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

FALL/AUTOMNE 2015

BULLETIN

SPECIAL ISSUE ON

Technology & Climate Change

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This issue, and new editor(s) for 2016

I'm delighted to introduce the fall 2015 issue of the CSME Bulletin.The feature focus of the issue is technology and climate change, an important and timely topic with the 2015 United Nations Climate Change Conference in Paris.The engineering community, and to a large extent the mechanical engineering community, play a central role in the climate change challenge both in terms of its historical origins and future mitigation. That is, increased CO_2 emissions are largely a product of industrialization, and it is difficult to imagine any viable solution in which technology does not play a central role. Four entries in this feature cover a broad spectrum of energy technologies with climate implications, with three of the four voices coming from Canadian industry. This issue was possible with leadership from my guest editor, Payam Rahimi (formerly with University of Alberta and currently with Ontario Power Generation) who leads off the discussion.

Our Canadian research highlights compiled by technical editors, Profs. Amy Bilton and Brendan MacDonald, also have an energy theme. Entries include the design of a hydro-kinetic turbine for run-of-river hydroelectricity generation, and the prospect of generating fuel from chicken litter.

CSME student chapters have been very active this year. Established student chapters at McGill University, University of Alberta and Western University continue to grow and serve their members and the Society in new ways. It has also been great to see new student chapters emerging across Canada, including at York University, University of Ontario Institute of Technology, and Memorial University of Newfoundland. Prof. Xiaohua Wu reports on these recent student chapter activities. We also highlight the results of the 2015 CSME National Design Competition and congratulate teams from Lassonde School of Engineering and Concordia Engineering.

Moving west-to-east, it is Ontario's turn for the New Faculty Spotlight series. Due to the large numbers of mechanical engineering departments in Ontario, and particularly in southern Ontario, we chose to highlight outstanding new faculty at Western University (Prof. Aaron Price) and the more easterly Queen's University (Profs. Clair Davies and Michael Rainbow). There is a biological theme to their research, from biomechatronic materials, brain imaging to improve accessibility, and musculoskeletal mechanics.

The Alumni Q & A in this issue features Matai Ghelesel, president and owner of Sonic Enclosures Inc. Matai is a great role model for entrepreneurial students. His own career path is remarkable, a testament to the value and flexibility of a mechanical engineering degree.

Last but certainly not least, in lieu of a Chair's Corner entry in this issue, we thank John Plant for his many contributions to the engineering community in Canada and the CSME in particular. John was honored, appropriately, at the most recent Engineering Institute of Canada meeting, and his many contributions are highlighted here by President Elect of the EIC, Richard Bathurst. Thank you John for all you've done.

Lastly, I'm stepping aside after this issue. The Bulletin has changed a great deal over the past two years, and it is time for fresh eyes and expertise. It is also the right time as we welcome new leadership within the CSME. While I'm proud of the many successes of the new Bulletin, I encourage the next editorship to improve further by incorporating a mix of French and English content - perhaps via two co-editors. Thank you to all who have worked closely with me in shaping the Bulletin: Prof. Brendan MacDonald, Prof. Amy Bilton, and especially the talented Sigrun Wister.

Enjoy the special issue,

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

President's Message

IN THE PAST YEAR AS THE PRESIDENT OF CSME, I HAVE BEEN FORTUNATE TO work with a number of talented and dedicated mechanical engineers in our society. We had a great year full of enthusiasm and success. Three of our high caliber members, Drs. Khajepour, Sinton, and Zhu, were inducted as fellows of the Engineering Institute of Canada (EIC) at the 2015 EIC awards gala for their significant contributions to the engineering profession. In addition, our CSME Honours, Awards, and Fellowships Ceremony was held on the campus of Western University during CANCAM 2015. Four well-deserved CSME members at various stages of their careers shared two medals and two awards. We also inducted four new CSME Fellows. Furthermore, Dr. John Plant received the CSME President's Award for his long-term contributions to the society. Many thanks go to Dr. Floryan and his colleagues at Western University for hosting this exciting event of celebration. I would like to take this opportunity to welcome Mr. Guy Gosselin as our new Executive Director and Mr. Baktash Hamzehloo as our Vice President-Quebec region. The society has significantly benefitted from their contributions in the past few months.

Like any other professional organization, the membership base is very important for the society's long-term stability. For CSME this becomes even more critical as it represents the unified voice of Canadian mechanical engineers. In order to reach out and further expand our society, we have formed the Membership Drive Committee, composed of industrial and academic members, to systematically look into our statistical database and plan for attracting new members from industry, academia and government. We count on your help to further support our society (and this newly formed committee) by engaging new members from your professional network, which is essential for the long-term sustainability of this national organization for mechanical engineers. Please share your thoughts with us for a vibrant mechanical engineering society.

Finally, I would like to invite you all to participate and network with fellow engineers at the CSME International Congress in beautiful Kelowna, BC, from June 26-29, 2016.

Sincerely yours,

ALI DOLATABADI,
PhD, PEng, FCSME, Professor and Concordia University Research Chair – Tier I, Department of Mechanical and Industrial Engineering, Concordia University

Message du président

À TITRE DE PRÉSIDENT DE LA SCGM, J'AI EU LA chance au cours de la dernière année de travailler avec plusieurs ingénieurs mécaniques talentueux et dévoués au sein de notre société. Nous avons eu une année excitante et prospère. Trois de nos membres de haut calibre, les professeurs Khajepour, Sinton et Zhu ont été établis dans leur fonction de Fellow de l'Institut canadien des ingénieurs (ICI) pour leurs contributions importantes à la profession d'ingénieur lors de la soirée de gala 2015 de l'ICI. De plus, notre cérémonie de remise de prix et distinctions ainsi que de fellowships a eu lieu au campus de l'Université de Western pendant le congrès CANCAM 2015. Quatre membres méritants de la SCGM ont partagé deux médailles et deux prix et quatre nouveaux Fellows ont été installés. De plus, le Professeur John Plant a reçu le prix du Président de la SCGM pour ses nombreuses contributions à la société. Nous remercions le Professeur Floryan et ses collègues de l'Université de Western d'avoir été les hôtes de cet événement festif. J'aimerais profiter de l'occasion pour souhaiter la bienvenue à notre nouveau directeur général, Monsieur Guy Gosselin et notre vice-président de la région de Québec, Monsieur Baktash Hamzehloo. La société a grandement bénéficié de leurs contributions au cours des derniers mois.

Comme pour n'importe quelle association professionnelle, ses membres sont essentiels à sa stabilité à long terme, et pour la SCGM ceci est encore plus important, car ces derniers expriment l'opinion des ingénieurs mécaniques Canadiens. Pour étudier cette question, nous avons formé un comité composé de membres des milieux académique et industriel afin d'examiner nos données statistiques et trouver une façon d'attirer de nouveaux membres venant des milieux industriel, académique et gouvernemental. Nous comptons sur votre aide pour soutenir notre société (et ce nouveau comité) en attirant de nouveaux membres de votre réseau professionnel, car ceci est crucial pour la survie à long terme de cette organisation nationale pour les ingénieurs mécaniques. N'hésitez-pas à partager vos idées avec nous afin de conserver la vivacité de notre société.

En conclusion, je vous invite tous à participer et échanger avec vos collègues ingénieurs lors du congrès international de la SCGM qui aura lieu dans la belle ville de Kelowna en Colombie-Britannique du 26 au 29 juin 2016.

Sincères salutations,

Special Issue on Technology and Climate Change

I'm delighted to serve as a guest editor, bringing you the special issue on technology and climate change. The issue focuses largely on the industry perspective and owes much to the Climate Change Technology Conference earlier this year. Even though today's news is full of a wide range of issues worldwide, climate change is emerging as the grand global challenge of our time. Based on a 2009 report by the Global Humanitarian Forum, set up by former UN Secretary General, Kofi Annan, climate change is already responsible for 300,000 deaths a year and is affecting 300 million people.

While views on technology as related to climate change – both in terms of causes and solutions – vary widely, it is clear the mechanical engineering community has a critically important role to play in our collective energy future. Specifically, we need engineers to reduce/reverse the impact of our activities on the environment, provide alternative sources for our tremendous thirst for energy, and offer solutions to the impacts of the global warming.

From my perspective, one of the technologies that can help us reduce greenhouse gases as a result of energy production is nuclear. I recommend a thought-provoking documentary about the nuclear industry called "Pandora's Promise" which offers a comprehensive view of nuclear technology and addresses some widely held myths. While the recent nuclear disaster in Fukushima is top of mind, it is noteworthy from an engineering perspective that it was not as a result of an inherent flaw in nuclear technology. Rather, the plant was designed to withstand waves of 10-m height, but hit with 15-m waves during the tsunami after the earthquake. The nuclear industry is actively addressing beyond-design-basis accidents as a result of this event. I hope to provide you a summary of these nuclear safety design efforts in a future issue. In this issue, I'm delighted to have Paul Frenger's insight into the emerging technology of thorium molten salt reactors.

