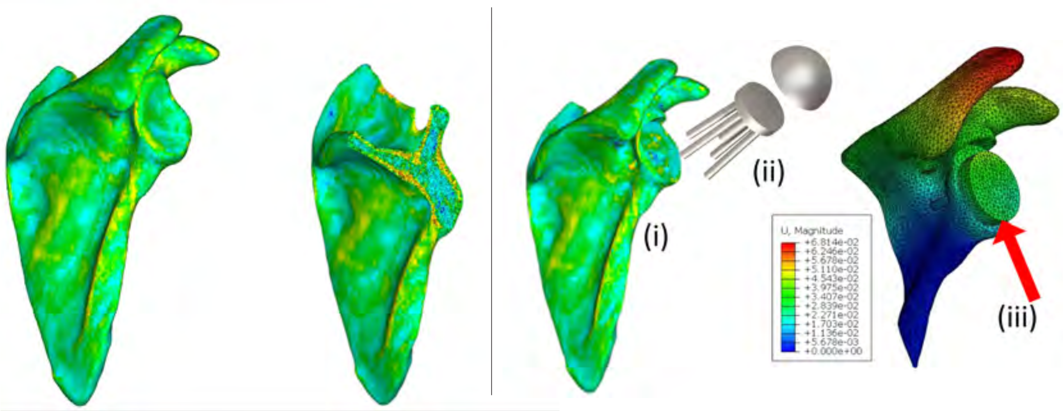


FIG. 1: SHOULDER BLADE 3D MODEL WITH COLOUR MAP OF BONE MATERIAL PROPERTIES (LEFT). SECTION VIEW SHOWING INTERNAL BONE PROPERTIES (RIGHT). FINITE ELEMENT MODEL SHOWING (I) RESULT OF 'VIRTUAL' SURGERY IN WHICH DISEASED BONE WAS REMOVED AND (II) VIEW OF RSR COMPONENTS (LEFT). FINITE ELEMENT DISPLACEMENT RESULTS WITH REALISTIC JOINT FORCE (III) APPLIED TO RSR IMPLANT (HEMISPHERE OMITTED) (RIGHT).

PORTRAIT PHOTO BY JENA BJOLA

Dr. JOSHUA W. GILES, PhD, P.Eng.

Dr. Giles joined the Department of Mechanical Engineering at the University of Victoria in 2017 as an Assistant Professor. Prior to this, he completed a Post-Doctoral Fellowship at Imperial College London, London, UK (2014-2017) where he developed a novel methodology and set of tools to enable minimally invasive shoulder replacement surgery. Dr. Giles earned his PhD (2014) and BESc (2009) at Western University in Biomedical Engineering and Mechanical & Materials Engineering, respectively. His lab is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canadian Institutes of Health Research (CIHR), the Canadian Foundation for Innovation (CFI), and other non-governmental sources. Dr. Giles and his team collaborate with orthopaedic surgeons, physical medicine doctors, mechanical and electrical engineers, computer scientists, mathematicians, anthropologists, and rehabilitation scientists.

Orthopaedic surgeons make many challenging decisions when treating patients in need of joint replacement. Surgeons must decide on which incisions to make to access the joint, what/if any technologies they will use to assist implant placement (e.g. optical tracking, 3D printed guides, or robotic systems), and finally they must choose which implant to use, how to configure its adjustable parameters (size, fixation, etc.), and where to place it in the joint (e.g. position and orientation). Much previous research has been conducted on optimizing implant components, fixation methods, and implantation assistance technologies. However, the myriad of implant selection decisions listed above remain at the discretion of surgeons and are based on their experience, medical images (e.g. x-rays), and manual physical examination. In the hands of world leading surgeons, this is a challenging but achievable task; however, for less experienced/low volume clinicians, the task of making optimal personalized decisions to optimize each patient's outcomes is nearly intractable.

With his multidisciplinary expertise, Dr. Giles and his group work to 1) design mechatronic tools that generate higher quality pre-operative patient data (i.e. more repeatable and objective than current techniques), and 2) develop computational and statistical musculoskeletal biomechanics methods that use these data to provide surgeons with patient-specific decision-making assistance. An ongoing project in this area involves Reverse Shoulder Replacement (RSR), where the anatomical ball-in-socket geometry of the two bones forming the shoulder joint is flipped by the implants. RSR is particularly challenging for surgeons as the implants have 10+ configuration choices, the biomechanical influences of which are non-intuitive because of the non-anatomical nature of RSR. Dr. Giles' group is addressing this planning challenge by developing computational musculoskeletal models that accurately simulate variation in bone shape across patient populations and RSR design variables in order to produce a broad set of biomechanical training data. In collaboration with computer science and statistical researchers, these data will be used to develop a clinically usable, machine-learned method that accounts for each patient's anatomy and pre-operative function, and is able to provide biomechanically-informed suggestions of the optimal surgical options for each individual patient. Through such a tool, it will be possible to level the playing field by providing less experienced surgeons with the assistance they need to make the same decisions a world leading expert would.

In addition to this primary program, Dr. Giles and his team are conducting projects that seek to answer a wide range of questions including: How do sex differences in walking kinematics affect the optimal design of prosthetics for lower limb amputees?; Can a custom designed ankle wearable sensor system be used to assist in the assessment of stroke patients with dysfunctional walking patterns?; And, in collaboration with a biological anthropologist: How can we harness computational musculoskeletal modeling to investigate the differing energy consumption of various pre-historic human populations?

