The School of Biomedical Engineering held its 6th annual Biomedical Engineering Symposium from January 5th – 6th at McMaster University. The riveting two-day symposium featured recognized leaders in their fields from all over North America, alongside msBME’s own graduate students. A diverse audience ranging from undergraduate students to multi-disciplinary faculty were brought together to exchange findings, establish collaborations and accelerate the development of biomedical technologies, materials and therapies to advance human healthcare and its understanding. Additionally, the symposium provided undergraduate and graduate students the opportunity to present their work in an inspiring and encouraging environment through oral and poster presentations.

Along with pushing the boundaries of the intersection between Engineering and Medicine, bio-entrepreneurship was thrown into the evolving discussion this year. Students and faculty were educated on different aspects of entering the biomedical engineering industry successfully. Once again, msBME’s commitment to continuous learning and advanced research was showcased through the 6th Annual Biomedical Engineering Symposium.
Thank-you!

msBME would like to recognize Christina Tellier for her expert interim administrative support for BME graduate functions. Moreover, a sincere thanks to the dedicated students of the Biomedical Engineering Graduate Association (BMEGA) for organization of the 6th Annual Biomedical Engineering Symposium, and our generous sponsors.
Dr. Milos Popovic, PhD  
Institute of Biomaterials & Biomedical Engineering (IBBME)  
Toronto Rehabilitation Institute (TRI)

Dr. Milos Popovic is an example of how the roles of a principal investigator have evolved to include entrepreneurship. At the BME symposium, Dr. Popovic presented on his work, which focuses on overcoming paralysis using electrical stimulation. The findings to date suggest that functional electrical therapy (FET) for reaching and grasping is a therapeutic modality that should be implemented in every rehabilitation institution that is treating patients with stroke and spinal cord injury. Students were also given insights into the process of creating a clinically used medical therapy or product, including intellectual property rights, patenting, and clinical trials.

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Dr. Gordon Hayward, PhD, P.Eng.  
Biological Engineering  
University of Guelph

Dr. Hayward is a Professor Emeritus at Guelph. His present research focuses on the design of biological and chemical sensors, particularly ones based on bulk wave acoustic devices. In addition, his research interests include fuzzy logic control systems, a natural extension of sensor technology into less tangible measurement problems. His talk at this year’s symposium discussed the development of a simple, inexpensive sensor for quick detection of brain-wasting infections related to bovine spongiform encephalopathy (BSE), or mad-cow disease in cattle, and related forms of transmissible spongiform encephalopathies, or prion diseases.

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Dr. Gordon Sarty, PhD, P.Eng.  
Psychology & Biomedical Engineering  
University of Saskatchewan

Dr. Gordon Sarty has a wide range of research interests including mathematical models of physiology, and the theoretical and observational astrophysics of compact objects. The basis of his talk at the symposium was related to his most recent work on the reinvention of MRI so it can be used on the space station and the Moon. Dr. Sarty believes the MRI would be a valuable tool that could lead to a better understanding of the altered physiological processes during space flight, such as changes in mass and strength of bone and muscle, and to find ways of ameliorating those changes.

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Dr. Kevin Plaxco, PhD  
Chemistry and Biochemistry  
University of California, Santa Barbara

Dr. Kevin Plaxco’s research focus is on the physics of protein folding and its many and varied engineering applications. A major aim of the group’s applied research, and the basis of his talk at the symposium, is to harness the speed and specificity of folding in the development of sensors, adaptable surfaces, and smart materials. He explained how the ideal molecular sensor will be sensitive, versatile, small enough to hold in your hand, and selective enough to work even when faced with complex samples. Dr. Plaxco also shared how it has proven difficult to create such an item, and the approaches his group has taken toward creating it.
Dr. Xiaowu (Shirley) Tang, PhD, P.Eng.
Chemistry & Waterloo Institute for Nanotechnology (WIN)
University of Waterloo

Dr. Shirley Tang carries out research in nanotechnology, focusing on the creation of "bio-inspired" materials and devices based on graphene, carbon nanotubes, and their chemical derivatives, primarily for biomedical applications. Dr. Tang’s talk focused on the development of new Chemical Vapor Deposition (CVD) synthesis methods to obtain diameter controlled CNTs with high yield and high purity. Microfabrication and chemical functionalization will further render ordered CNT architectures on surfaces. The Tang research group are also exploring bio-molecule directed methods for CNT self-assembly and extrapolating its potential for large-arrayed nanoscale electronic devices.