Another aspect that needs the attention of the mechanical engineering community is coal. Coal plays a central role in electricity generation worldwide - over 40% globally according to the World Coal Association. While coal use in Canada is likely to decline going forward, this is not the case for much of the world. Particularly many populous developing regions rely almost exclusively on coal for electricity critical to their economies and ultimately their development. Replacing coal as the source of electricity generation is not currently feasible for many regions, and coal will remain a large component of the global energy system for the foreseeable future. Bruce Peachey addresses the global future of coal and technological opportunities for the mechanical engineering community in his feature entry.

And finally, energy storage technologies are getting more traction every day. Large scale electrical energy storage has the potential to address many of the problems associated with wind, solar, and nuclear energy while providing options for energy surplus, electrification of road transport, short capacity, and export potential. Wind and solar are often being suggested as preferred renewable energy sources, but currently they can't generate the amount of base electricity to replace fossil fuel sources. In addition, wind and solar are both intermittent and still relatively expensive. In another of our feature articles, Dr. François Bouffard addresses new technologies for energy storage from renewables.

The featured topics here are just a fraction of what is happening in Canada and around the world but we hope it inspires you to think about the role of mechanical engineering in the fight against climate change. Also, please note that the comments expressed in this and all feature articles in the Bulletin are those of the authors, and do not necessarily reflect those of the Bulletin or the CSME. We would love to hear your thoughts on the feature articles, as well as additional views you would like represented in future issues (to BULLETIN@CSME-SCGM.ca).

This is the first time I contributed to the CSME Bulletin. It was a great experience and made me aware of the effort and passion that goes into each issue. All with the hope that you find the Bulletin a good source of information, inspiration and connection with the Canadian mechanical engineering community. Thank you to the editorial team for letting me contribute to this issue and their dedication and hard work in creating the Bulletin.

PAYAM RAHIMI
PhD, PEng, FCSME, Senior Technical Officer, Ontario Power Generation
Sessional Instructor, University of Toronto

We would love to hear your thoughts on the feature articles, as well as additional views you would like represented in future issues to bulletin@csme-scgm.ca

call for

CSME

AWARDS NOMINATIONS 2016

Nominations are solicited for the 2016 awards and honours of the Canadian Society for Mechanical Engineering (CSME), which aim to recognize and honour deserving members of the Society and the mechanical engineering community.

HONOURS AND AWARDS

1) The **I. W. Smith Award** was established in 1977 to honour Professor I. W. Smith who devoted a lifetime to teaching mechanical engineering at the University of Toronto. It is awarded annually for outstanding achievement in creative mechanical engineering within 10 years of undergraduate graduation.
2) The **G.H. Duggan Medal** was established in 1935 to honour Dr. G.H. Duggan who was president of the Engineering Institute of Canada (EIC) in 1916. It is awarded annually for the best paper dealing with the use of advanced materials for structural or mechanical purposes. (revised 1983)
3) The **Robert W. Angus Medal** was established in 1957 to honour the late Robert W. Angus who was for many years Professor of Mechanical Engineering at the University of Toronto. It is awarded annually to a Canadian engineer for outstanding contributions to the management and practice of mechanical engineering. (revised 1993)
4) The **Jules Stachiewicz Medal** was established in 1983 to honour the late Jules Stachiewicz who was for many years Professor of Mechanical Engineering at McGill University. It is awarded alternately by the Canadian Society for Chemical Engineering (CSChE) and the CSME for outstanding contributions to heat transfer in Canada. This award will next be presented by CSME in 2017.
5) The **C.N. Downing Award** may be presented annually to a member of the Society for distinguished service to CSME over many years.
6) The title, **Fellow of the CSME**, may be awarded to members in good standing with uninterrupted membership in the society for at least 3 years, who have attained excellence in mechanical engineering and who have contributed actively to the progress of their profession and of society.
7) A **Certificate of Service** may be awarded to CSME members in recognition of outstanding service to the Society in a particular capacity.

NOMINATIONS

Nominations should be addressed to the Chair of the HAF Committee, and in time to reach the CSME office by **January 31, 2016**:

Chair, Honours and Awards Committee,
Canadian Society for Mechanical Engineering
P.O. Box 280
Merrickville, ON, K0G 1N0

Email: ggosselin.eic@gmail.com
Tel: (613) 796-4750

PLEASE ENSURE TO INCLUDE THE FOLLOWING IN THE NOMINATION PACKAGE:

a. A completed nomination form showing the nominee's name, occupation, position, title, affiliation, CSME membership number, and full address and contact information (including telephone and email). The CSME 2016 Awards Nomination Form is available on the CSME website.

b. The nominee's CV.

c. A nomination letter from the nominator indicating the nominee's principal contributions and the reasons the nominee merits the award.

d. A draft citation for the nominee (125-150 words), which is intended for use in announcing the award recipient and publicity should the nomination be successful.

e. The nominator's name, position, title, affiliation and full address and contact information (including telephone and email).

f. Two letters of support for the nomination from members or fellows of the CSME, along with their names and addresses (including telephone and email).

Thorium molten salt reactors

BY PAUL FRENGER

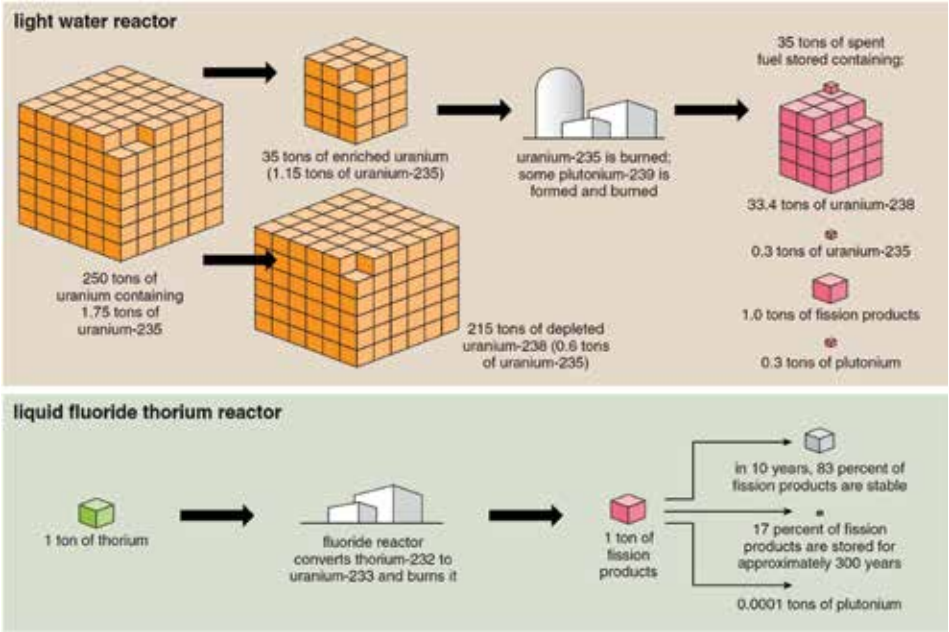
A Working Hypothesis Inc., Houston, Texas, USA

At this year's EIC Climate Change Technology Conference in Montreal [1], I argued that Thorium-powered Molten Salt Reactors (MSR) best embodied the concept of "green energy". This was due to their conservation of scarce resources, absence of greenhouse gases (CO_2) and reduced production of other pollutants. MSR technology is "walk away safe" since physical laws will keep the reactor under control. Even more intriguing, MSRs could burn nuclear wastes from conventional Pressurized Water Reactors (PWRs) and Boiling Water reactors (BWRs), thereby mitigating dangerous long-lived isotopes. Other fuels for MSRs include non-radioactive isotopes such as depleted Uranium (U-238) and other heavy metals, thus conserving the scarce fissile isotope U-238.

Thorium is a slightly radioactive metal, existing as Th-232 in nature, with a half-life of 14 billion years. Th-232 can be transmuted by capture of a slow neutron into U-233 which is fissile. Thorium does not need to be "enriched" as Uranium does, and fuel rod fabrication is unnecessary in a MSR, which saves money, energy and potential radioactive contamination [2].

Thorium-based reactors can be built in many ways, especially MSRs which have several beneficial design features. First, they operate at atmospheric pressure so that devastating explosions don't occur. Second, the fuel is already molten so that core "meltdown" is not a risk. Third, they have a negative fuel temperature coefficient of reactivity, giving a passive safety profile. MSR designs include an actively-cooled reactor freeze plug that will melt if electrical power is lost, gravity-draining the fuel-salt mixture from the reactor into storage tanks where the geometry inhibits an ongoing chain reaction.

MSR technology was pioneered in the U.S. Aircraft Reactor Experiment in 1954 and the Molten Salt Reactor Experiment 1965-1969, operated at criticality using U-235 and U-233 from Thorium for 17,655 hours. These were small reactors with a core volume of under 2 m^3, but upward scalable. Issues of salt composition, construction metals selection to avoid corrosion, coolants, moderators, neutron reflectors, breeder designs and overall safety were explored in these experiments half a century ago.



*SCHEMATIC ILLUSTRATING THE DIFFERENCES IN VOLUME OF MATERIAL REQUIRED FOR URANIUM (UPPER) AND THORIUM (LOWER).

Thorium MSRs are 30% more efficient than coal or natural gas plants. They can be operated continuously, not requiring prolonged shutdowns since fresh fuel can be added as needed and waste products can be removed from the molten salt round-the-clock by chemical scrubbers.