University of Alberta
Dr. Wylie Stroberg

In silico cell biology: Computational approaches to physiology and disease

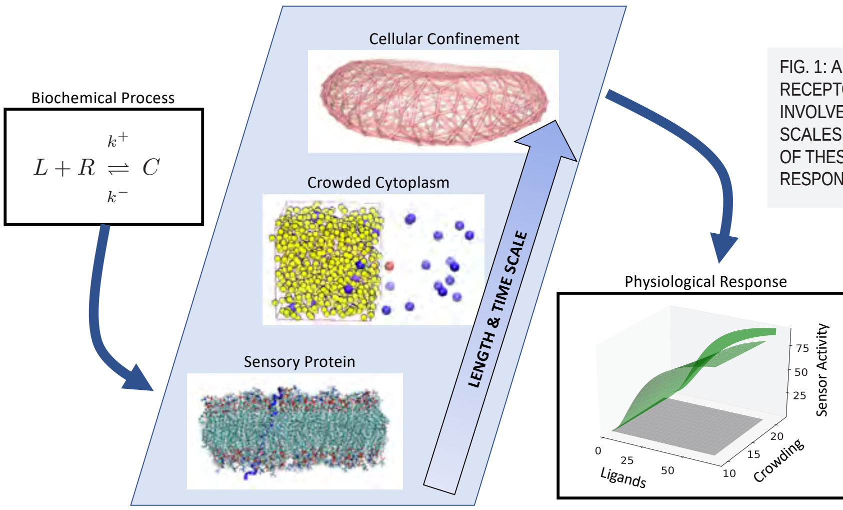


FIG. 1: A SIMPLE BIOCHEMICAL PROCESS SUCH AS A RECEPTOR SENSING THE CONCENTRATION OF A LIGAND INVOLVES PHYSICAL PROCESSES ACROSS MULTIPLE SCALES. ACCURATELY CAPTURING THE EFFECTS OF THESE SCALE PROVIDES A PREDICTION OF THE RESPONSE IN THE COMPLEX CELLULAR ENVIRONMENT.

Dr. WYLIE STROBERG, PhD

Dr. Stroberg is an Assistant Professor in the Department of Mechanical Engineering at the University of Alberta. He received a BSc in mechanical engineering from the University of California, Berkeley (2010), and a PhD in Theoretical and Applied Mechanics from Northwestern University (2016). In 2016, Dr. Stroberg joined the Department of Molecular and Integrative Physiology at the University of Michigan as an IRACDA Postdoctoral Fellow, where he was recognized with several awards including the Early Career Award in Research Excellence from the Department of Molecular and Integrative Physiology and the Outstanding Postdoctoral Fellow Award from the University of Michigan. Dr. Stroberg currently directs the Computational Biosystems Lab at the University of Alberta where his group applies techniques from engineering and applied mathematics to problems in cell biology.

Advances in computational power, along with large data sets from increasingly-detailed experiments have made computation indispensable to cell biology and physiology. In many cases, physiological effects at the cell or tissue scale emerge from complex interactions of subcellular components such as macromolecules and organelles. Understanding these physiological effects requires knowledge not only of the underlying molecular interactions, but also of how many such interactions combine to collectively produce cellular-scale behavior. The Computational Biosystems Lab at the University of Alberta, under the direction of Dr. Stroberg, develops and applies techniques that integrate information from multiple spatial and temporal scales to capture emergent biological effects. By connecting molecular interactions to larger-scale physiological consequences, this research aims to identify potential therapeutic targets for diseases and uncover evolutionarily-tuned design principles for controlling complex systems.

One particular area of interest for the lab is how cells remain viable in fluctuating environments. Cells of all types, from bacteria to highly-specialized cells within the human body, are continuously subject to changing environmental conditions. The fitness of these cells, and the organisms they constitute, depend on the ability of cells to cope with these environmental perturbations. Failure to do so has potentially devastating physiological consequences, leading to diseases such as diabetes, Alzheimer's disease, and viral infections such as COVID 19. The Computational Biosystems Lab employs multiscale models of cellular feedback networks to understand how cells maintain function in the face of environmental challenges.

Cells have evolved complex control systems that sense chemical and mechanical disturbances in their surroundings, and activate specific sets of genes with the aim of restoring homeostasis to the cell. While the networks of proteins and signaling molecules that detect and transmit signals throughout the cell are in many ways analogous to electronic control systems, they differ fundamentally in that they must operate through physical interactions of molecules within the heterogeneous interior of cells. Understanding how cells have evolved to efficiently transmit signals through the crowded, confined cytoplasm has the potential to guide therapeutic interventions that harness the cells own responses to treat disease.

The interdisciplinary research conducted in the Computational Biosystems Lab relies on a team of researchers with diverse backgrounds and skillsets, along with close collaboration with experimental biologists. This allows the lab to work at the interface of biology and engineering, with the long-term goal of uncovering fundamental principles for controlling complex systems, and leveraging those principles for engineering design.