Dr. Thomas Willett, PhD, P.Eng.
Systems Design Engineering & Biomedical Engineering
University of Waterloo

Dr. Thomas Willett’s research interests involve the applied mechanics and engineering of skeletal biomaterials and tissues. His talk at the symposium focused on engineering of bone mimetic materials for skeletal reconstruction and repair (orthopaedics), particularly graft materials for treating large skeletal defects caused by trauma, cancer, etc. Dr. Willett stressed that by leveraging the exciting and rapidly advancing fields of additive manufacturing and 3D printing, biomineralization, and mechanics of multi-scale biological and biomimetic composites, we can develop an improved understanding of the mechanisms that determine the mechanical behaviour and failure of bone, and how collagen modifications due to ageing, disease, irradiation, and other causes alter these mechanisms.

Dr. Michael Doschak, MSc, PhD
Pharmacy and Pharmaceutical Sciences, Medicine and Dentistry & Biomedical Engineering
University of Alberta

Dr. Michael Doschak’s expertise with non-invasive imaging modalities such as Micro-Computed Tomography, and industrial biomaterials experience allowed him to make sizable contributions to research involving advanced drug delivery strategies. His current research looks at the targeting and controlled release of drugs and peptide biologics within bone tissues, for orthopaedic, orthodontic (dental) and biomaterial applications. Dr. Doschak’s excellent talk specifically described cytokine drug delivery to bone from nanofiber biomaterials. These therapeutics would be capable of reducing the pain and suffering attributed to bone diseases such as Osteoporosis, Arthritis and bone pain secondary to cancer metastases.
STUDENT SPOTLIGHT

Sara Makaremi

Investigating diffusion of receptors on macrophage membranes using Raster Image Correlation Spectroscopy.

Macrophages are among the central constituents of the innate immune system and are known for phagocytosis or ‘eating’ particulates of pathogens. Macrophages express several cell-surface receptors including Toll-like receptors (TLR), which play a vital role in their response to pathogenic stimuli. Studies suggest that macrophages exhibit age-related deficiencies in TLR function, and as a result elderly are more susceptible to infections. Sara Makaremi, a PhD student co-supervised by Dr. Dawn M.E.

Evan McNabb

Localizing fiducial markers using undersampled co-RASOR MRI for radiation therapy planning.

Metallic fiducial markers, implanted inter/intra-tumour are used for Computer Tomography (CT) Electron Beam Radiation Therapy of prostatic and bladder lesions due to their low migration. CT images can overestimate volumes with larger interobserver variability, and lead to higher radiation to adjacent regions henceforth Magnetic Resonance (MR) imaging is commonly used for planning. However, these metallic fiducials cause image artifacts in MR leading to hypointense signal voids. Hyper-intense contrast from paramagnetic brachytherapy seeds was demonstrated using centre-out Radial Acquisition using Off-Resonance Reception (co-RASOR) by radially rewinding signal pile-ups around the edges of field perturbers. Radial readouts have additional benefits of oversampling the centre of k-space and can be reconstructed from undersampled data using multi-channel coils and variation penalties. Evan McNabb, a PhD student in Dr. Michael Noszeworthy’s lab demonstrated that undersampled co-RASOR can be used to quickly and accurately locate paramagnetic fiducial markers to accelerate abdominal imaging in order to avoid motion artifacts and reduce clinical scan times.
Roqibul Hasan

Electrochemical protein detection by target-responsive programmable Dynamic DNA assembly.

