BRIDGING PARALYSIS BY TAPPING INTO THE BRAIN

From the Chair

As Case Western Reserve University's Department of Biomedical Engineering approaches its 50th anniversary next year, I've begun to reflect on the impact our department has on educating the next generation of biomedical engineers, contributing to cutting-edge research, collaborating with clinicians to translate research into reality and ultimately benefitting society at large. All four of these form the pillars of our success. In this issue, I'm honored to present departmental highlights that only begin to touch upon the remarkable work we're doing now – and setting our sights on for the future.

Sincerely,

Robert F. Kirsch

Robert F. Kirsch
Allen H. and Constance T. Ford Professor
Chair of Biomedical Engineering
Case Western Reserve University

43 labs

31 faculty

410 undergraduates

145 graduate students

49 co-ops
in the '16-17 academic year

In the Spotlight

Putting the science in sci-fi

Hollywood Rolls Out the Red Carpet for Bolu Ajiboye

While much of what you see in a Hollywood blockbuster may seem far-fetched, a fair amount is actually based on science. During the opening gala of *Doctor Strange* last fall, several experts discussed the science behind the fiction at "The Science of the Marvel Cinematic Universe" event, including A. Bolu Ajiboye assistant professor of biomedical engineering at Case Western Reserve University.

At the invitation of the National Academy of Sciences, Ajiboye shared the technological possibilities of restoring movement to people with severe arm and hand damage. Just as Dr. Strange – a neurosurgeon-turned-superhero – regains function of his hands in the movie following a car crash, so too have paralyzed patients in research programs led by Ajiboye, other biomedical engineering professors and their partners.

"As in the case of Dr. Strange, we are restoring to these brave individuals the powers they had before their injuries so they can achieve independence and an enhanced quality of life," says Ajiboye. "They are the real superheroes."

Faculty Highlights

Three biomedical engineering faculty, **Jeffrey Capadona, Nicole Steinmetz,** and **Dustin Tyler** were elected to the 2017 Class of American Institute for Medical & Biological Engineering (AIMBE) College of Fellows. They were inducted at a ceremony during the AIMBE's 26th annual meeting at the National Academy of Sciences Great Hall in Washington, DC, March 20.

Jeffrey Duerk, dean of the Case School of Engineering, has been named an Institute of Electrical and Electronics Engineers Fellow for contributions to rapid magnetic resonance imaging technologies. Duerk has also been elected to fellowship in the National Academy of Inventors (NAI) for lifetime achievement and leadership in innovation and scientific discovery.

Eben Alsberg, professor of biomedical engineering, was awarded a new NIH R01 grant aimed at repairing osteochondral defects from the National Institute of Arthritis and Musculoskeletal and Skin Diseases. He is currently serving on the Americas Council of Tissue Engineering and Regenerative Medicine International Society and is on the editorial board of *Tissue Engineering, Nature Scientific Reports, Journal of Biomedical Materials Research Part A* and *Biomedical Materials.*

Dustin Tyler, professor of biomedical engineering, and director of the Functional Neural Interface Lab, was featured on *CNN's Great Big Story*; *For Amputees, Reactivating the Sense of Touch*. Watch the full video at: *greatbigstory.com/stories/for-amputees-reactivating-the-sensation-of-touch.*

Anant Madabhushi, professor of biomedical engineering and director of the Center of Computational Imaging and Personalized Diagnostics, was awarded a $3.3 million, five-year academic-industry grant by the National Cancer Institute to partner with Inspirata for breast cancer risk assessment assay. They aim to develop and validate a digital pathology image-based predictor to identify which breast cancers will respond to hormone therapy alone to spare these patients from the adverse effects of adjuvant chemotherapy.

Robert F. Kirsch, chair of biomedical engineering, is the chair of the national BME Council of Chairs. The Council of Chairs of Bioengineering and Biomedical Engineering consists of the chairs of about 120 biomedical engineering departments in the US and the Americas, with the mission of promoting excellence in biomedical engineering education and training.

Translational Impact

Translational research is the process of developing scientific discoveries into knowledge, programs and products that improve the health of individuals and their communities. Translation is a critical part of our mission. The Case-Coulter Translational Research Partnership is the primary vehicle for driving innovation in the department, but there are many resources.

