CHAIR’S MESSAGE

Our department continues to be at the forefront of biomedical research and in this issue of BE-connected, we highlight the grant and entrepreneurship successes of our BE students and faculty. Our Department is leading the effort in internationalizing Speed School programs by working with the Ministry of Education in Egypt to open an engineering campus in Al-Alamein, Egypt.

While COVID-19 continues to pose a challenge, our faculty, staff, and students are working diligently to further the mission of our Department by delivering classes online and conducting research. Our faculty and students continue innovating to help our healthcare workers and patients with COVID-19. The BE faculty had a productive year and secured major grants from the National Institutes of Health, Department of Defense, and National Institute of Justice. Our BE PhD trainee, Landon Tompkins, received a small business innovation award from the National Institutes of Health to develop a biomedical device technology. We recently received approval to offer a certificate program in Artificial Intelligence in Medicine.

The Bioengineering program successes would not have been possible without the support of our alumni, donors and students. We are very grateful for the support of our donors, and we look forward to your continued support to help us achieve our target of raising $200,000. Your donations have already made a difference and we have established six new awards for our students. With your support, we hope to increase the number of student awards.

We hope that you and your family stay safe and healthy during these testing times. We would love to hear from you. Please feel free to contact Betty Nunn to send us your updates. We wish you all a joyous and healthy holiday season and a wonderful new year.

Shah Tarun

Shah Tarun, a bioengineering student and a Bangladesh native who first came to the U.S. in 2015, spent his spring semester co-op working on a very timely issue and is using his experience to further his professional development. Tarun worked with Dr. Jaimin Trivedi, an instructor of Cardiovascular and Thoracic Surgery at the UofL School of Medicine, to figure out how to better protect healthcare workers against COVID-19 in a clinical setting with improved PPE.

“I believe this experience will showcase my overall skillset within the HTM/biomedical profession and continue to show my determination on doing what is right for the community,” he said. He found his work with Dr. Trivedi to be especially rewarding because of that community aspect.

“It feels amazing to know that such a project can benefit PCP, ED, nurses, etc. It is even more amazing if you think that this project could help the common person too, making it commercialize-able for the community and providing the need for everyone if they so wish to,” Tarun said. Tarun, who is scheduled to graduate in December, said he chose to attend UofL because of its diversity and friendliness toward international students. “I felt very welcomed when I first came. Most of my peers and mentors were helpful and kind, and I learned a lot of new things in Louisville, specifically being part of the Cardinal family,” he said. “I just hope that I can benefit UofL in some way in the future.”

Tarun plans to stick around for now, with plans to enroll in UofL’s MEng program for Biomedical Engineering. He then hopes to go into the research field and apply for medical school. This co-op and bioengineering degree, he says, has prepared him well for whatever comes next.

“I feel like this experience made me better prepared for the worst outcome that could happen in the near future,” he said. “Overall, it made me hopeful that we can provide the hope that our healthcare providers need in these dire circumstances.”
1. What prompted you to enter the Ph.D. program in Bioengineering?

I am interested in the intersection between biology and engineering. In Bioengineering, I can study biology from an engineering perspective and apply engineering principles to biological processes in order to build better solutions to a large variety of healthcare problems. I am an engineer who likes to work with biological data such as medical images, biomedical signals, and genetic information and find solutions to better people's lives. Therefore, I found the Ph.D. program in Bioengineering really attractive and fulfills my aspirations.

2. Overall, how do you feel about the program?

I am ecstatic about the program. I really enjoyed the classes because they increased the range of my knowledge and understanding. The classes broadened my horizons. The professors of the program are highly knowledgeable, friendly, and always welcome the questions from students.

3. How has the program improved your knowledge and opportunities?

In the Bioengineering program, I was introduced, for the first time, to a new scientific topic called bioinformatics. In bioinformatics, I enjoyed analyzing large sets of genetic data. Furthermore, I believe pursuing a Ph.D. degree in Bioengineering will improve my opportunities that align with my passion in the workplace.