At the 2013 EIC Climate Change Technology Conference, University of Toronto Professor Peter Ottensmeyer advocated using IFR reactors to burn up nuclear wastes [3]. He gave three reasons for doing so. First, this would alleviate the problem of what to do with the 370,000 tons of high-level nuclear waste products worldwide that will otherwise require millennia of safe storage. Second, the energy content of these wastes, if burned with stockpiles of worthless depleted Uranium (U-238), would produce about US$ 2.3 quadrillion worth of electricity (enough to last between 500-1000 years for the entire world). This electricity would be generated with no significant release of CO_2; saving the biosphere about 19 trillion tons of this greenhouse gas if the electricity had come from coal-fired power plants (over 6 times the current load of carbon dioxide present in the atmosphere). Finally, not having to excavate fuel ores would spare the environmental pollution of mining.

A Uranium reactor requires 800,000 tons of ore, giving 250 tons of Uranium (but only 1.15 tons fissionable U-235). Enriched to reactor-grade, 35 tons of fuel are produced and 215 tons of U-238 is a by-product. After burning, 35 tons of highly radioactive waste is produced that must be safely stored for about 10,000 years. For a Thorium reactor, 200 tons of ore yield 1 ton of fertile Th-232. This is converted to fissionable U-233 which is burned with wastes from other reactors, giving 1 ton of fission products (but no actinides, Plutonium or depleted Uranium). Within 10 years, 83% of this waste becomes safe; and the remaining 17% will become safe within 300 years.

Many of these nuclear power reactors were successfully tested in the 1950's and 1960's. They were largely abandoned for political, military or commercial reasons that are no longer relevant. Efforts to revive Thorium nuclear power on a massive scale are underway [4].

REFERENCES

[1]FRENGER, P. "THORIUM – THE GREENEST NUCLEAR POWER", 4TH CLIMATE CHANGE TECHNOLOGY CONF, MONTREAL, CANADA, 2015, PG.56-57.
[2]KAZIMI, M., "THORIUM FUEL FOR NUCLEAR

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The University of Manitoba is a place where you can define your future and your career. Our commitment to discovery and community encompasses everything we do, from the education we offer students to the workplace we create for staff.

The University of Manitoba offers excellent benefits, world-class facilities and an inspirational environment where you can shape your career and make a positive impact every day.

Tier 2 Canada Research Chair (CRC) in Additive Manufacturing Materials and Processes

The University of Manitoba is seeking applications for a Tier 2 Canada Research Chair (CRC) in Additive Manufacturing Materials and Processes. These chairs were established by the Government of Canada to foster world class research excellence in Canadian Universities **(www.chairs.gc.ca).** With a reduced teaching and administrative load, the Chair will be expected to pursue a vigorous research program in the field of additive manufacturing of metals and ceramic materials and processes based in the **Department of Mechanical Engineering** in the Faculty of Engineering. The CRC chair has been created to take advantage of a new state-of-the-art University characterization facility **(www.materials.umanitoba.ca)**, which has been funded through partnerships with SFR, FEI, GE, CIC, Western Economic Diversification, the Province of Manitoba and the University of Manitoba, and in addition an extensively equipped Department of Mechanical Engineering Materials and Manufacturing laboratory. The addition of this Chair will be a critical step in building capacity and establishing a world-class research environment in the University of Manitoba's strategic priority area of New Materials and Technologies.

The ideal candidate should have a record of research excellence in the field of process design in additive manufacturing of metals and ceramics, hold a doctoral degree in Mechanical Engineering, Materials Science and Engineering, or Metallurgical Engineering, and be eligible for registration with the Association of Professional Engineers and Geoscientists of Manitoba. The position represents an exciting opportunity for individuals who are emerging scholars with demonstrated potential of becoming recognized internationally as leaders in their field and who are currently in the rank commensurate with CRC guidelines (for eligibility consult **http://www.chairs-chaires.gc.ca/program-programme/nomination-mise_en_candidature-eng.aspx#s2**). In addition, the individual should: have a superior record of attracting and supervising graduate students and postdoctoral fellows and, as a chairholder, be expected to attract, develop and retain excellent trainees, students and future researchers; and be proposing an original, innovative research program of the highest quality. The position represents an exciting opportunity for an outstanding and innovative researcher whose accomplishments have made a major impact in Additive Manufacturing.

The Department of Mechanical Engineering is a research intensive department that is comprised of 30 academic staff, 15 support staff and over 30 postdoctoral fellows, visiting scholars and adjunct professors. It offers an accredited undergraduate program in Mechanical Engineering, with over 500 students. The Department has a strong graduate teaching and research program with over 120 graduate students in its PhD, MSc and MEng programs. It maintains funded research activities with industrial partners and government research laboratories, and is home to a Canada Research Chair and a NSERC Industrial Research Chairs. Additional information can be found at our website: **http://umanitoba.ca/faculties/engineering/departments/mechanical/index.html**

The University of Manitoba is the province's largest, most comprehensive and only research-intensive post-secondary educational institution. It is home to a wide range of research centers and institutes. For more information, please see: **http://www.umanitoba.ca/about**

The University of Manitoba is located in Winnipeg; a prairie city with a population exceeding 700,000. Its ethnic diversity is notable and is celebrated through its many annual Festivals. Experience Winnipeg's world-class arts and entertainment, and professional sports teams. Winnipeg boasts a balanced lifestyle with affordability; the Winnipeg housing market is one of the most favorable in Canada. Winnipeg is located close to superb outdoor recreational activities with a wide variety of lakes, beaches, and wilderness areas within an easy drive from the City. For more information about the city of Winnipeg visit: **https://destinationwinnipeg.wordpress.com/** and **http://www.winnipeg.ca/interhom/**

Review of applications will commence on December 15, 2015 and will continue until the position is filled. Applications including complete curriculum vitae, a statement of research interests, a sample of 3 peer-reviewed publications, a statement of their teaching philosophy, names of three referees and contact information should be sent via email, referencing **Position Numbers: 21228/21229** to: **David Kuhn, Professor and Head, Department of Mechanical Engineering, C/O Ms. Kris Nabess, Department of Mechanical Engineering, University of Manitoba, E2-327 EITC, 75A Chancellors Circle, Winnipeg, Manitoba, Canada R3T 5V6, Email: Kris.Nabess@umanitoba.ca**

Application materials will be handled in accordance with the protection of privacy of the *"Freedom of Information and Protection of Privacy Act"* (Manitoba). Please note that curriculum vitae and other documentation may be provided to participating members of the search process.

Note that all Chairs are subject to review and final approval by the CRC secretariat.

The appointment will commence in late 2016 or as may be mutually agreed upon. Salary will be commensurate with qualifications and experience.

The University of Manitoba is committed to creating a diverse and inclusive workplace. Applications are encouraged from qualified applicants including members of visible minorities, Aboriginal peoples, persons with disabilities and people of all sexual orientations and genders. All qualified candidates are encouraged to apply; however, Canadian citizens and permanent residents will be given priority.

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please visit: umanitoba.ca/employment

2015 MANITOBA'S TOP EMPLOYERS

UNIVERSITY OF MANITOBA

Is there a "greener" future for coal? — There had better be!

BY BRUCE PEACHEY, FEIC, FCIC, PEng, New Paradigm Engineering Ltd., Edmonton

THE GLOBAL FOCUS ON GREENHOUSE Gas (GHG) emissions has made it "politically incorrect" to discuss coal fueled power generation in developed countries, and past and current coal mining and power generation practices have deservedly been labeled as "dirty" and not just because of carbon emissions. Thousands of miners still die in underground coal mines every year, untold thousands more suffer from the effects of "black lung", and the internet is full of pictures of the dense and toxic air pollution that dominates industrial areas of developing countries like China. Mountain top removal and open pit coal mines have scarred the landscape in many parts of the world, and the majority of abandoned legacy mines (of all types) continue to cause environmental and health concerns long after they have ceased operation and the mining companies have disappeared. At the same time, simple cycle, pulverized coal plants are still the largest source of power generation in the world, and the number of plants in operation grows weekly. Globally, coal-fired power plants generate more energy than hydro, nuclear, renewables and natural gas combined. They are also still the lowest cost power generation process in the world. As a result of the widespread access to low cost coal resources and the relatively low capital cost of pulverized coal plants, coal consumption for power is still on the rise to meet the needs of growing economies. The Asia-Pacific region alone now consumes ~66% of the world's coal production, but this increase in coal power generation has also contributed to cutting the number of people living in poverty by half.

Some developed countries, like Canada and the U.S., have the luxury of being able to find lower cost solutions with cheap natural gas, or can afford to subsidize higher cost power generation systems based on nuclear, hydro, wind, solar, or other renewables. However, there are still over 1.3 billion people who live without a reliable power supply, and who can only look to coal to power their countries and raise their standard of living. Generally those developing countries also lack access to biomass, hydro, petroleum or other natural resources but do often have access to coal or peat. So if the developed countries are truly concerned about GHG emissions and ending poverty, then they should be looking to find a way to more sustainably generate lower cost and lower impact power from coal since it will not be going away. This article discusses why the Coal Industry's "Clean Coal" and other potential coal related options have failed to meet the need and to suggest that there potentially is a way to create a "greener" future for hundreds of millions of the Earth's inhabitants by using coal.