For more information visit, *bme.case.edu/research.*

66 total projects

20 licensed

24 in-human

37 patents
since 2014

$7.3 M invested in projects → **$80 M** follow-up investment

Q&A with Sam Senyo

A native Virginian, Sam Senyo joined the biomedical engineering faculty in January 2016. This spring, he's teaching a course on structural biological materials for both biomedical engineering and macromolecular engineering undergraduates, as well as furthering his research on cardiac regeneration.

What is the focus of your research on cardiac regeneration?

Part of it is simply trying to understand how muscle grows. But even more importantly, in the setting of injury we want to understand what factors limit the replenishment and repair of tissue and see if we can prompt more robust regeneration in response to injury.

What excites you about your research?

This idea that we can actually direct the tissue to repair itself or direct drugs to the exact site of necessity, and in doing so avoid side effects. That's pretty powerful. I'm excited at the opportunity to use engineering design principles – both for microfluidic devices to study cells on the benchtop and also for implantable scaffolds to direct regeneration in the injured heart.

What influenced your decision to join the Department of Biomedical Engineering at CWRU?

At every institution where I've been, there's interaction between a hospital and the engineering department. But at Case, there is integration with the School of Engineering and the School of Medicine within the same department. That's extremely unique.

What's your favorite spot on campus and why?

The School of Medicine cafeteria is not to be missed. There are plants everywhere and an atrium, so regardless of the time of year it feels like a nice spring day in there.

Now that you've spent a year getting acclimated to Case, what do you look forward to?

I really enjoy being with faculty here, but I am very excited about the potential to meet students both through classes and in the lab. Our lab is definitely open to recruiting more student researchers.

BrainGate

Work on a neural bypass could help bridge paralysis

Researchers at Case Western Reserve University are moving one step closer to helping paralyzed patients take steps. A team led by Robert Kirsch, chair of biomedical engineering, and Bolu Ajiboye, an assistant professor in the department, developed a small device that attaches to the brain. Made of silicon, the device features 100 metal probes that pick up commands from neurons in the brain.

Case Western Reserve is one of five partner institutions in BrainGate, a collaborative team that creates, researches and tests devices that will transform neurotechnology. The groundbreaking research indicates that neural signals associated with the intent to move a limb can be decoded by a computer in real time and used to operate external devices, according to BrainGate.

The system developed by the Case Western Reserve team has been implanted in a patient who is paralyzed from the neck down. In addition to the brain implant, physicians placed more than a dozen fine electrodes into the muscles of the man's arm and hand. With the assistance of a spring-loaded arm rest, the patient was able to slowly raise his arm, making the simple task of raising a glass to his lips – something he hasn't done in years – possible.

Results of the Case Western Reserve system implant are published in *The Lancet.*

Illustration courtesy of the Cleveland FES Center

Cleveland's Web of Science

Collaborations creating possibility

Cleveland is one of the nation's top medical hubs, with a unique blend of globally-recognized clinical, educational and research institutions, as well as biomedical companies. Case Western Reserve University's Department of Biomedical Engineering calls northeast Ohio home alongside more than 1,200 other bioscience-related organizations, according to the "Ohio Bioscience Growth Report 2015." Proximity fosters collaboration, which is key to the area's success as a global center for health innovation.

Partnerships with World Class Hospitals

"GPS" for Rectal Cancer Surgery

Assistant Professor Satish Viswanath leads a research team, including clinicians from Cleveland Clinic and the Louis Stokes Cleveland Veterans Affairs Medical Center, that's developing a "GPS" for rectal cancer surgery. Funded by a $569,000 grant from the Department of Defense, Viswanath's group is creating a risk assessment scoring system to determine whether or not patients with rectal cancer need surgery after chemotherapy and radiation treatments.

Welcome New Faculty

Satish Viswanath

Satish Viswanath joined the biomedical engineering faculty in August 2016 as an assistant professor in the School of Medicine. The primary focus of his research has been developing novel medical image analysis and quantitative data integration tools for imaging and pathology data, in order to discover deep correlations and cross-linking between these heterogeneous modalities. These methods have been applied in the context of computerized decision support schemes for disease quantification, detection, diagnosis, and treatment response evaluation, with special focus on prostate and colorectal cancer.