4. What advice can you impart to potential applicants of the Ph.D. program?

The Ph.D. program is an interdisciplinary degree with wide range of topics. Therefore, the student should find a specific scientific topic which suits their passion. I found artificial intelligence very interesting due to its wide range of applications and I think it is the future of healthcare.

5. How might the program be improved?

The program can be improved by adding some advanced computer science classes. As a Ph.D. student I am allowed to take classes from the Computer Science department but I feel that expanding computer science related course offerings in Bioengineering with a focus on bioinformatics will help all students.

6. What has this program helped you to achieve?

During my study in the program, I was able to publish scientific articles in high impact factor peer reviewed archival journals. Writing articles has really helped me improve my scientific writing skills. I have also been given opportunities to present my work in scientific conferences. The program encourages students to be active and publish scientific articles in conferences and journals.
In October 2020, Dr. Tommy Roussel (or Dr.T. as his students call him), a transplanted Cajun originally from New Orleans, LA, (aka The Big Easy or simply NOLA), celebrated his 21st year as proud UofL Cardinal. After spending five years as a full-time research engineer in the Mechanical Engineering Department, he transferred to the Bioengineering Department at its formation in 2006. Originally a full-time research engineer and course instructor, he has served in the BE department as an Assistant Professor since 2015. He holds a PhD in Mechanical Engineering (UofL, 2014), an MS (2001) and BS (1997) in Biomedical Engineering (Louisiana Tech University), and BA in Chemistry (University of New Orleans, 2003). Dr. Roussel currently serves as Assistant Director of the newly formed Louisville Automation and Robotics Research Institute (LARRI). He has published 23 peer-reviewed journal articles, three book chapters, over 100 conference papers and abstracts, has been awarded eight patents (with several currently pending), and has formed seven startup companies to commercialize his research products. Dr. Roussel has a passion for educating the next generation of engineers and outside of the courses he teaches throughout the year (BE 322, BE 524, and BE 621), he has mentored 25 graduate students at the PhD and MEng level, and over 50 undergraduate students, both in his research lab and during the Senior Capstone Design Course (BE 497). In response to the global COVID-19 pandemic in March 2020 and in concert with the leadership at UofLs Advanced Manufacturing Institute of Science and Technology (AMIST), Dr. Roussel organized and led a group of over 160 community “makers” to assist in the 3D printing of tens of thousands of PPE components that were manufactured, assembled, disinfected, and shipped across the city, state, and region to numerous hospitals, clinics, and dentist offices.

Dr. Roussel has been funded by the Wallace H. Coulter Translational Research Partnership, the UofL Innovation Grant program, NASA Human Research Program, NIH (ExCITE, KYNETIC, I-Corps), and NSF (Sensors, EPSCoR), and with this support has developed concept-to-prototype custom instrumentation, embedded control, sensors, and micro/meso-scale microfluidic systems focused on a variety of research areas. Current projects include “BreathForce”, an international patent-pending cardiovascular and respiratory training system for patients with COPD and spinal cord injury (SCI), “RockinRehab”, an instrumented rocking chair to promote and monitor trunk control in pediatric SCI patients, a multi-functional surgical device and autonomous fluidic control system to investigate how surgery might be performed in zero gravity, and a remote platform to monitor and report heavy metal contamination in groundwater and aging facilities. Dr. Roussel's most recent work is centered around the development of a point-of-care blood test using Differential Scanning Calorimetry (DSC) for the real-time identification and discrimination of different types of myocardial injury, including different types of myocardial infarction (MI).

The Speed School of Engineering is in the process of establishing an agreement with the government of Egypt in the development of the Al-Alamein International University (AIU) near Alexandria, Egypt. Bioengineering chair Dr. Ayman E-Baz and Associate Dean Dr. Thomas Rockaway visited the site of the construction of the university to offer their expertise. Drs. El-Baz and Rockaway met with the Minister of Education in Egypt and other officials from the Ministry of Education.