There are many options for accessing and generating power from coal.

Why did the "Clean Coal" Initiative Fail? Since the Kyoto Protocol was signed in 1997, developed countries who committed to reduce their emissions, and, even those, like the U.S., who did not sign the protocol, have been under pressure to reduce carbon emissions from "fossil fuel" sources. By the time Kyoto came into effect in 2005, growing concerns had also arisen about potential shortages of natural gas resources, concerns about nuclear power (reinforced later by the Fukoshima tsunami nuclear disaster in Japan in 2011), and declining numbers of good potential locations for hydroelectric dams, had made the world acutely aware of the rising demand and costs for power, and the need to find new alternatives but with lower carbon emissions. The coal industry proposed various "Clean Coal" processes and other potential sources of coal-based energy such as coal bed methane began to be evaluated. These options soon showed that they were not even viable options for rich developed countries much less for developing countries. Coal bed methane options only allowed access to limited amounts of the energy in coal seams, had large environmental footprints, and were not as economical to develop. Low gas production rate per coal bed methane well was another setback. The "Clean Coal" options, while more profitable for coal producers and coal transportation companies, encountered major barriers in that they:

- **rely on unproven and expensive carbon capture and storage;**
- **increase power costs to consumers;**
- **increase capital investment needed for power plants;**
- **increase volumes of coal mined per MW of power;**
- **increase consumption of water due to lower efficiency of power generation; and**
- **could not compete economically with pulverized coal or natural gas, which were also better able to be matched with intermittent solar and wind energy sources.**

Exploring a potential new road to "greener" coal. There are many options for accessing and generating power from coal. Most of these options have been extensively studied, and most have failed to be viable. The traditional methods of mining and pulverized coal power are the "dirty coal" sources the world would like to eliminate. "Clean coal" options have been evaluated and some projects even built, but have been shown to be uneconomical compared to now more plentiful sources of natural gas, and due to high costs and uncertainties associated with carbon capture and storage. Options to access methane which is naturally found in coal through coal bed methane and other methods cannot compete with the high volumes of gas produced from shale gas developments. The option that remains, almost totally unexplored, is in-situ bioconversion of coal to methane.

In-situ bioconversion of coal. Bioconversion of coal to methane and other materials is not new and has been going on naturally for millennia as beds of organic matter have gradually been digested and physically converted from layers of thick living bog or muskeg, to peat and eventually, with greater burial depths and time, into various types of coal resources.

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Energy storage systems for carbon footprint reduction

BY FRANÇOIS BOUFFARD

Department of Electrical and Computer Engineering, Trottier Institute for Sustainability in Engineering and Design (TISED), McGill University, and Group for Research in Decision Analysis (GERAD)

Historically, electric power systems have been developed with the assumption that energy storage systems were either too expensive or technically inadequate to play a major role in electric power systems. The poor energy conversion efficiencies of most legacy storage technologies and centralized, generation-driven utility planning have clearly been major barriers, which held back wider deployment. Aside from classic pumped-hydro storage power stations (such as the Sir Adam Beck Complex in Niagara Falls and the well-known Dinorwig power station in Wales), often built to help manage nighttime load in power systems with significant nuclear generation capacity, grid-side energy storage has had limited scope and range of applications up to now.

With the ongoing deployment of increasingly variable, intermittent, distributed and, most importantly, low carbon power generation from sun and wind, energy storage systems are finally gaining ground in the power industry. This evolution is coupled with significant progress in battery technology as well as in less conventional technologies, like compressed air energy storage.

In the Canadian context, two principal business cases for grid-connected storage have emerged.

Today's energy storage systems serve three main purposes in assisting power system operators and planners integrate more renewable energy sources, as shown in Figure 1. First, energy storage systems can assist with reserve and response services. In such cases, the storage technologies involved are able to help grids ride through fast-acting disturbances like major wind and solar power ramps, and when large numbers of wind turbines shut down quasi-simultaneously in high wind conditions.

In addition, energy storage systems are essential to provide bridging power in timescales of 10 to 60 minutes to assist with grid management and support. For these applications battery technologies dominate. Typical roles for storage here will involve short-term wind power generation balancing, network congestion relief and operating reserve provision.

Over longer time scales (beyond 1 hour), energy storage systems are tasked with bulk energy movements potentially spanning several hours. Applications here would include profit-driven energy arbitrage (i.e., buying and storing electricity when it is cheap and reselling it when its price is high) and intra-day energy shifting with the goal of reducing peak demands.

The main challenges for grid-side energy storage technologies at the moment and for the years to come are very similar to those encountered by the solar photovoltaics and wind power generation industries over the last decade. The main goal is to reduce manufacturing costs. At the same time, in the case of batteries, it is essential that manufacturers can roll out battery packs with potential for more charging/discharging cycles and less performance degradation due to repeated cycling.

In the Canadian context, two principal business cases for grid-connected storage have emerged. The first one is associated with improving the greenhouse gas emission performance and operating costs of power generation in off-grid communities and mining operations. Here, energy storage can be used, in combination with local wind power generation, as a partial substitute to local diesel-fired generation. Glencore's Raglan nickel mine in northern Quebec with its 3 MW wind turbine, 1.8 MW diesel units and a hydrogen-based storage system is a great example of such a hybrid diesel-wind-storage system.

Another business opportunity is within the Ontarian power market with its near zero (or even negative) energy prices at nighttime and very high prices during the day. Here storage operators can reap the benefits from the inherent inflexibilities of nuclear power and from the fact that the Ontario electricity market does not have a lot of spare generation capacity at peak times.

Last but not least, just like with all the other now mature renewable energy generation technologies out there, energy storage technologies will most likely benefit from some regulatory stimulus. This is why several jurisdictions in North America — e.g., in Ontario and California, — have launched energy storage mandates to stimulate further technological development, enable actual field deployments and attract investors. In California the energy storage mandate launched in 2014 was a great success with multiple bidders overshooting the mandate's target. The world is now watching to see if the exercise will deliver its promises as deployments begin.

FRANÇOIS BOUFFARD *is with the Department of Electrical and Computer Engineering at McGill University and the Group for Research in Decision Analysis (GERAD). He is also active with the Trottier Institute of Sustainability in Engineering and Design (TISED). His research is in the fields of power system modelling, economics, control and optimization.*

HIGHLIGHTS

Fuel from chicken litter

It is possible to generate a liquid fuel from chicken litter (i.e. chicken manure combined with waste bedding material) with the characteristics of fossil fuels. Refinement of chicken litter yields a liquid fuel similar to biodiesel or petroleum diesel, but with a higher boiling range, that could be useful for transportation.

Erik Tolonen and William Hallett from the University of Ottawa along with Carlos Monreal from Agriculture and Agri-Food Canada have investigated the evaporation characteristics of single droplets of a liquid fuel produced from chicken litter. Their experiments revealed that at temperatures of 500°C and above, a surface "skin" forms on the droplet which confines the underlying liquid so that internal vapour generation leads to bubbling and disruption of the droplet surface. They attribute this behaviour to polymerization of the surface which causes the confined liquid to reach higher temperatures. They observed that a solid residue remained after evaporation under most conditions. A computational model for the fuel evaporation was also developed and they found that it gave accurate predictions of droplet temperature and diameter during evaporation. Their work is an important step towards understanding the behaviour of this alternative liquid fuel.
—Technical Editor, Professor Brendan MacDonald

E. TOLONEN AND W.L.H. HALLETT, DROPLET EVAPORATION BEHAVIOUR OF A LIQUID FUEL FROM CHICKEN LITTER, FUEL, 2015, 139, 26-34.

INCREASED HYDRO-KINETIC TURBINE EFFICIENCY THROUGH INCLUSION OF A SHROUD

Can the efficiency of hydro-kinetic turbines be increased by including a shroud to encompass the rotor? This question has been investigated by the team of Mohammad Shahsavarifard, Eric Louis Bibeau, and Vijay Chatoorgoon at the University of Manitoba. They tested run-of-the-river hydro turbine configurations with and without shrouds of differing geometries to evaluate the influence of the parameters. These were tested in the water tunnel facility at the University of Manitoba where they observed a maximum 91% increase in power output over the unshrouded turbine system. This is contrary to the majority of literature which claims the main advantage of the shroud is a decreased sensitivity to flow direction. Their work also indicates that an overall system design should consider financial tradeoff between the size of turbine required and the inclusion of a shroud to meet the power output requirements. The influence can make a large impact on power generation for remote communities in Canada.
—Technical Editor, Amy Bilton

SHAHSAVARIFARD, M., BIBEAU, E. L., AND VIJAY CHATOORGOON. "EFFECT OF SHROUD ON THE PERFORMANCE OF HORIZONTAL AXIS HYDROKINETIC TURBINES." OCEAN ENGINEERING, 96, 2015, PP 215-225.