IMAGES COURTESY OF THE RESEARCHERS

ACTION BY ACAMP - A95™ RESPIRATOR IMAGE COURTESY OF WWW.ACTIONBYACAMP.CA

KEN BRIZEL, *CEO of ACAMP, has 38 years' experience in managing and developing advanced technology products and organizations. He is an international executive with operational experience in public and private corporations. He is a hands-on leader and mentor, with extensive operational background strategy, business development, planning, team building, sales, marketing, engineering, operations and manufacturing experience. He previously served as CEO to LightPath Technologies, a NASDAQ listed public company, and also served as a Senior Vice President for Strategy & Business Development at Oplink Communications and at AT&T Bell Labs/Lucent Microelectronics. He was Director of Strategic marketing for Infrastructure Products and Product line Director for Consumer Digital Signal Processors. Ken has worked in two start-ups, one which sold and the other which went public. He was trained in business at GE's corporate Crotonville global leadership institute. Ken holds a Master's Degree and Bachelor's Degree in Electrical Engineering with a concentration in solid state physics from RPI (Rensselaer Polytechnic Institute) and was awarded the prestigious David Sarnoff Award for Outstanding Technical Achievement at RCA Corporation.*

CSME: Thank you Ken for agreeing to this interview. ACAMP, in collaboration with University of Alberta researchers Profs. Warren Finlay and Andrew Martin, have developed a reusable A95 mask in order to fight COVID-19.

ACAMP is a non-profit organization dedicated to advancing technologies in the areas of electronics hardware, firmware, software (ML/AI), sensors, and embedded systems, these are quite different from the development of face masks. How did the idea of developing a A95 respirator mask start?

Brizel: Back on March 21st 2020, I went into a grocery store and discovered none of staff or shoppers were wearing either masks or respirators, even though I was wearing a 3M N95 respirator. I went home and tried to find respirators for sale on Amazon and Google searches, without any luck. So, I decided ACAMP was going to engage in the development of a respirator that mimics the performance of a standard N95 respirator to help the general public. As you are aware a respirator is higher performance than a simple face mask, by causing the user to breathe directly through the filter.

CSME: What was the most critical design challenge that you faced when developing the face mask?

Brizel: The two challenging pieces for the respirator were the filter and the mask to hold the filter.

Searching the CDC website I found articles from 2006 to 2008 about the use of cloth for filters during the bird flu and SARS epidemic with promising results.

ACAMP began working with our University of Alberta aerosol respiratory lab colleagues, creating lots of experiments in April 2020 on cloth based filter materials, which are the key to a good respirator or mask. Most fabric materials had sadly less than 50% filtration efficiency. But, after careful analysis of a few fabrics types we came up with a fabric mixture that produces the best results for approaching an N95 in performance, > 95% filtration efficiency using over 8 layers of the fabric. Surgical masks are between 88 to 92% efficiency, but also aren't respirators by design.

The other problem to solve was the creation of a mask to hold the fabric filter while sealing properly to a person's face. We went through five design iterations to finally come up with a mask made up of two major components, the base which contacts the skin on the face and a cover that sandwiches the filter to the base. We went online and found information on facial features, distances between a wide variety of facial features and tried to design a single adult mask that covered 85% of the population. We found the most difficult feature to be the nose bridge design. More recently using a Thermal Plastic the user can heat the nose bridge with hot water and deform it to best fit each individual.

CSME: ACAMP worked with University of Alberta researchers in order to develop the face mask. What was the role these researchers played in the project? Was it an experience you would recommend to other innovation driven companies?

Brizel: It was truly a learning experience for all of us. Dr. Findlay's team opened their lab to do the testing and contributed many hours of research into the different materials commonly available. The ACAMP team provided samples from all over Canada for testing. This was all done during the early days of the COVID crisis and quite scary times; the teams took precautions and followed protocols for safety. I think it was highly unusual for U of A to help us this way, but highly informative for both sides. I would highly recommend U of A for research and development in this way.

CSME: As you are aware, the Government of Alberta has substantially reduced their contribution to funding higher education over the past few years. How critical do you think it is, for an innovation company like yours, to have access to research-intensive universities, such as the University of Alberta?

Brizel: It is imperative that research institutions like the U of A be well funded for their work with industry. Dr Findlay and his team are experts in aerosol dynamics and it helped ACAMP to understand the issues and create solutions. The relationship between university research and industry needs to be nurtured by government.

CSME: COVID-19 cases continue to increase as more countries try to re-start their economies. Some European countries, such as Spain, have decided to make wearing masks mandatory outside the home. Do you think the masks that your team have developed could be produced fast enough to have a reusable A95 mask every Canadian household in case they become mandatory?

Brizel: We have two Canadian textile companies and injection molding companies engaged in manufacturing the A95 components at capacities up to 50,000 per day. ACAMP is presently assembling the components into the finished products which is the limiting factor for A95 production. If the requirements were more than 2,000 per day ACAMP would engage contract manufacturing to assemble the A95 respirator. More textile and injection molding companies can easily be engaged for extremely high volume requirements, so production is scalable.

CSME: The 2019 pandemic has changed the world and its impact on many aspects of our life is still unknown. How do you think this disease and future potential outbreaks will affect research and development at academic institutions and in industry? How are partnerships between the two going to be affected in your view?

Brizel: SARs and the bird flu outbreaks in 2003 and 2005 were precursors to the present pandemic. The 2019 pandemic and 2020 crisis, I believe is a precursor to potential ongoing issues for disease outbreaks worldwide. We need to be more vigilant and react faster to future disease outbreaks. Academic institutions are not normally known for fast response. The relationship formed between University of Alberta and ACAMP is a great example of speed of development during a crisis. In extremely short time spans going forward industry and academic institutions will need to come together to solve future problems. This is how the partnerships are being affected.

IN MEMORIAM

Dr. Thomas Anthony Brzustowski
(1937- 2020)

Dr. Brzustowski, PhD, P.Eng., O.C. passed away peacefully June 19th 2020 at Grand River Hospital following a brief illness. Lovingly remembered by Louise, his wife of 56 years, sons John (Emily), Marc (Colette), Paul (Kelly), and grandchildren Luc, Julia, Sadie and Sebastien.