Dr. El-Baz's Bioengineering PhD student, Mohamed Shehata, has won 2nd Place in the 2020 Podium Abstract Awards hosted by the American Society of Diagnostic and Interventional Nephrology (ASDIN) in Las Vegas, NV for his work on the project entitled, “Precise Identification of Renal Transplant Status Using BOLD MRIs.” This technology uses BOLD-MRI to provide a more rapid, but precise assessment of renal allograft function after transplantation instead of performing biopsy. Biopsy is invasive and associated with higher costs, and adverse events such as internal bleeding, infection, etc. Congratulations Mohamed!!
New BE Grants in 2020

Major bioengineering research grants by faculty & staff are listed below by name, grant source and amount.

Development of dried blood for prolonged field care in austere environments, J. Kopecek, M. Menze (co-PIs), B. Janis (co-I), DoD Project Period, Sept. 2020 - Aug 2023, Amount $899,217. Blood transfusions are critical life-saving procedures for treatment of blood loss due to trauma and other conditions. Over 13 million units of red blood cells (RBCs) are transfused in the U.S. each year making it the most common medical procedure in U.S. hospitals. Blood is acquired from donors but in most cases must be used within 42 days. Frozen storage can extend the shelf-life but this approach is limited by complex processing requirements and slow thawing which is disadvantageous when blood is needed rapidly. These limitations are responsible for blood shortages that occur in many hospitals and pose a significant barrier to transfusion medicine in places where refrigeration is not available, such as far forward military operations in austere environments or medical centers in remote locations.

Wireless ultrasonic powering and monitoring of LVAD through Internet of Medical Things (IoMT). Drs. Slaughter, Koenig (co-PIs), Drs. Giridharan, Powell, Monreal (co-Is), NIH SBIR Project Period, May 2020-April 2021, Amount $468,993. Bionet Sonar has developed an Internet of Medical Things (IoMT) platform that will eliminate LVAD drivelines by solving the challenges associated with wireless power and data transfer to help improve patient outcomes and quality of life.

Inter-System Closed-Loop Control of Locomotor and Bladder Function in Individuals with Acute Spinal Cord Injury (SCI), Claudia Angeli, Maxwell Boakye, (co-PIs), National Institute of Neurological Disorders and Stroke Project Period Sept 2020-June 2025, Amount $781K. In the last few years, we have shown that neuromodulation using epidural stimulation of the lumbar sacral spinal cord can activate latent neural circuits and restore voluntary movement, standing and stepping, and improve bladder function in individuals with chronic SCI. Advances to upgrade the stimulator's programming and wireless communication platforms are critically needed to integrate multiple training paradigms across multiple systems (i.e. motor and autonomic), while taking advantage of wireless monitoring technology to improve the patient experience. For this study, first we will acquire data necessary for implementation of learning algorithms and closed-loop systems with the implanted neurostimulator. Second, 8 additional individuals will be randomized into training interventions for locomotion and bladder. This trial will upgrade technology for epidural stimulation and make it specific for use by individuals with spinal cord injury.

Remote wireless monitoring of bi-ventricular pacing through the Internet of Medical Things (IoMT). Drs. Slaughter, Koenig (co-PIs), Drs. Powell, Monreal (co-Is), NIH SBIR Project Period May 2020-April 2021, Amount $444,327. Our innovation is to apply our novel platform technology to enable wireless pacing, node-to-node communication, data transmission, and wireless recharging with remote pressure monitoring to enable real-time feedback control. This approach may provide clinicians with early detection and diagnostics of device performance and patient health informatics for therapeutic modifications to optimize patient outcomes and lower healthcare costs.