PHOTOS: CHICKEN, ISTOCK.COM, HYDRO-KINETIC TURBINE, V.CHATOORGOON

U of A CSME student chapter hosts oil and gas codes essentials course

UNIVERSITY OF ALBERTA CSME STUDENT CHAPTER AND MECHANICAL ENGINEERING CLUB FROM TOP TO BOTTOM, LEFT TO RIGHT 1ST ROW: JAKUB PIWOWARCZYK, ERIC HAMEL, TREVOR BAYNE, TJ CASSIDY, 2ND ROW: SPENCER ELLIOTT, JUSTIN LUTZ, SEAN CARLEY, KEVIN WICKENS, 3RD ROW (NEXT 5): MATT JAMIESON, ANNA SULIT, BROOKS ATLEY, CHANO HWANG, WILL SERINK 4TH ROW (BOTTOM 2, ON EITHER SIDE): SHO OKAMOTO, MUHAMMED KHAN PHOTO CREDIT: BROOKS ATLEY

The recent oil and gas codes essentials course at the U of A, was a huge success. The course was offered through collaboration of the CSME, International Pressure Equipment Integrity Association (IPEIA) and the Mechanical Engineering Club. We had a turnout of 133 people, an increase from last year. The increase can be attributed to the invitation of Northern Alberta Institute of Technology (NAIT) students. Feedback about the course was overwhelmingly positive, with several attendees coming up afterwards to express thanks. A welcome improvement over last year was the increase in food supplied for the event!

Thank you again to CSME for helping to fund this event. It's one of our most popular events throughout the year and a fantastic way for CSME and the mechanical engineering club to collaborate. We look forward on organizing more professional development events in the future. —*Adam Wasyliw*

CSME, A HOME FOR MECHANICAL ENGINEERING STUDENTS

(LEFT) SOME MEMBERS OF THE NEW MEMORIAL UNIVERSITY OF NEWFOUNDLAND CSME STUDENT CHAPTER

SOME MEMBERS OF THE NEW UOIT CSME STUDENT CHAPTER, FROM LEFT TO RIGHT: ABDULLAH ANSARI, NOORULLAH NOURI, AND ROHAN TONKALA.

UNDERGRADUATE AND GRADUATE STUDENTS in the mechanical engineering departments of Canadian universities have been actively engaging in CSME to seek support in their engineering career development and industry outreach. This year, CSME welcomed new student chapters from York University, University of Ontario Institute of Technology, and Memorial University of Newfoundland. These CSME student chapters are initiated by students under the guidance of their faculty advisors in accordance to the procedures outlined on the CSME website. CSME Board of Directors are delighted that our society has been able to provide a warm home and strong base for students to launch their mechanical engineer endeavors.

The CSME Board of Directors considers the activities of its Student Affairs Section as its core mission. Spearheaded by Professor Sushanta Mitra, CSME recently established the Student Activity Fund to provide support for the student member chapters to organize mechanical engineering related events. This new initiative has received strong participation and feedback.

With this CSME sponsorship, approximately thirty engineering students from all year levels at the University of British Columbia Okanagan gathered earlier this year for

PHOTO CREDIT: U OF A, CSME, BROOKS ATLEY, U OF NEWFOUNDLAND, BRIAN PEACH, UOIT CSME, NOORULLAH NOURI

a three-hour session on the fundamentals of AutoCAD with guest presenter Shari Tambasco. This workshop allowed students to become familiar with the interface of AutoCAD, which will be beneficial in their future coursework and employment. After the overwhelming success and positive feedback from both the presenter and the students, the CSME Chapter at Okanagan plans to hold another similar workshop next year that will be focused on more advanced AutoCAD features.

CSME also sponsored McGill University students' first annual MAME Industry Dinner this year. This event offered an opportunity for leading companies to engage with McGill mechanical engineering students on a more personal level than possible in a formal career fair. The event attracted six participating engineering companies including Schlumberger, TRU Simulations, RWDI Consulting, National Instruments, Pepsi Co, and MDA Satellites – including two CEOs.

CSME STUDENT CHAPTER EVENT AT MCGILL UNIVERSITY, SPONSORED BY CSME

Each of the six companies made presentations, followed by a networking session. During the event, students were able to have lengthy discussions with the industry representatives.

CSME was also pleased to sponsor the Oil and Gas Code Essential course organized by the Student Chapter at the University of Alberta. The course provided practical information on the application of codes in piping, pressure vessels, and the maintenance of safety in the oil & gas industry. Detailed topics included ASME codes, CSA standards, ABSA and Federal guidelines. Students also learned techniques on inspection and quality control, as well as case studies on incorporation of codes into pipeline design and pressure vessel monitoring (see separate article and pictures provided by the student group). *...continued on page 21*

PHOTOS: MCGILL UNIVERSITY CSME, IAN RICHARDSON, LASSONDE AND CONCORDIA STUDENTS: RALPH BUCHAL

AWARD CEREMONY AT THE 2015 CSME NATIONAL DESIGN COMPETITION ON 3D PRINTING. FROM LEFT: A. CZEKANSKI (CSME NATIONAL DESIGN COMPETITION CHAIR), A. BOUCAUD, M. AMIN, V. JAIN, R. MBABAALI, M. ROCHE, D. LAPOINTE, A. HEIDARI, A. ROUSSAC, A. DOLATABADI (CSME PRESIDENT). [NOT PRESENT: S. YOUNES, M. SILVERSTEIN, S. SMITH, R. PATEL, D. KRASTEV]

LASSONDE AND CONCORDIA STUDENTS WIN THE 2015 CSME NATIONAL DESIGN COMPETITION

Teams from Lassonde School of Engineering and Concordia Engineering took first place in this year's National Design Competition, hosted by the CSME. This year's design challenge was to engineer, build, and assemble a 3D printer designed within a fixed budget of $300. The awards were given out at the June CANCAM conference in London, Ontario.

The annual National Design competition run by CSME encourages undergraduate students to demonstrate creativity and innovation while showcasing their business development skills and grasp of design principles.

Despite the fixed budget, Lassonde and Concordia students produced high quality and low cost, functioning 3D printers. The challenge tested the students' business acumen, technical skills and design expertise. The proposed innovative design exhibited an integrated and elegant solution to the CSME challenge.

"Successfully building a printer that can print other [not space-related] components has not only increased my knowledge and interest in anything mechanical, but my personal confidence as a student engineer has grown significantly as well," says Alex Boucaud, team lead and fourth year Space Engineering student at Lassonde.

The 2016 National Design Competition is currently open to teams from educational institutions. Eight semi-final design projects will be selected and invited to the 2016 Canadian Society of Mechanical Engineering International Congress to present their designs and have a chance to win one of the grand prizes. —*Jane Iordakieva*

DEFINING THE NEXT
GENERATION UNIVERSITY

UNIVERSITÉ Concordia UNIVERSITY

FACULTY POSITIONS

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

TENURE-TRACK POSITION (ASSISTANT/ASSOCIATE PROFESSOR) IN AEROSPACE DESIGN ENGINEERING

The DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING at Montreal's Concordia University seeks outstanding candidates for a tenure-track position in the area of AEROSPACE DESIGN ENGINEERING with research interests which could include but are not limited to: aircraft and/or spacecraft design, propulsion system design, multi-disciplinary design optimization, structural analysis, stress analysis. A PhD degree in aeronautical/mechanical engineering or related discipline is required. Applications (electronic) must include a CV, teaching and research statements, and names of three referees. Applications should be submitted by December 31, 2015. More details at: **http://www.concordia.ca/encs/about/jobs.html**

TENURE-TRACK POSITION (ASSISTANT/ASSOCIATE PROFESSOR) IN THERMO-FLUIDS AND ENERGY ENGINEERING

The DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING at Montreal's Concordia University seeks outstanding candidates for a tenure-track position in the area of THERMO-FLUIDS AND ENERGY ENGINEERING with research interests which could include but are not limited to: fluid mechanics, heat transfer, wind energy, fuel cells, thermodynamics, combustion, propulsion, micro-fluidics, CFD. A PhD degree in mechanical engineering or related discipline is required. Applications (electronic) must include a CV, teaching and research statements, and names of three referees. Applications should be submitted by December 31, 2015. More details at: **http://www.concordia.ca/encs/about/jobs.html**

TENURE-TRACK POSITION (ASSISTANT/ASSOCIATE PROFESSOR) IN AERO-ELASTICITY ENGINEERING

The DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING at Montreal's Concordia University seeks outstanding candidates for a tenure-track position in the area of AERO-ELASTICITY ENGINEERING with research interests which could include but are not limited to: Aeroelasticity, aerodynamics, aeroservoelasticity, aircraft and aerospace structures, stress analysis, vibrations. A PhD degree in aeronautical/mechanical engineering or related discipline is required. Applications (electronic) must include a CV, teaching and research statements, and names of three referees. Applications should be submitted by December 31, 2015. More details at: **http://www.concordia.ca/encs/about/jobs.html**

TENURE-TRACK POSITION (ASSISTANT/ASSOCIATE PROFESSOR) IN ADVANCED MANUFACTURING

The DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING at Montreal's Concordia University seeks outstanding candidates for a tenure-track position in the area of ADVANCED MANUFACTURING with research interests which could include but are not limited to: Additive manufacturing, micro-machining, electro-chemical machining, welding, hydro-forming, powder sintering, coating and other non-traditional manufacturing processes. A PhD degree in mechanical or manufacturing engineering or related discipline is required. Applications (electronic) must include a CV, teaching and research statements, and names of three referees. Applications should be submitted by December 31, 2015. More details at: **http://www.concordia.ca/encs/about/jobs.html**

