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INSIDE THIS ISSUE

Cover image courtesy of Vanderbilt University Biomedical Engineering Department

MEET OUR NEWEST FACULTY MEMBER: DR. BRETT BYRAM

DYLAN DOVER

This year has been very exciting for biomedical engineering at Vanderbilt. We've been celebrating the 45th anniversary of Vanderbilt BME, making us one of the most storied programs in this relatively new field. It seems only fitting that during this historic year for our department, Dr. Brett Byram, who attended Vanderbilt for his undergraduate BME degree and Duke for his PhD, would return to join the faculty. I got a chance to talk with Dr. Byram about his return to Vanderbilt, some of his current research, and any advice he might have for Biomedical Engineering students.

PHOTO COURTESY OF VUSE

Dr. Brett Byram

Dr. Byram's excitement to be back in Nashville and at Vanderbilt was evident. He mentioned that he and his wife both enjoy the friendly, exciting Nashville culture and the many excellent restaurants around town. He went on to say, "I've enjoyed being back at Vanderbilt as well. It's a different environment, but this department is very strongly geared towards the clinic and associations with the hospital. There's a lot of potential for clinical collaboration."

Dr. Byram also talked about the research in his new lab BEAM (Biomedical Elasticity and Acoustic Measurement Lab) which launched this August. According to its website, "The BEAM Lab is interested in ultrasonic beamforming and elastography solutions to clinical problems." One topic Dr. Byram expounded was his research on ultrasounds, about which he recently gave a seminar for the Vanderbilt Initiative in Surgery and Engineering (ViSE), entitled "Decluttering Diagnostic Ultrasound: Searching for the Polar Bear in the Blizzard." Dr. Byram explained during both this lecture and our discussion that there have been a number of recent systems that dramatically increase the rate at which ultrasonic data can be processed. As he put it, "Before, we could only look at one location at a time, and had to continue to move around, but now, we can use very high frame rates that allow us to see transient phenomena. Ultrasound can be used to measure functional brain behavior, various kinds of propagating waves, and even dynamic cardiac rates." In a very general context, Dr. Byram explained that while his research is trying to push the boundaries on what certain medical technologies are capable of today, his overall goal is to come up with methods that work not only in a laboratory setting, but also out, in the clinic where such technologies need to be efficient and affordable.

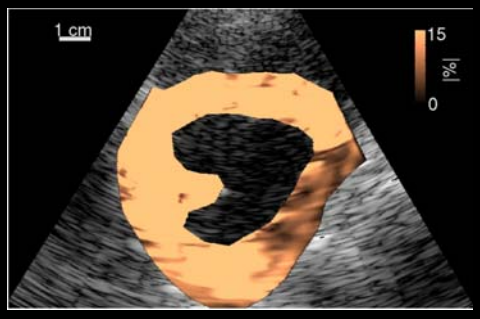

PHOTO COURTESY OF BEAM LAB

AKIS image of a chronic myocardial infarct

At the end of our discussion, I mentioned that Dr. Byram's trajectory as a biomedical engineer is one that many students hope to replicate, and asked if he had any advice for current Vanderbilt BME students. He responded: "I think one of the best things that students can do is getting involved with the faculty through research. There are a lot of great online courses where you can get access to really high quality material for free, but what you can get at Vanderbilt is experience working with and learning from experts in the field." He expanded on this by saying that students at Vanderbilt have the ability to work with faculty in a way that just isn't possible at many other universities. At the end of the interview, Dr. Byram reaffirmed why he is excited to be back by saying, "The Vanderbilt BME department does a good job of collaborating both internally and externally, creating more a sense of teamwork than of competition, and encouraging faculty to work together—you don't find that everywhere."

45 YEARS OF VUBME

STEVEN WANG

> “The growth of Vandy BME in the past few decades is staggering and shows how Vandy BME continues to be the innovation leaders in the field.”