Ronald Triolo

Ronald Triolo joined the biomedical engineering faculty in March 2017 as a professor in the School of Medicine. He is the executive director of the Advanced Platform Technology (APT) Center at the Louis Stokes Cleveland VA Medical Center. Triolo has developed implanted neuroprostheses for standing and walking, developed new multicontact peripheral nerve electrodes and pursued original research providing new and clinically useful options for automatically regulating standing and seated balance, and designed powered exoskeletons for walking and stair climbing after paralysis.

Team Cleveland Wins the Gold

Last October, a research team led by Professor Ronald Triolo gained worldwide attention for its pioneering electrical stimulation work at the first-ever Cybathlon in Zurich, Switzerland. Representing the U.S. Department of Veterans Affairs' Advanced Platform Technology Center, Team Cleveland won the gold medal in the bike race, one of six events for disabled people using the latest assistive technologies. Paralyzed from the chest down, the bike's pilot won the 750-meter race in less than three minutes – more than a minute faster than the closest competitor – with the assistance of implantable electrical stimulators connected to muscles that send pulses of electricity into nerves to facilitate pedaling.

Alumni Spotlight

Our alumni make an impact in the field of biomedical engineering. Here are a few of their recent accomplishments:

Christine (Fleming) Hendon

Christine Hendon (Fleming), PhD (CWR '07, GRS '10, biomedical engineering) was one of 102 scientists and researchers former President Obama named as recipients of the Presidential Early Career Awards for Scientists and Engineers (PECASE) this year. Fleming is currently an assistant professor in the Department of Electrical Engineering at Columbia University. Her research interests are in developing optical imaging and spectroscopy instruments for applications in cardiac electrophysiology and interventional cardiology.

Marc Penn

Marc Penn, MD, PhD (GRS '89, biomedical engineering, MED '94) is a cardiologist and director of research and the director of the Cardiovascular Medicine Fellowship at the Summa Cardiovascular Institute, Summa Health System in Akron, Ohio, and professor of Medicine and Integrative Medical Sciences at Northeast Ohio Medical University, where he leads the Skirball Laboratory for Cardiovascular Cellular Therapeutics. Penn's research has led to several discoveries in the field of cardiovascular medicine.

Kyle Salem

Kyle Salem, PhD (CWR '97, GRS '02, biomedical engineering) is the chief of staff at CQuence and serves on the board of directors for Ensocare, a care coordination company. He is also the vice president of corporate strategy at Cassling. Prior to Cassling, he worked with Siemens Healthcare's Magnetic Resonance Imaging division serving as a scientist and manager. Salem has a passionate interest in the future model of care coordination, payment reform and new technologies in healthcare delivery.

Senior Design Project

Undergraduates making a difference

An older adult falls every second each day, making falls the leading cause of injuries and deaths from injury among older Americans, according to the Centers for Disease Control and Prevention. A group of students in Case Western Reserve University's Biomedical Engineering Senior Design course tackled a project to help reduce the impact of falls.

The students designed a cane with an embedded intelligent system. While most canes are merely passive devices used to assist in gait, the sensitized cane collects 3-D accelerated data in real time. That data can be used to detect fall accidents of the elderly or other users, then alert the person's family or healthcare providers so that help can be provided immediately after the fall occurs.

The senior biomedical engineering majors involved in the project are Grace Foxworthy, Nicholas Hazen, Hanna Huss, Nathaniel Landis and James Mcginnity, with help from the team's teaching assistant Dhruv Seshadri, a graduate student in biomedical engineering. Adjunct Assistant Professor Matt Williams serves as advisor. Williams says the project was ideal for the students because it required them to utilize critical thinking skills, understand user needs and implement their engineering training. "It helps them transition from being career students to their lifelong engineering career," he says.

The device has clear clinical benefits, too. "Wearable health monitors are becoming more common, and a sensitized cane would fit nicely in this ever-growing niche," says Williams. "Given our overall aging population, such a device could provide both useful information, as well as invaluable monitoring of walkers in the event of a fall."

#ThrowbackThursday

Case Western Reserve Biomedical Engineering faculty circa 1990

Standing (left to right):
Roger E. Marchant, Patrick E. Crago, David L. Wilson, Miklos Gratzl, J. Thomas Mortimer
Seated (left to right):
Stanley A. Brown, Janie M. Fouke, Gerald M. Saidel, Dominique Durand

Follow us to see weekly Throwback Thursday posts from the department's history!

For more history on Case Western Reserve's Department of Biomedical Engineering, visit *bme.case.edu/about/history.*

Cover photo by Russell Lee

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