Tom was born in Warsaw in 1937 and survived WWII in Poland thanks to the personal courage of his mother, Helena. After the war, they escaped to England to reunite with his father, Jerzy, who had been working as an engineer in the Polish squadron of the RAF. The family emigrated to Toronto in 1949.

Tom held a BASc in Engineering Physics from the University of Toronto in 1958, and a PhD in Aeronautical Engineering from Princeton in 1963. He was a professor in the Department of Mechanical Engineering at the University of Waterloo (UW) from 1962 to 1987, teaching and carrying out research in thermodynamics and combustion, and mentoring numerous grad students with whom he maintained lifelong contact. Tom served as Chair of Mechanical Engineering from 1967 to 1970, as Vice-President, Academic from 1975 to 1987, and was eventually named Provost, the first at UW to hold that office.

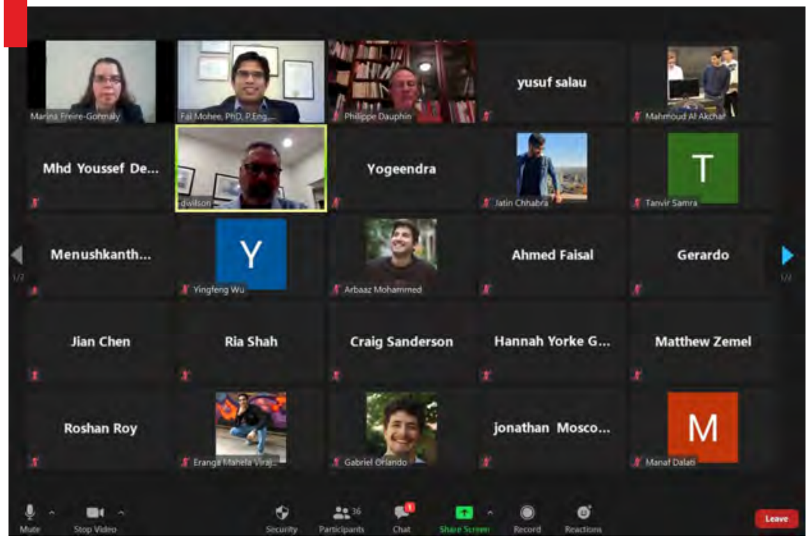
Tom would say that his greatest achievements while in Waterloo were to marry Louise and help her raise a family. Tom loved the Canadian landscape and made sure that his boys had every opportunity for the outdoor fun and adventure that he missed as a child. Logging countless miles (and later km) on multiple family station wagons, he piloted numerous camping trips to the Rockies, Maritimes and Northern Ontario, with frequent visits to Louise's family in Quebec.

Tom continued his life's work to build a better Canada by serving as deputy minister in the Government of Ontario from 1987 to 1995, first in the Ministry of Colleges and Universities, and later in the Premier's Council. He was appointed President of the Natural Sciences & Engineering Research Council of Canada (NSERC) in October 1995 and served with vigor for 10 years.

"Retirement" was a teaching position at the University of Ottawa Telfer School of Management, where Tom was the inaugural RBC Professor in Commercialization of Innovation. Author and lecturer, he advocated tirelessly for innovation in Canada and received honorary doctorates from several universities across Canada. Tom is an Officer of the Order of Canada and he served on the Board of the Institute for Quantum Computing at UW and the Council of Canadian Academies.

Tom was an avid reader, puzzler, cyclist and photographer, but above all else, he loved his family, especially Louise. For 56 years she enriched and expanded his world, welcoming students, colleagues and neighbours, many new to Canada, into their home. Together Louise and Tom attended live plays, live music events, live sports and hosted lively dinner parties, right up until all of those were cancelled by the pandemic. Not to be held down, the young couple took to walking together on the empty UW campus every day of the COVID-19 lockdown, Tom fending off the campus geese with a walking stick, a gentleman to the end.

CSME STUDENT AFFAIRS & YOUNG PROFESSIONALS REPORT



FAIZUL, DEREK, PHILIPPE, MARINA AND ATTENDEES AT THE CSME WEBINAR ON NOVEMBER 4, 2020.

THE CSME STUDENT & PROFESSIONAL AFFAIRS committees facilitate the CSME Student Chapters and new Professional Chapters to organize events, networking and outreach activities. During the past few months, the committee organized a webinar, open to all CSME members. We are looking forward to future online events that the CSME chapters will host over the next few months!

Dr. **Faizul Mohee**, led the organization and moderation of a joint CSME Professional Affairs and CSME Student Affairs webinar on November 4, 2020. The keynote lectures were presented by **Philippe Dauphin**, Director General, Natural Resources Canada (NRCan); **Derek Wilson**, Vice President, Nuclear Waste Management Organization (NWMO); and York University Assistant Professor, **Marina Freire-Gormaly**. A total of 64 CSME members from across Ontario (Toronto, Ottawa, Windsor, Mississauga, London, Hamilton) as well as, Alberta, British Columbia, Quebec, New Brunswick, Nunavut, Yukon and the Northwest Territories.