Nucleic acid amplification is responsible for pushing the limit-of-detection of molecular diagnostic assays to unprecedented levels. PhD student Roqibul Hasan’s vision was to develop an assay based on protein-responsive programmable dynamic DNA assembly (PRPDA) to detect proteins via an intermediate process involving nucleic acids for taking advantage of nucleic acid amplification strategies. PRPDA has previously been designed for sensitive protein analysis in fluorescent assay formats. To further push the detection limit and to achieve assay miniaturization and multiplexing, Roqibul along with his supervisor Dr. Leyla Soleyamni sought to combine PRPDA with electrochemical readout. They were able to successfully demonstrate that hybridization of methylene blue-modified complementary DNA can be detected electrochemically through toe-hold mediated strand displacement assay, which is a key step for signal generation in the PRPDA protein detection system. Roqibul expects to increase the sensitivity and limit-of-detection of this system by employing high surface area wrinkled gold electrodes. The next steps would be to further use this system for the detection of protein biomarkers using the proposed target-responsive dynamic DNA assembly.

Sandy Zakaria

A revolutionary approach for early colorectal cancer detection.

Colorectal cancer (CRC) is the 3rd most commonly diagnosed cancer attributing to 1.4 million incidences and 694,000 deaths per year. CRC disease management, such as regular screening for people 50 and above can avoid >60% of CRC-related deaths. However, compliance of CRC screening programs is low due to current diagnostic inherent limitations such as invasiveness and high cost of colonoscopy, and low sensitivity and specificity of Guaiac Fecal Occult Blood test. Currently, many studies have shown the important role of the microbiome in CRC, where the microbial dysbiosis of the gastrointestinal tract results in colorectal carcino genesis. Efforts in sequencing the microbiome of feces have identified the bacterium Fusobacterium nucleatum (Fn) in CRC fecal samples, especially in early stages of CRC. Sandy Zakaria a master's student working under Dr. Yingfu Li is using this new approach to detect Fn in fecal samples to provide a new platform for CRC diagnosis. To achieve this, the development of a paper-biosensor using highly specific and sensitivity functional nucleic acids, such as DNAzymes, will be implemented as a detection probe for Fn. Furthermore, this paper-based test shows promise for developing an inexpensive, non-invasive and accurate early diagnostic test for CRC, thereby increasing compliance of regular screening programs and reducing CRC associated deaths.


Mohammed Ali Warsi
MD, PhD

The setting: 10:30 pm, John F. Kennedy airport, during a 3-hour layover on our way home from attending two academic conferences in San Diego. Estimated time of arrival home, undetermined, our flight has been delayed. This seemed like the perfect opportunity to chat with Dr. Mohammed Warsi about his time as a BME student.

Dr. Warsi is a practicing psychiatrist who graduated with a PhD from the BME program in 2012. Dr. Warsi completed his PhD work with Dr. Michael Noseworthy’s imaging group. Now, in addition to being a clinical psychiatrist, he is a supervisor in the BME program.

Okay, let’s start with an easy question, do you really have to work in 9 hours?

One thing about being a clinician-scientist is that it’s hard to give up clinical time. Even when you get back from a conference, you have to hit the ground running. I just wasn’t expecting a three-hour delay.

Why did you pursue a PhD in BME when you were already a clinical psychiatrist?

Because I love the idea of creating new knowledge. I remember studying for exams in high school and if you knew everything in the textbook you would do really well. Then I went to university and I learned about what researchers do. The idea that you could create the knowledge that would one day be in a textbook blew my mind. I thought about doing an MD-PhD, but most people that do research before doing their MD have to focus on basic science questions. I wanted to bring the rigor of a PhD to clinical science questions. So I decided to wait to do my PhD until I had finished medicine.

So, why BME?