Development of intravascular circulatory support device for PCI and CS, Drs. Slaughter, Koenig (co-PIs), Drs. Giridharan, Powell, Monreal (co-Is), NIH SBIR Project Period May 2020-April 2021, Amount $491,583. RT Cardiac Systems (RTCS, Cary NC), with a track record of innovation in blood pump development (FDA-approved HeartWare HVAD), is developing an innovative pMCS device as an alternative percutaneously delivered circulatory support device. The RTCS pMCS is designed to provide full physiological perfusion (>2.0 L/min/m2) for up to 30 days, in a small radial profile (16F) to enable standard percutaneous implant without the need of an external lubrication system patient management and outcomes.

An injury plausibility assessment model for differentiating abusive from accidental fractures in young children, G. Bertocci, M.C. Pierce (co-PIs), NIH RO1 Project Period 2020-2024, $2.7M. Each year in the United States there are more than 90,000 emergency department visits for fractures in children age 0-5 years (most often involving the long bones), with abuse-related fractures peaking in the first 3 years of life. It can be extremely difficult for providers to differentiate abuse-related fractures from those associated with an accident in these young children. This difficulty results in a bidirectional problem: under evaluation and missed abuse for some (which may result in re-injury or even death), and over evaluation for abuse and reporting to state child protective services (CPS) for others (which also impacts families negatively, and occurs most often in race/ethnic minority groups). Such “bidirectional” errors in decision making come at a high cost to all involved. These issues highlight the critical need for an evidence-based fracture assessment model to inform medical decision-making when attempting to differentiate abusive from accidental fractures.

Cavopulmonary assist to reverse the Fontan. G. Giridharan (PI), K.Powell, S.Koenig, A.El-Baz (co-Is) NIH-R01 Grant, Project Period Sept 2020-Aug 2024, $8.94M. (See Page 2)

Enabling of a Wireless and Remotely Monitored Deep Brain Stimulation System through Internet of Medical Things (IoMT) for Parkinson’s Disease, Drs. Neimat, Koenig (co-PIs), Drs. Powell, Monreal (co-Is). NIH SBIR Project Period, 9/2019-8/2021 Amount $328,562. Our innovation is to apply our novel platform technology to DBS enabling wireless stimulation, external wireless recharging, and remote system monitoring. This approach will not only address many of the primary complications, but remote device monitoring and reprogramming shall also optimize patient outcomes and lower healthcare costs.

BE Student and Mentee Recieve SBIR Grant

Landon Tompkins, a doctoral student in the Translational BE, Ph.D. program, has secured a new grant with mentee, Steven Koenig (serving as a co-PI) on a project entitled, “Development of partial occlusion device to aid coring and anastomosis of the aorta.” The $278, 487 annual grant comes from NIH-SBIR. Landon was assisted with preparation of prototype development and testing by BE Senior Design and MEng students Francesca Mayhaus and Victoria Sanger. Other investigative roles in the project include Drs. Mark Slaughter, Dr. Karen Powell, Dr. Gretel Monreal (as co-I’s). This is the second SBIR grant that Landon has received as the principal investigator.

New Certificate Program in Artificial Intelligence

The Department of Bioengineering received approval for a certificate program in Artificial intelligence in Medicine. The program trains students to design and manage automated analysis of biomedical data to find innovative solutions to medical challenges and improve patient care. The certificate program requires 15 credit hours of graduate coursework that can be completed online. The program is offered in conjunction with the Department of Computer Science & Engineering (CSE) and the School of Public Health & Information Sciences.

BE Donations

We have established a student endowment with a goal of raising $200,000 in the next 4 years. Due to the generosity of our donors we have raised approximately $45,000 to date. This has enabled us to present six new BE student awards this year. We are deeply grateful to all our donors for contributing significant amounts to this cause. Your continued support is vital to fulfilling the endowment objective of recognizing meritorious students. For more information about how your donations can help transform the BE Department, please contact Mark Daily or call (502)852-2400.