Attendees learned from Derek Wilson, Vice President, NWMO about the development of a Deep Geologic Repository for Canada's nuclear waste. Mr. Wilson provided an overview of several exciting R&D projects the NWMO and their research partners are undertaking to ensure the safe long-term storage of the nuclear waste. These R&D projects include the development of the Used Fuel Container with a layer of Copper coating which uses both electrodeposition and cold spray technologies to completely coat the Used Fuel Container. Mr. Wilson also described the use of hybrid laser arc welding to securely seal the Used Fuel container. Derek Wilson also described another level of safety is provided by placing the Used Fuel Container in Highly Compacted Bentonite buffer boxes. Since these boxes are heavy and custom sized, the NWMO also needed to develop customized forklifts for the buffer boxes.

Attendees learned from Philippe Dauphin, Director General, NRCan about the exciting research projects conducted in the CanmetMATERIALS Program. The clean energy Research and Development (R&D) projects that Mr. Dauphin leads include materials for reducing energy end-use, for example making vehicles lighter for lower gas consumption energy; materials for energy distribution, for example making pipelines safer and less susceptible to failure; materials for clean energy production, for example making new materials to scale-up biomass conversion technologies, technologies for bitumen upgrading and cleaner thermal power, and also materials for safe nuclear power. In addition, Mr. Dauphin highlighted research on materials for the safety and security of the Canadian Armed Forces, Navy and Coast Guard and NRCan's mandate to manage Canada's National Non-Destructive Testing (NDT) certification body.

Participants also heard from Prof. Freire-Gormaly (York U) about on-going research projects in her laboratory on novel materials, the aerosol transmission of COVID-19, and renewable powered water treatment technologies. The attendees were very engaged and there was a lively Q&A session after the talks. The CSME Student & Professional Affairs committee is looking forward to hosting monthly webinars over the next year to facilitate member learning, collaboration and networking.

Please join as a CSME member — it's FREE for students (csme-scgm.ca/application)! The Engineering Careers site (www.engineeringcareers.ca) also provides an opportunity for students and graduates to career-plan. We look forward to facilitating more opportunities for CSME students to learn about the ME industry in Canada and network with industry professionals.

If you are interested in leading and founding a CSME Student Chapter at your campus or a Professional chapter in your community, let us know. We are also looking to expand the CSME Student Affairs Committee and the CSME Professional Affairs Committee. If you are interested in helping lead activities locally or at the national level, please reach out!

DR. MARINA FREIRE-GORMALY, PhD, EIT, LEED GA
Chair of CSME Student Affairs
Marina is an Assistant Professor at York University in the Department of Mechanical Engineering. She completed her PhD at the University of Toronto in the Department of Mechanical and Industrial Engineering. Marina's research team is investigating how COVID-19 transmits in air, and how to make energy and water systems more reliable and sustainable. Her research and teaching spans energy systems, nuclear, computational modelling and sustainability.

DR. FAIZUL M. MOHEE, PhD, P.Eng., PMP
Chair of CSME Professional Affairs
Faizul is the Director of Research at TMBN Extrados Inc. in Toronto. He completed his PhD at the University of Waterloo on mechanical anchors for composite materials and completed his master's at U of T. He has taught a Machine Learning, Artificial Intelligence and Big Data for Manufacturing course at York University and the Materials Science course at U of T's Department of Mechanical & Industrial Engineering. He previously worked at Hatch, WSP and has completed projects for OPG, Bruce Power, Terrestrial Energy, Baffinland, Stornoway, SaskPower and Emera. Faizul works in research and development for the energy, mining and nuclear industries and is currently is conducting research on COVID-19 transmits in air and HVAC systems. Faizul is passionate about research, teaching and student engagement to build smart and sustainable infrastructure that is resilient and adaptive to climate change.

The Canadian Society for Mechanical Engineering
A constituent society of the Engineering Institute of Canada

La Société Canadienne de génie mécanique
Une société constituante de l'Institut canadien des ingénieurs

NEWS COMMUNIQUÉ

Office of the President 4 November 2020

The Canadian Society for Mechanical Engineering (CSME), founded in 1970, is pleased to announce the winning recipients of its 2021 technical awards. These awards may be bestowed biannually to members of the society for their outstanding contributions to specific areas of mechanical engineering in Canada.

The following three exceptional engineers will be presented with their medals at the 2021 CSME International Congress currently scheduled to be held on 27-30 June 2021 at the Faculty of Sustainable Design Engineering, University of Prince Edward Island, Charlottetown, PE. Each winner will also be presenting a plenary lecture at the 2021 Congress.

Please consider attending the 2021 CSME International Congress to congratulate these exceptional winners and attend their lectures: www.csmecongress.org.

Jules Stachiewicz Medal

For "exceptional contributions in research and development of advanced thermal spray heating coatings and modelling of phase change phenomena"

André McDonald, PhD, MCSME

Professor and Associate Chair, Mechanical Engineering Dept, University of Alberta, AB

Emerging Technologies Medal

For "exceptional research and innovation contributions to the field of microfluidics"

Mina Hoorfar, PhD, FCSME

Professor and Director of School of Engineering, University of British Columbia Okanagan, BC

Mechatronics Medal

For "exceptional contributions to robotics and automation at micro-nano scales"

Yu Sun, PhD, FCSME

Professor and Director of Robotics Institute, MIE Department, University of Toronto, ON

Nominations by Fellows of the CSME are currently solicited for 2021 Regular Awards of the Canadian Society for Mechanical Engineering (CSME). These aim to recognize deserving mechanical engineering professionals who are members of the CSME. Final decisions regarding award winners are made by CSME's Awards Committee. Please nominate your peers for the 2021 regular awards (csme-scgm.ca/awards) before **Jan. 31, 2021**.