BME is the perfect bridge between basic science and clinical relevance. I found my education in BME helped me bridge the foundational theory of physics and imaging to relevant clinical questions in neuroscience. The partnership of the faculties of health science and engineering in BME encourages clinicians to learn more about theory and math without it seeming intimidating. Just like it introduces engineers to questions that they would not usually be exposed. I would never have guessed that learning MATLAB, scripting in Bash, and using SharkNet would ever be so relevant and valuable to my clinical research.

“RESEARCH, LIKE A LOT OF ACADEMIA, IS 10% SWEAT, 20% TEARS, AND 70% WORRYING ABOUT THE SWEAT AND TEARS.”

Surprisingly, no. A lot of my learning was incremental and from my peers who were only few years my senior. If I didn’t know something, there were always some other students taking a break from Halo, that were more than willing to explain it to me. And once it had relevance to my own research, it became quite easy.
5. Do you think it might be hard for the opposite, for the engineers to learn the clinical side of BME?

That’s where working in an interdisciplinary department like BME comes in handy. I was lucky enough to work in an interdisciplinary lab; I was happy to teach the neuroscience principles to engineers, just like they were willing to teach me MATLAB. And if there’s no one in your lab that can teach you, there’s always someone one or two labs down who is willing to help. Plus, the BME core curriculum helps.

6. How did you have time to start your clinical practice, get married, and have your first child, all while doing your PhD?

Research, like a lot of academia, is 10% sweat, 20% tears, and 70% worrying about the sweat and tears. Most productive research happens in short bursts, usually two days before the abstract deadline (the 10% sweat). Then you spend time trying to make that into a paper, with lots of edits and re-edits (the 20% tears). The trick is to recognize that, and do the most with the remaining 70%.

7. How much of that 70% was spent playing Halo?

Actually a lot up front, and I think it was important. Our whole lab would network our computers together and play bursts of Halo, and then eventually hanker down and get to work for the rest of the evening as a team. Later on I slowly shifted that Halo time into other aspects of my life.

8. Sounds like you guys had a fun lab, any fun stories to share?

All I can say is, what happens in Sweden stays in Sweden.

9. Did you travel a lot during your PhD?

It’s all about the carrot. As a supervisor, Dr. Noseworthy said that if we got our abstract prepared, submitted, and accepted to an international meeting, we could go. He believed that a carrot like that motivated people to see research through to publication more than a stick, and it worked! The lab and I went to conferences in Hawaii, East Germany, Scandinavia, and Toronto (woohoo!), all with abstracts to our name. It was a great motivator and a lot of fun.

10. Did that influence you now that you supervise students?

Well…we are sitting at JFK airport after a week in San Diego, having presented at two international meetings. Other than the travel, bringing students to conferences introduces them face-to-face to people that they cited in their abstracts and their papers, and they realize that the work they do is respected and influential in their field. It’s sometimes hard to know that if you’re stuck all day in a lab.

11. What kind of opportunities do you think that a BME degree awards students?

I guess having the broad experiences in BME is a double-edged sword. It doesn’t guide you into any specific career afterwards. But I probably could have taken this degree into ten directions afterwards, and then you multiply that by the many types of projects you could potentially do in BME. I think you should start with the research you enjoy and then halfway through your degree start thinking about where this can apply to your future, be it academia, industry, or even another degree. At that point you could start networking and honing your resume towards a specific tract. Definitely take advantage of the diversity within the BME faculty to get advice and mentorship. After your degree, whether you end up in medical school, working for a biotech start-up, or become a professor, you definitely won’t forget your time in BME.
Dr. Kathryn Grandfield is an Assistant Professor with the Department of Materials Science and Engineering and an Associate Member of the McMaster School of Biomedical Engineering, teaching graduate-level courses in Biomaterials. Her research focuses on the development and characterization of implant devices for bone applications, such as joint replacements, and dental implants. In particular, the Grandfield Research Group has pioneered advanced electron microscopy and tomography techniques to better understand soft-hard tissue interfaces and mechanisms of biomineralization. Recently, an article by Dr. Grandfield on “Bone, implants, and their interfaces” was featured on the cover of Physics Today, a leading scientific journal (Physics Today 68, 40 (2015); http://doi.org/10.1063/PT.3.2748). Dr. Grandfield has a clear passion for STEM and is supportive of her students, documenting both their successes, and social gatherings - most recently an outing to the Maple Syrup festival (@ProfGrandfield).