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

CONCORDIA.CA

For detailed information about working at Concordia, these positions, and deadlines, visit: concordia.ca/facultypositions

concordia.ca

"ONTARIO IN CANADA" BY TUBS

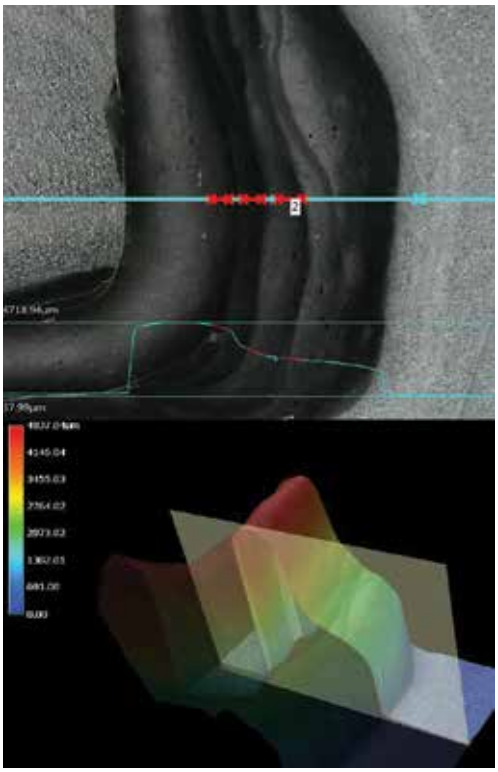
NEW FACULTY SPOTLIGHT SERIES:

FOCUS ON ONTARIO

This recurring series highlights some new Canadian ME faculty members, by region. We focus on Ontario in this issue. From west to east we have a new addition from Western University, Dr. Aaron Price, and two new additions from Queen's University, Dr. Claire Davies and Dr. Michael Rainbow.

University of Western Ontario Professor, **Aaron Price**

Discovering new smart materials for biomechatronic systems



AN EXAMPLE 3D PRINTED CONDUCTIVE POLYMER STRUCTURE (LEFT) PRINTED CONDUCTIVE POLYMER STRUCTURE (BELOW) DR. PRICE AT THIS YEAR'S CANCAM CONGRESS.

Smart materials exhibit unique physical responses to external stimuli such as heat, voltage or magnetic fields, and enable engineers to add innovative new features and functions to their designs. One well-known family of smart materials consists of electroactive conductive polymers. These soft materials change shape in response to an electric field, and can therefore be harnessed as actuators to perform mechanical work.

Due to the intractable nature inherent to those conductive polymers that exhibit significant actuation behaviour such as polypyrrole, conventional manufacturing techniques cannot be directly applied. Instead, active layers are directly deposited on planar surfaces in-situ via electro-polymerization. While this approach is well-suited for growing simple monolithic films of uniform thickness, it is unsuitable for the deposition of detailed planar or multi-dimensional patterns, and hence improved actuation behaviours that may be achieved through more complex shapes (due to additional actuation modes and reduced diffusion distances) are not yet realizable. This restriction to simple film geometries represents a significant barrier to the utility of conductive polymer actuators, and strategies to circumvent this obstacle through the manufacturing of more complex shapes are not yet realizable.

To this end, Dr. Price's research program aims to fabricate complex nanoscale conductive polymer actuator arrays by means of specially developed 3D printing technologies based on both radiation curing and thermochemical processes. Despite the ubiquity of commercial 3D printing systems, the lack of processable intrinsically conductive polymer materials currently inhibits the 3D printing of conductive polymer components. Furthermore, in the case of conductive polymer actuators, realization of the smallest possible component features is critical as diffusion distances often dominate actuator response times. Hence, Dr. Price's group ultimately seeks to formulate new conductive polymer materials and concomitant processes capable of feature resolutions in the sub-micron to nanoscale range.

The compliant nature of these materials and their ability to operate in ionic liquids lends to their frequent use in clinical biomedical applications. In this capacity, conductive polymer materials have been applied in tissue scaffolds, steerable catheters, biosensors, drug delivery systems, cell manipulators, and implantable nano-biotics. As a member of Western's Bone & Joint Institute and the Western Cluster of Research Excellence in Musculoskeletal Health, Dr. Price is currently engaged in applying these new technologies in the fields of pediatric rheumatology and orthopaedic surgery.

DR. AARON PRICE *began investigating smart materials in 2004 through an Institute of Robotics and Intelligent Systems project. In 2006 he completed a M.A.Sc. degree from the University of Ottawa. He received his Ph.D. in Mechanical Engineering at the University of Toronto in 2012, where he developed novel nanoscale EAP actuator technologies for adaptive optics systems. From 2011 to 2014 he was a member of ABB's Corporate Research Center in Germany. He joined the University of Western Ontario in January of 2015 where he leads the Organic Mechatronics and Smart Materials Laboratory.*

PHOTO: AARON PRICE

Queen's University Professor, **Claire Davies**

Increasing the independence of people with disabilities

DR. CLAIRE DAVIES HELPS POSITION A BRAIN-COMPUTER INTERFACE (EMOTIV) TO ACCESS A COMPUTER (ABOVE) AND SOME EXAMPLES OF EVOKED POTENTIALS MEASURED IN RESPONSE TO RECOGNIZING A FAMILIAR FACE.

Human performance is affected by perceptual, cognitive and physical limitations. Systems that recognize these limitations and are designed to minimize negative outcomes can improve function allowing the user to be less susceptible to failure. Dr. Davies focuses on increasing independence of people with disabilities. The most important focus is to keep the user at the centre of the design process, involving the end-user throughout to provide feedback and suggestions for improvement.

Understanding the perceptual and physical responses of all the senses, primarily vision, haptics and sound, has given her insight into how design of devices should be undertaken to create human-machine interfaces that are easily navigated and accepted. After spending several years designing to meet the needs of specific clients, she realized the need for universal design. Universal design is becoming increasingly popular such that devices should be easy to use by all people without the need for adaptation.

How does her research group set out to design systems that can be used by all? Measuring motion of people with and without disabilities can provide insights into the sources of movement differences among people, devices, conditions, and impairment levels. By fully understanding modes of access and different population groups, her group is developing generalized models of use that can identify those areas of difficulty that are common amongst all users. Understanding those issues can provide knowledge in the development of requirements and specifications for the design of systems that can allow for universal access. A truly universally designed system can enhance function for differing population groups and access modes.

DR. CLAIRE DAVIES *is an assistant professor at Queen's University in Mechanical and Materials Engineering where she also did her undergraduate degree. After completing her Master's degree at the University of Calgary, she worked at the Saskatchewan Abilities Council as a Rehabilitation Engineer before eventually returning to Waterloo for a doctorate. She has spent the last nine years in New Zealand, the last five of which she was a senior lecturer at the University of Auckland.*

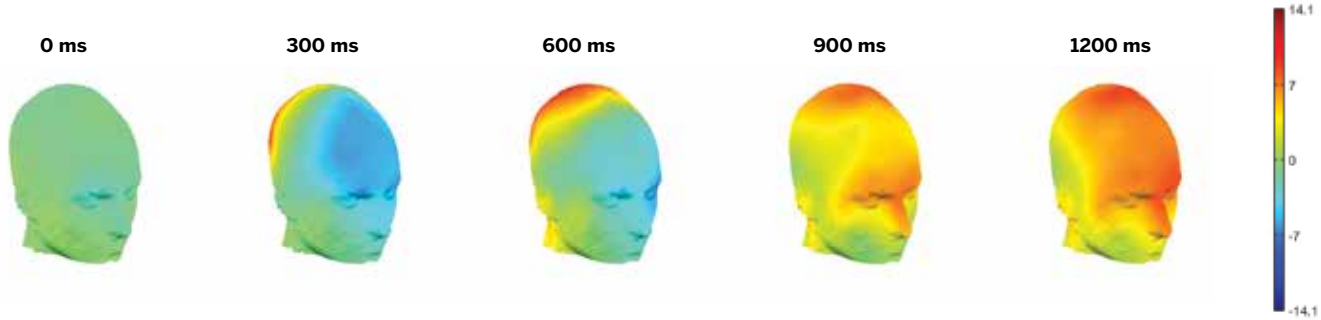
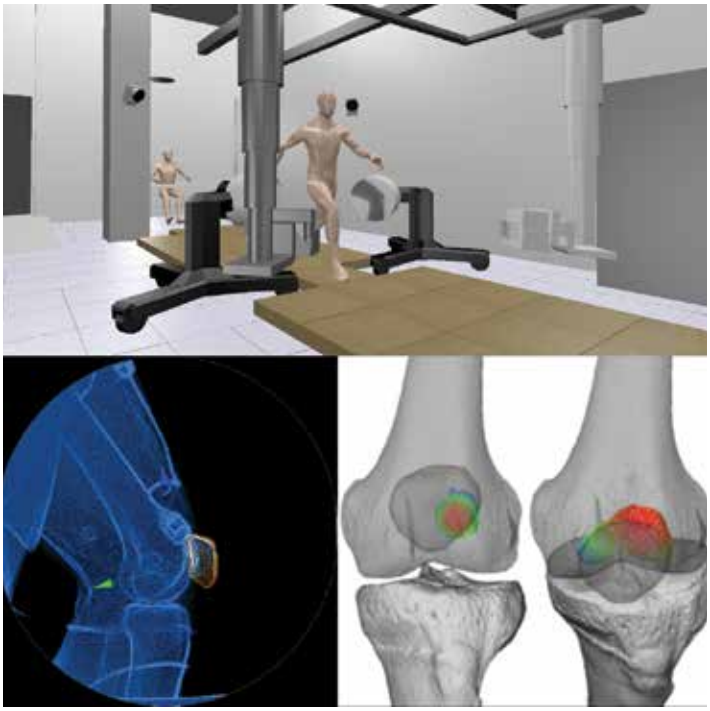


PHOTO: CLAIRE DAVIES

Queen's University Professor, **Michael Rainbow**

Discovering how an individual's unique anatomy and motion patterns protect from or contribute to musculo-skeletal overuse injuries.