PO Box 40140, Ottawa ON K1V 0W8
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Dr. Yu Sun

Dr. Yu Sun is a Professor in the Department of Mechanical and Industrial Engineering, with joint appointments in the Institute of Biomedical Engineering, Department of Electrical and Computer Engineering, and Department of Computer Science at the University of Toronto (UofT). He is the Founding Director of the UofT Robotics Institute. He is a Faculty Affiliate of the Vector Institute for Artificial Intelligence. His Advanced Micro and Nanosystems Laboratory specializes in developing innovative technologies and instruments for manipulating and characterizing cells, molecules, and nanomaterials.

Sun is an inventor on 15 granted US/PCT patents. He has published 5 books and 211 journal papers, both in interdisciplinary journals such as Nature Materials, PNAS, Nature Cell Biology, Nature Communications, Science Robotics, Science Advances, Nano Letters, ACS Nano; and in core engineering journals such as IEEE Trans. Robotics, IEEE Trans. Mechatronics, Intl J. Robotics Research, IEEE Trans. Biomed Engineering, IEEE/ASME J. MEMS etc. He was elected Fellow of RSC, CAE, IEEE, ASME, NAI, AAAS, AIMBE, EIC, and CSME for his work on micro-nano devices and robotic systems.

Dr. Yu Sun is awarded the 2021 CSME Mechatronics Medal in recognition of foundational contributions to robotics and automation at micro-nano scales.

Dr. Mina Hoorfar

Dr. Mina Hoorfar is Professor and Director of School of Engineering at the University of British Columbia Okanagan. She is known internationally for her research and innovation in the area of flow in microstructures, straddling the fields of fluid mechanics, membrane science, and sensors. Her group has developed a microfluidic-based olfaction technology for selective detection of gases in mixtures. An industry collaborator has licenced this technology for safety/security applications. She has trained over 150 HQP (3 in faculty positions and many others now fellows at top-ranked institutes). Her group has received over $11M in funding. She has been a keynote speaker at numerous microfluidics conferences. To date, Dr. Hoorfar's research has resulted in 120 journal papers, 2 book chapters, 150 conference proceedings, 2 patents (1 filed), 1 provisional patent, and 5 invention disclosures.

Dr. Mina Hoorfar is awarded the 2021 CSME Emerging Technology Medal for her exceptional research and innovation contributions to the field of microfluidics.

Dr. André McDonald

Dr. André McDonald's work in heat transfer at the University of Alberta has been innovative, diverse, interdisciplinary, and sits at the nexus of heat transfer, materials science, and advanced manufacturing. His research on the metallization of polymers is internationally recognized as cutting-edge work on the functionalization of polymeric structures to provide heating for airfoils and mitigate freezing in pipes. He developed predictive modelling of moving boundary phase change problems in finite length-scales. This has resulted in new deployable software to predict melting and freezing times of water on flat surfaces and in pipes. By engaging and collaborating broadly with industry end-users, he developed a simple, low-cost heat flux sensor to measure energy released from burning vegetative fuels in wildland fires and determine ignition times of the fuels.

Through leadership roles as President of the ASM Thermal Spray Society Board, Theme Lead and Member of the NSERC Green Surface Engineering for Advanced Manufacturing Strategic Network Scientific Committee, and Lead Editor of the Journal of Thermal Spray Technology, Dr. McDonald has facilitated dissemination and awareness of new knowledge and technology development in the area of heat transfer.

Dr. André McDonald is awarded the 2021 CSME Jules Stachiewicz Medal in recognition of his significant contributions in research and development of advanced thermal spray heating coatings and modelling of phase change phenomena.

NATIONAL DAY OF REMEMBRANCE AND ACTION ON VIOLENCE AGAINST WOMEN

Do You Know What Happened on December 6, 1989? It Matters

The Montreal Massacre, as it was initially known, was the result of a man brutally killing 14 women (6 of whom were 4th-year Mechanical Engineering students) and shooting ten other women and four men at the École Polytechnique with a legally-obtained rifle. The victims were not random. The gunman was targeting women engineering students, enraged at the idea of women working non-traditional jobs.

This mass murder was unprecedented. It is hard to imagine now when there is more than one mass shooting every day, but in 1989 we didn't associate mass shootings with schools or public places. The Montreal Massacre was one of North America's first mass shootings, Canada's worst gendercide, and Canada's worst mass murder before the attacks this spring in Nova Scotia.

The Montreal Massacre truly shocked the nation. Almost every Canadian over 40 can tell you exactly where they were when they heard about it. It affected everyone. People turned their personal sorrow and their outrage into public discussion and positive actions on issues of gun violence, misogyny and violence against women, and barriers to women in engineering and other male-dominated fields. Ultimately, the Montreal Massacre led to Canada's Firearms Act, which included the now-defunct Long Gun registry, and the designation of December 6 as the National Day for Remembrance and Action on Violence Against Women, which has since grown to a number of international campaigns for Activism Against Gender-Based Violence. And "closer to home," it has motivated new scholarships, internships, and changes to hiring practices to recruit and retain more women in engineering.

Every year, ceremonies commemorate the event at universities across the country. At Dalhousie, the ceremony is organized by the students of their Women in Engineering Society. It includes a moving candlelight vigil, in which current students and a staff member stand in for each victim and blow out candles to represent the lives that were extinguished. The ceremony also invites speakers from the university and local community who put things into a modern and broader context. The event serves not only to help heal the wounds of gendered-violence but to educate people who were too young or have recently arrived in the country. Only by knowing our past can we understand our present selves and take action to shape a future where women, men, and children are safe, treated fairly and with respect.