1. **What inspired you to pursue research in Biomedical Engineering?**

I always had a passion for biomaterials – I think it partly came from watching The Six Million Dollar Man (Google it!) as a child. I was fascinated by this idea of that medicine and engineering could be used to rebuild or repair someone – albeit a bit far stretched in the show! A research career in biomedical engineering was a clear choice, it was a field where I felt I could innovate as an engineer while making a positive impact on others.

2. **What do you like most about what you do?**

In our research, we use electron microscopes to peer into the nano-world of many biological and materials systems. My favorite part of my job is still those days when my team and I look at something in the microscope for the very first time. Maybe it’s a new implant device, maybe we uncover a structure in an ancient tooth, or a pathology in bone arising from medication. It’s a feeling that is hard to describe, and an excitement that carries us through to the next experiment!
What are you looking forward to focusing on in the future?

Our society is in the midst of several transitions; we’re faced with an aging population and seeing changes in our technological capabilities with developments in cloud computing and additive manufacturing - I’m excited to harness the power of personalized medicine and 3D-printing in our future projects to meet our new health care challenges.

Why should young engineers consider a graduate degree in Biomedical Engineering?

A graduate degree in Biomedical Engineering can be a platform for many different career paths. Perhaps it will propel you towards a career in research and development, towards medical or law school, or even towards your own biomedical start-up. I think the versatility of this degree is one of its key attributes.

Do you have any advice for students pursuing a career in this field?

My first piece of advice is to always do what you love – when you enjoy your line of work, you’ll have the passion and motivation to become an expert. My second piece of advice is to take advantage of the diverse opportunities available through the School of BME – go to lecture series from affiliated groups, get out of your lab, and learn something new. Now is the time to be inspired and broaden your horizons.

What would students be surprised to learn about you?

I love diving with sharks! I’ve been up close and personal with at least 4 species – including the Great White!
Upcoming Events

2017 September
14 McMaster Engineering Technology Research & Innovation Conference (METRIC) @ McMaster Innovation Park
Abstracts Due: TBA

2017 October
02-04 IEEE 12th Annual Nanotechnology Materials and Devices Conference (NMDC) @ Singapore
Abstracts Due: 16 June 2017

2017 December
04-05 2nd World Biotechnology Congress @ Sao Paulo, Brazil
Abstracts Due: 24 July 2017
10-14 International Conference on Mechanics of Biomaterials and Tissues @ Waikoloa, Hawaii, USA
Abstracts Due: 16 June 2017
13-15 International Conference on Epigenetics and Bioengineering @ Miami, Florida, USA
Abstracts Due: 03 July 2017

2018 January
18-19 7th Annual McMaster Biomedical Engineering Symposium @ CIBC Hall, McMaster University
Abstracts Due: TBA
27-01 Feb SPIE Biophotonics, Optics, Imaging (BIOS) @ San Francisco, California, USA
Abstracts Due: 17 July 2017

2018 February
10-15 SPIE Medical Imaging 2018 @ Houston, Texas, USA
Abstracts Due: 07 August 2017

2018 July
10-15 8th World Congress of Biomechanics @ Dublin, Ireland
Abstracts Due: 19 December 2017

Upcoming Defences

June 22nd @ 11:30 AM MUSC 301
Madiha Khan, PhD Candidate
The Antibacterial Activity of Silicone-Polyether Surfactants
Supervisor: Dr. M. Brook & Dr. H. Sheardown

June 29th @ 10:00 AM TBA
Anna Korol, PhD Candidate
Role of Cytoskeletal Signaling in Lens EMT
Supervisor: Dr. J.A. West-Mays

Do you have something to say or news to share? We would like to hear from you.

Contact BME Editorial Board:
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