DR. MICHAEL RAINBOW (LEFT) AND A RENDERING OF THE NEW HIGH-SPEED SKELETAL IMAGING LAB SLATED TO BE BUILT AT HÔTEL DIEU HOSPITAL (BELOW). THE LAB ALLOWS FOR THE HIGH-SPEED CAPTURE OF THE HUMAN SKELETON IN MOTION WITH EXAMPLES SHOWN.



When everything is working properly, humans can perform high-demand activities of daily living for more than 100 years. This rarely happens, and not surprisingly the greatest barrier to achieving this is pathology to the musculoskeletal system. Joints, which are critical elements for enabling complex movements between body segments, are remarkable in their ability to facilitate motion while transmitting large forces. The onset and progression of changes due to disease and injury interferes with this mechanical function and limits mobility and independence. Importantly, the inability to maintain an active lifestyle significantly decreases quality of life, limits ability to perform activities of daily living, and can lead to increased risk of other morbidities such as obesity and heart disease.

One reason musculoskeletal diseases remain among the most disabling and costly conditions in the world is a lack of information on whether clinical interventions effectively alter joint mechanics as intended. This lack of information is partly due to an inability to measure joint mechanics pre- and post-treatment and partly due to missing details on how a healthy joint mechanically functions. In order to answer these questions, dynamic measurements of the joints are required.

Dr. Rainbow's research program aims to directly measure a person's specific anatomy in motion while they perform high-demand activities of daily living. Precise data describing the motion of the skeletal system coupled with state of the art modeling approaches will provide clinically relevant functional assessments of joint health. Active engagement with clinical collaborators will ultimately enable the development of optimal treatment strategies tailored to the individual.

This work will be accomplished in the new, state of the art, High-Speed Skeletal Imaging Laboratory. High-speed skeletal imaging technologies can capture the three-dimensional motion of nearly any joint of the human skeleton during dynamic activities. The proposed High-Speed Skeletal Imaging Laboratory will be strategically placed at Hôtel Dieu Hospital, with access to patients. Dr. Rainbow's laboratory will be part of a cluster of researchers and clinicians in the fields of neuroscience, biomechanics, and exercise physiology.

DR.MICHAEL RAINBOW *received his PhD in Biomedical Engineering at Brown University. His interest in biomechanics began in a gymnasium, where he applied the principles of mechanics to the gymnastics skills he was practicing. During his graduate studies at Brown, he continued his work in the musculoskeletal system by developing a three-dimensional multi-articular model of the human wrist joint. Dr. Rainbow joined Queen's University in July, 2014 where he uses imaging and biomechanical modeling to gain a better understanding of the relationship between the structure and function of the wrist, foot and patellofemoral joint.*

PHOTO: DR.MICHAEL RAINBOW

Q&A:

Matei Ghelesel UBC Alumnus 2005, top 40 under 40: President of Sonic Enclosures

UBC ME graduate Matei Ghelesel talks to the Editor about his unique career path and perspective on ME education

SONIC ENCLOSURES CEO MATEI GHELESEL INSIDE ONE OF SEVERAL ELECTRICAL HOUSES CURRENTLY UNDER CONSTRUCTION AT SONIC'S DELTA BC LOCATION

PHOTO: JUSTIN ECKERSALL PHOTOGRAPHY

You graduated in 2001, then worked as an engineer and project manager at several companies, what were the big lessons from those experiences?

In the 12 years prior to acquiring I was fortunate to work internationally and over a number of industries. I think it's very important for people in the early stages of their careers to not be complacent and stay at one company or one division for too long. Diverse experience will give you what I call "range" to solve a multitude of issues not necessarily in your wheel house. The biggest lesson for me during this period was realizing that technical skills were important, but the common denominator with all of the Chief Engineers or VP's that I worked with was that they had good people skills-specifically being cool under pressure. When you truly appreciate that the people side of the equation is more important than the technical, you mentally sign up for a new world of learning and you will be humbled because with people 1 + 1 does not equal 2 like it does in engineering.

What aspects of your ME education were most useful in those early years?

Back to my previous comment, Mechanical Engineering is such a broad skill set that it enabled me to face many technical issues even in industries that were new to me. The problem solving process itself is ingrained in engineer's brains all the way through school and it's that keen desire to fix stuff that was most useful for me in the early years. You have to take it personally though and take pride in becoming the go-to on important issues. Stay late, work weekends buy your team lunch, make hats and have fun doing it.

You eventually moved from engineering roles into management and finance, what triggered that shift?

I'm an immigrant and after 12 years of technical I wanted more. I read lots of real-estate and finance books and learned about money and finance- the more I read the more I realized that owning and operating an asset was the only way to truly get ahead. Improving the financial performance of an investment property is very similar to improving the operations of a company- the biggest difference though is just about anybody can do the real-estate bit.

How is your ME education serving you in these management and finance roles (i.e. do you wish that you simply started with a business degree instead of an engineering degree?)

I played in a golf tournament with the Association for Corporate Growth; one of the fellows i golfed with was a Private Equity guy and what he said something that answers this question perfectly. "you can teach an engineer finance, but you can't teach a finance guy engineering". Engineering all the way.

In 2012 you purchased and grew Sonic Enclosures Ltd, which now employs nearly 100 people. Did the specific opportunity present itself, or did you first make a conscious decision to become a business owner?

MATEI GHELESEL PEng, PMP *is President and Owner at Sonic Enclosures Ltd, a 40 year old company in Delta British Columbia specializing in mobile metal enclosures and industrial equipment servicing. Prior to acquiring Sonic, he worked in engineering and management all over the world, at many companies including Westport, Harley Davidson, Oceanworks, Advanced Lithium Power and Prudent Energy. He has won numerous awards, including the Buisness in Vancouver top 40 under 40.*

I had managed several large projects in the lower mainland and I used Sonic as a supplier for about 6 years prior to acquiring it. I did in-fact consciously decide that I wanted to own Sonic so I simply asked Stan (the previous owner) if he'd like to sell. He said yes, and that was the beginning of a 2 year process to acquiring the business starting with being hired as his VP to run $17M job for Bechtel / Rio-Tinto Alcan.

Sonic Enclosures clearly has a mechanical focus, do you have any suggestions on how ME educators can better prepare graduates to advance your industry?
Our core business is manufacturing a metal building, which as you point out is largely a mechanical discipline. The stuff you put inside the box however is what determines the function/application of the product and we do more electrical houses than mechanical ones. System integration is the common thread- all of the issues are at the interfaces of systems, so any curriculum development that gives students a broader cross section of knowledge would benefit the work we do at Sonic. As the complexity of the systems being integrated goes up, so do the gross margins AND most importantly fewer people have the technical know-how to do the work so you become more and more specialized and sought after by your customers. You're also actively involved in the community.

How did you combine your work with the Children's Wish Foundation with your interest in sports cars?
My involvement with Children's Wish is a neat story- it literally was a fluke, but I'm having a ton of fun. After winning top 40 under 40, a fellow recipient of the award sent out a hand written note congratulating the other winners. I thought that was a nice touch so we had coffee, I was asked to come to the gala so I did, then I suggested we put a logo on the side of me and my brother's 2003 Ferrari 360 Spyder and participate in the Diamond Rally as a charity car rather than a private one like we had done in years prior. I was then paired with my little buddy Joey who is a wish kid and loves everything Ferrari and we had a goal to raise $25,000. We ended up raising nearly $70,000 (full details @ #joeyswish). We even got him a hat signed by Vettel and Raikonnen. We had such a blast. The Chair of the Local BC Chapter who heads up a very large benefits company in-town then asked if i'd like to join the board and be the chair of a new campaign called "More wishes more wonders." There is only one answer to that question- YES! I've met great people along the way and have been humbled on so many levels. We just recently raised another $37,000 for the More Wishes More Wonders campaign through our first annual Sonic Invitational Golf Tournament – a video is available on youtube.

Anything else you would like to share with the Canadian ME community?
We need to find a way to get more engineers on the tools and more trades folks on the computers. Every time my engineers brainstorm with my production crew on the shop floor BEFORE a design is started, amazing things happen. We need to stimulate this process more formally perhaps through curriculum development or government incentives to send engineers away to welding school! :)

Thorium Salt...continued from pg.7

ENERGY", AMERICAN SCIENTIST, SEPT-OCT 2003. [3] OTTENSMEYER, P., "NUCLEAR FUEL WASTE CONSUMED AND ELIMINATED: ENVIRONMENTALLY RESPONSIBLE, ECONOMICALLY SOUND, ENERGETICALLY ENORMOUS", EIC CLIMATE CHANGE TECHNOLOGY CONFERENCE, 2013, PAPER NUMBER 1569693995, PP.1-12. A [4] "THORIUM-FUELLED MOLTEN SALT REACTORS". THE WEINBERG FOUNDATION. JUNE 2013.