— *Dr. Wendy C. Gentleman*

Resources:

- Engineers Canada. 2019. Remembering the Montreal Massacre 30 years later. engineerscanada.ca/news-and-events/news/remembering-the-montreal-massacre-30-years-later.
- Gentleman, W.C., based on her December 6, 2014 multimedia presentation "A Montreal Massacre Memorial and Legacy: 'Do you know what happened December 6, 1989?' It's been 25 years. It still matters". csme-scgm.ca/content/history-committee (PDF).
- Film: "Polytechnique", a 2009 Canadian drama film directed by Denis Villeneuve and written by Villeneuve and Jacques Davidts.

Ottawa, 20 Sep 2020

Engineering Institute of Canada - ANNUAL REPORT

We collectively find ourselves in a unique and challenging position where the effects of the Covid-19 pandemic have turned our world upside-down. Every aspects of our personal, social, and business lives have been impacted. In the face of these unprecedented circumstances, it is as important as ever that we maintain our sense of calm and resolve. It is essential that our engineering instincts remain alive and alert.

Like all organizations, we have been tracking the Covid-19 pandemic and its human, social and economic impacts. As we question our respective roles in this process, we are reminded that our obligations as professional engineers include public health and safety. A comparable global virus outbreak of cholera in the 19th century resulted in the engineering community developing water and wastewater treatment infrastructure systems. Over the years, the evolution of these engineering infrastructure systems has been credited with saving more lives than the medical profession specific to the cholera crisis. These systems are so entrenched now they are often taken for granted as one of the foundation blocks of society.

Is the nature of this new coronavirus the beginning of another seminal moment for engineering? Is "physical distancing" going to be a new normal? What new R&D is going to be needed to address the social interactions of our world in protecting communities from the spread of future health hazards like Covid-19? What new design criteria will be added to our already growing list of key considerations in engineering the infrastructure on which all of society relies? And lest we forget, climate change considerations are in their infancy. Engineering must be at the front line of these challenges!

We cannot predict what the future will look like, however, more than ever, an organization like the EIC will have an increasingly important role to play. We believe our mandate to support excellence and share knowledge on the practice of engineering, is essential in the face of these new challenges.

With that being said, we are pleased to report that the EIC is remaining active and growing, strengthening our ability to fulfill our mandate and our relevance as an organization. The activities of our continuing education program, wherein we accredit quality learning providers, remain strong as many are transitioning their offerings to online delivery. While our gala has been postponed to next year (24 April), the honourees for our awards program provide evidence of another outstanding group of engineers excelling in their fields of endeavour with world class leadership. The History and Archives Committee is actively pursuing an Oral History Interviews project to expand and retain important evidences of engineering excellence.

Opportunities to enhance our relevance are found in the endeavours of our Strategic Conference Planning committee to connect with external agencies of interest in our themed area of interest – sustainable development of infrastructure in the north. We are looking at the potential revival of the Canadian Engineering Leadership Forum, a representation of national engineering organizations exploring the concept of combining the expertise and voice of Canada's leading engineering associations representing all aspects of the engineering profession to work together in shaping the future of and advancing the engineering profession in Canada.

The EIC also offers an excellent engineering career site (EngineeringCareers.ca) that caters specifically to job-seekers within the engineering community and organizations that are seeking to hire quality engineering professionals. Attractive volume discounts are available for multiple ad placements. For details on how to place ads, click: employers.engineeringcareers.ca.

And finally, we are pleased to announce that the EIC has grown this past year through the addition of two new constituent societies: the Tunneling Association of Canada (TAC) and the Canadian National Committee of the International Union of Radio Science (URSI Canada). This is a vote of confidence in the relevance that others see in the EIC.

The EIC federation is now made up of the following constituent societies:

- Canadian Dam Association (CDA): www.cda.ca
- Canadian Geotechnical Society (CGS): www.cgs.ca
- Canadian Medical and Biological Engineering Society (CMBES): www.cmbes.ca
- Canadian National Committee of International Union of Radio Science (URSI Cda): ursi.ca
- Canadian Nuclear Society (CNS): www.cns-snc.ca
- Canadian Society for Bioengineering (CSBE): www.csbe-scgab.ca
- Canadian Society for Chemical Engineering (CSChE): www.cheminst.ca/about/about-csche
- Canadian Society for Civil Engineering (CSCE): csce.ca
- Canadian Society for Engineering Management (CSEM): www.csem-scgi.org
- Canadian Society for Mechanical Engineering (CSME): www.csme-scgm.ca
- Canadian Society of Senior Engineers (CSSE): seniorengineers.ca/csse
- Institute of Electrical and Electronics Engineers – Cda (IEEE Cda): www.ieee.ca/en
- Institute of Industrial and Systems Engineers – Cda (IISE Cda): www.iise.org/Details.aspx?id=13558
- Tunnelling Association of Canada (TAC): www.tunnelcanada.ca

Yours sincerely,

Reg Andres, P.Eng., FEIC
President 2018-2020 Engineering Institute of Canada

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Ottawa, le 20 Sep 2020

Institut canadien des ingénieurs – RAPPORT ANNUEL

Nous nous trouvons collectivement dans une position unique et difficile où les effets de la pandémie de Covid-19 ont bouleversé notre quotidien. Tous les aspects de notre vie personnelle, sociale et professionnelle ont été touchés. Face à ces circonstances sans précédent, il est plus important que jamais de maintenir notre sentiment de calme et de détermination. Il est essentiel que nos instincts d'ingénierie restent bien actifs et alertes.

Comme toutes les organisations, nous avons suivi la pandémie de Covid-19 et ses impacts humains, sociaux et économiques. Alors que nous remettons en question nos rôles respectifs dans ce processus, il nous est rappelé que nos obligations en tant qu'ingénieurs professionnels incluent la santé et la sécurité publiques. Une épidémie mondiale comparable de choléra au XIXe siècle a conduit la communauté des ingénieurs à développer des systèmes d'infrastructure de traitement de l'eau et des eaux usées. Au fil des ans, l'évolution de ces systèmes d'infrastructure d'ingénierie a permis de sauver plus de vies que la profession médicale spécifique à la crise du choléra. Ces systèmes sont si bien ancrés aujourd'hui qu'ils sont souvent considérés comme acquis comme l'un des fondements de la société.

La nature de ce nouveau coronavirus est-elle le début d'un autre moment charnière pour l'ingénierie? La «distanciation physique» et le port de masques demeureront-ils une nouvelle norme? Quelle nouvelle R&D sera nécessaire pour aborder les interactions sociales de notre monde en protégeant les communautés contre la propagation de futurs risques pour la santé comme Covid-19? Quels nouveaux critères de conception seront ajoutés à notre liste déjà croissante de considérations clés dans l'ingénierie de l'infrastructure sur laquelle repose toute la société? Et n'oublions pas, les considérations relatives au changement climatique n'en sont qu'à leurs débuts. L'ingénierie doit être en première ligne de ces défis!
Nous ne pouvons pas prédire à quoi ressemblera l'avenir, mais plus que jamais, une organisation comme l'ICI aura un rôle de plus en plus important à jouer. Nous croyons que notre mandat de soutenir l'excellence et de partager les connaissances sur la pratique du génie est essentiel face à ces nouveaux défis.

Cela dit, nous sommes heureux d'annoncer que l'ICI (eic-ici.ca/fr) demeure actif et en croissance, renforçant notre capacité à remplir notre mandat et notre pertinence en tant qu'organisme représentant plusieurs sociétés techniques. Les activités de notre programme de formation continue, dans le cadre duquel nous accréditons des prestataires de formation de qualité, restent solides car beaucoup font la transition de leurs offres vers la prestation en ligne. Bien que notre gala ait été reporté à l'année prochaine (24 avril), les lauréats de notre programme de récompenses témoignent d'un autre groupe exceptionnel d'ingénieurs excellant dans leurs domaines d'activité avec un leadership de classe mondiale. Le comité d'histoire et d'archives poursuit activement un projet d'entrevues d'histoire orale afin d'élargir et de conserver d'importantes preuves de l'excellence en ingénierie.

Les possibilités d'accroître notre pertinence se trouvent dans les efforts de notre Comité de planification stratégique des conférences qui tente d'établir des liens avec des organismes externes d'intérêt dans notre domaine d'intérêt thématique – le développement durable des infrastructures dans le Nord. Nous examinons la renaissance potentielle du Forum canadien de leadership en ingénierie, un regroupement voulant combiner l'expertise et la voix des principales organisations d'ingénieurs du Canada pour travailler ensemble à façonner l'avenir de et faire progresser la profession d'ingénierie au Canada.

LICI offre également un excellent site de carrières en génie (www.engineeringcareers.ca/?locale=fr_ca) qui s'adresse spécifiquement aux chercheurs d'emploi au sein de la communauté du génie et aux organisations qui cherchent à embaucher des professionnels de l'ingénierie de qualité. Des remises intéressantes sont disponibles pour plusieurs placements d'annonces. Pour connaître comment placer des annonces, cliquez ce lien (employers.engineeringcareers.ca/?locale=fr_ca).

Et enfin, nous sommes heureux d'annoncer que l'ICI a pris de l'expansion au cours de la dernière année grâce à l'ajout de deux nouvelles sociétés constituantes : l'Association canadienne des tunnels (TAC) et le Comité national canadien de l'Union internationale de la radio-science (URSI Canada). C'est un vote de confiance dans la pertinence que d'autres voient dans l'ICI.

La fédération de l'ICI est désormais composée des sociétés constituantes suivantes:

- Association canadienne des barrages: www.cda.ca/FR
- Société canadienne de géotechnique: cgs.ca/index.php?lang=fr
- Société canadienne de génie médical et biologique (SCGB): www.cmbes.ca
- Comité national canadien de l'Union radio-scientifique internationale (URSI Cda): ursi.ca
- Société nucléaire canadienne (SNC): www.cns-snc.ca
- Société Canadienne de génie agroalimentaire et de bioingénierie (SCGAB): www.csbe-scgab.ca
- Société canadienne de génie chimique (SCGCh): www.cheminst.ca/about/about-csche
- Société canadienne de génie civil (SCGC): csce.ca/fr
- Société canadienne de gestion en ingénierie (SCGI): www.csem-scgi.org
- Société canadienne de génie mécanique (SCGM): www.csme-scgm.ca
- Société canadienne des ingénieurs seniors (SCIS): seniorengineers.ca/csse
- Institut des ingénieurs électriciens et électroniciens - Cda (IEEE Cda): www.ieee.ca/fr
- Institut des ingénieurs industriels et de systèmes - Cda (IISE Cda): www.iise.org/Details.aspx-?id=13558
- Association canadienne des tunnels (ACT): www.tunnelcanada.ca

Cordialement,

Reg Andres, ing., FEIC Président 2018-2020
Institut canadien des ingénieurs

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