PAUL FRENGER *is an IEEE Senior Member, ACM Life Member, practicing physician and ex-USAF Lt. Colonel. Using computers since 1973, he has 200 papers, 3 patents, works in artificial intelligence, robotics, bioengineering and space science. He presented two papers at IEEE Green Technologies Conference in 2012, one in 2013 and one at the 2015 EIC Climate Change Technology Conference. He chaired IEEE Computational Intelligence Society in Houston since 2007 and Workshop on Automation and Robotics at NASA-Houston since 2008.*

Greener Coal...continued from pg.10

It is well known that bacterial communities degrade coal to generate methane or other precursor chemicals, and that the addition of nutrients will enhance bacterial growth and the rates of methane production. The major challenge to bioconversion methods is the long retention times required for bioprocesses, which make any bioprocess uneconomic when using large process facilities on the surface. However, abandoned, underground legacy coal mines still usually contain 40-50% of the original coal in place and can also serve as pre-constructed bioreactors for coal conversion. The same methods adopted by the oil and gas industry can be used to drill wells into selected parts of the mines, block off specific mine sections, inject nutrients, provide mixing, and remove and treat the biomethane for use in local power plants to replace coal combustion. A bonus is that many of the mines are already flooded with water, and waste heat and flue gases from downstream gas power generation units can be used to heat and charge the mines with CO_2 to speed up conversion. Nutrients could be any locally available streams of fish processing waste, feedlot waste, sewage, or byproducts from bioethanol, biodiesel or other bioprocesses.

Moving towards a "greener" coal future. What is now needed is for developed countries and researchers to focus on developing a greater understanding of biocoal processes and refine methods of accessing and enhancing the in-situ bioconversion of coal resources. This effort needs to focus on methods which will be economical for use by developing countries, and which can serve as a viable, easily scalable, and low-impact energy source that can be utilized wherever coal resources are available. At the same time the work must demonstrate that the negative environmental, health and societal impacts associated with conventional "dirty" coal can be eliminated or reduced to sustainable levels through in-situ bioconversion. All we as engineers have to do is to take up the challenge!

BRUCE PEACHEY *has over 35 years of experience in the oil and gas industry in Western Canada including roles at Imperial oil and Esso Resources Ltd. He is currently the President of New Paradigm Engineering Ltd. New Paradigm solves chronic problems for the oil and gas industry - problems requiring non-standard solutions, new insights, and innovation.*

CSME, a home for mechanical engineering students...continued from pg.13

The student chapter at the Western University hosted a CSME sponsored workshop, "Working in the HVAC Industry". Their invited guest speaker, Mounib Chadi, was a mechanical engineer graduate from Western. Since Mr. Chadi was a fairly recent grad, students found it was very useful to get his insights on his career to date. He discussed all of the co-ops/summer jobs he had during his university years as well as his work experiences after graduating. It was helpful to see how his career path was shaped by each of his work experiences. It was especially interesting for students to hear about his entrepreneurial experiences, and the important projects he had worked on at the HVAC industry. The event was attended by more than 100 undergraduate and graduate students.

The Board of Directors at CSME are determined to make continued efforts to help mechanical engineering students prepare and launch their future careers by providing a solid home base for our student chapters. For further information, please visit the Student Affairs entry on the CSME web site.

— Xiaohua Wu, FAPS, AFAIAA, and past Chair of CSME student affairs

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UPCOMING

RESEARCH FOCUS ISSUE

In the upcoming issue of the Bulletin we hope to feature recent Canadian ME grant funding awardees. The Bulletin welcomes your input on all things related to research funding in Canada

The Bulletin welcomes your input on this topic!
Please send comments, or suggestions to
bulletin@csme.sgra.com

UNIVERSITY OF WATERLOO
FACULTY OF ENGINEERING
Department of Mechanical & Mechatronics Engineering

Tenure-track Position in Thermal Engineering and Energy

The Department of Mechanical and Mechatronics, in the Faculty of Engineering at the University of Waterloo, invites applications from highly qualified candidates for a tenure-track position in thermal engineering and energy. Candidates will be considered at all levels, though preference will be given to individuals applying at the Assistant and/or Associate Professor levels.

The successful candidate will hold a PhD in Mechanical Engineering or similar discipline. Duties will include developing and maintaining an active and internationally recognized research program in one of the areas of, but not limited to, energy conversion, storage, transport, and efficiency. Duties will also include teaching at the undergraduate and graduate levels, and advising graduate and undergraduate students. To continue one of our historical research strengths in experimental, theoretical, or computational investigations of multi-scale heat transfer phenomena, we particularly encourage applicants with a background in multiphase/multiscale thermal-fluid transport processes and/or nano/microscale thermal sciences. Applicants must have excellent communication skills and a dedication to both teaching and research.

Applicants should send their full curriculum vitae, a concise research and teaching vision statement, and the names of three references to:

Dr. Jan Huissoon
Chair, Department of Mechanical and Mechatronics Engineering
University of Waterloo
Waterloo, Ontario, Canada N2L 3G1
Email: mmechair@uwaterloo.ca

Applications will be accepted until Dec 31, 2015, with an anticipated start date of May 1, 2016. The successful applicant is expected to have an engineering license for practice in Canada or to apply for an engineering license with Professional Engineers Ontario within five years of joining the University. The salary range for this position is $100,000 to $150,000 CAD. Negotiations beyond this salary range will be considered for exceptionally qualified candidates. Information about the Faculty, Department and Research Group can be found at www.eng.uwaterloo.ca, www.mme.uwaterloo.ca and at https://uwaterloo.ca/mechanical-mechatronics-engineering/research/thermal-engineering

The University of Waterloo respects, appreciates and encourages diversity. We welcome applications from all qualified individuals including women, members of visible minorities, aboriginal peoples and persons with disabilities. All qualified candidates are encouraged to apply; however, Canadian citizens and permanent residents will be given priority.

(LEFT TO RIGHT): A WARM RECEPTION FOR OUTGOING CSME AND EIC EXECUTIVE DIRECTOR JOHN PLANT AT THE ENGINEERING INSTITUTE OF CANADA AWARDS GALA IN MONTREAL 2015

A STANDING OVATION AT THE EIC GALA

GUY GOSSELIN WITH JOHN PLANT

Dr. John Plant retires as Executive Director of the EIC and CSME

It is difficult to imagine the day to day affairs of the Engineering Institute of Canada and the CSME not being in the capable hands of Dr. John Plant. But that time has come with John's decision to retire from his position as Executive Director of the EIC and the CSME earlier this year. John has served the EIC in this capacity with great distinction since 1999 and more recently as the Executive Director of the CSME since 2003.

John has had an outstanding career beginning with training as a Naval Cadet at the Royal Military College (RMC) of Canada, Kingston, Ontario, and the Royal Naval Engineering College, Plymouth, England, where he studied mechanical and marine engineering. By 1965 he had earned a PhD in Electrical and Electronics Engineering from the Massachusetts Institute of Technology (MIT). He served in the Royal Canadian Navy from 1953 to 1970 retiring as a Commander. For his outstanding service to the Canadian Armed Forces, he was appointed an Officer of the Order of Military Merit in 1984.

John held academic appointments at RMC from 1965, ranging from Professor and Head of the Department of Electrical Engineering to Dean of Graduate Studies and Research. His academic career culminated with his appointment as Principal in 1984 in which position he served until the end of 1999. Earlier this year he was named Principal Emeritus of RMC in recognition of his outstanding service to the College.

John has remained actively engaged as an engineer, and has been recognized for his noteworthy contributions to all facets of engineering. Among other recognitions, he is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), Canadian Academy of Engineering and the Engineering Institute of Canada. He is also a recipient of the following prestigious awards and medals:

- **Queen Elizabeth Silver Jubilee Medal**
- **Association of Professional Engineers of Ontario Citizenship Award**
- **IEEE Centennial Medal**
- **Canada 125th Medal**
- **General AGL McNaughton Award (IEEE Canada)**

Above all, John has been instrumental in keeping engineering alive and present in Canada. As President of the EIC (1994-96), and long-serving Executive Director of the EIC, he has led and developed the profession of engineering and the Institute to new levels. His dedication, innovative ideas and enthusiasm have led to an increased and more predominant presence of engineering across Canada. As one example, he was the leader in launching the first in a series of four Climate Change Technology Conferences held in Montreal starting in 2006. His efforts have contributed to the recognition of outstanding and distinguished Canadian engineers through the awards and honours program of the EIC.

In May of this year the EIC awarded Dr. John Plant the first President Service Award.

On behalf of all of us who have known John for many years and have benefited from his leadership, I wish John good sailing and a pleasant retirement.

RICHARD J. BATHURST, *PEng, FEIC, FCAE, President-elect EIC*

PHOTOS: GUY GOSSELIN

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