The 45th anniversary of the biomedical engineering department here at Vanderbilt University was celebrated with many events and interesting seminars. The first seminar given by Thomas Harris, one of the original founders of the BME department, gave an insightful overview of the history of the department as a whole. The BME department was created because in the 1960s biomedical engineering became a focal point for some engineers because of its powerful application to important societal issues such as diagnosis and treatment of diseases. Thomas Harris, Bill Baker, and Ensign Johnson laid the early foundations of the BME department in 1964, and the BME bachelor’s program and curriculum was approved in 1968, with the first student graduating the BME department in 1969. In 1980, the graduate school approved the masters and Ph.D. program in BME and in 1993, the VU undergraduate BME program became an ABET accredited program. From there biomedical engineering faculty continued to build cross-institutional and multi-disciplinary efforts to address many important questions in medicine, science, and engineering. For example, in 2001, the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE) was realized as a VU interdisciplinary research institute focused at innovative systems biology and systems engineering under the leadership of BME faculty member and University Professor John Wikswo. In 2002, the Vanderbilt University Institute for Imaging Science (VUIIS) was founded under the direction of BME faculty member and University Professor John Gore. VUIIS’s mission is the advancement of the basic science of medical imaging and working on pressing clinical imaging research goals. In efforts to widen the impact of engineering, in 2011 the Vanderbilt Initiative in Surgery and Engineering (VISE) center was founded under the direction of electrical & biomedical engineering, and radiology faculty member Benoit Dawant. VISE’s mission is the translation of methods, techniques, and devices from bench to bedside. The impact of Vanderbilt’s BME program just continues to grow and push the boundaries of innovation.

Now in 2013, with more than 100 institutions that offer the BME degree, Vanderbilt University’s BME graduate program is ranked 16 in the U.S by *U.S. News and World Reports*.

There are a wide variety of laboratories in the BME department, including, cardiopulmonary circulation, OR monitoring, therapeutic bioengineering, image guided surgery, imaging science, cell bioengineering, biophotonics, cell sensing and control, biomedical modeling and simulation, BME education, and biomaterials. The growth in the student body in the BME department is evident with an undergraduate student body on the order of 300+ and a graduate student body 65+. The growth of Vandy BME in the past few decades is staggering and shows how Vandy BME continues to lead the field.

Of special note, as part of Vanderbilt BME’s 45th anniversary, esteemed bioengineer, national academy of engineering member, and professor at Boston University, James J. Collins, came during Vanderbilt’s BME department’s 45th anniversary to give a special seminar to give a brief overview of his exciting research for the past few decades. His focus has been “life redesigned,” essentially the importance and the emergence of synthetic biology.

A HISTORY OF STEVENSON 5

SIMENG MIAO

Many at Vanderbilt have come to associate the 8th and 9th floors of Stevenson Center Building 5 as headquarters of the biomedical engineering department. The two floors are home to many of Vanderbilt's BME labs, administrative staff, and the office of the department chair, Dr. Todd Giorgio. "I came to Vanderbilt in January of 1987," says Giorgio. "When I came, there was no BME department." Much has changed in the past couple decades; Giorgio has helped to create a successful BME department at Vanderbilt, growing in faculty size, students, and floor space.

Originally, the BME program consisted of various engineering faculty members working from their own departments, including electrical and chemical engineering. Once the BME department was officially formed in 1988, faculty members were given the opportunity to switch their primary appointment to biomedical engineering. At that time, the department of chemistry occupied the upper floors of Stevenson 5, so the small, newly formed BME department was loosely based in the building that predates Featheringill Hall. Most BME professors, though, still remained in the offices of their former departments.

About 15 years ago, "BME was able to get the 8th and 9th floors when chemistry built the extension on (Stevenson Center) Building 7," says Giorgio. For the first time ever, the entire Vanderbilt BME faculty was able to coalesce into one space, thanks in large part to Dr. Tom Harris, then the chair of the BME department. "He had the vision to put us all together," says Giorgio of Harris. Obtaining the Stevenson floor space proved to be valuable to the development of the BME department. More faculty members, including Giorgio, switched their appointments to BME. With a centralized location in Stevenson finally established, the BME department at Vanderbilt was able to increase departmental collaborations and become among the most respected BME programs in the nation.

PHOTO COURTESY OF VUSE

BME department chair Dr. Todd Giorgio

PROJECT C.U.R.E.

RYAN SPEARS

Project C.U.R.E. is an international non-profit relief organization based in Denver, Colorado. Since 1987, the organization has been delivering donated medical supplies to the medically underserved around the world. Project C.U.R.E. operates through distribution centers located in Denver, Houston, Phoenix, Chicago, and Nashville, and collects supplies at twelve collection centers located across the United States. With the only distribution center on the Eastern seaboard, Nashville is one of the busiest Project C.U.R.E. hubs in the world, sending out shipments to Mexico, Guatemala, Kenya, and Nigeria in the month of September alone.

Located less than a mile from Vanderbilt's campus, the Nashville distribution center is an excellent opportunity for the Vanderbilt community to volunteer. With highly flexible opportunities to volunteer offered daily, Project C.U.R.E. is tailored to fit within a busy schedule. Several Vanderbilt organizations have already volunteered with Project C.U.R.E., the most recent of which was the Biomedical Engineering Society. On Saturday, September 21 twelve group members volunteered at the Nashville distribution center. There, they packed medical supplies from surgical tools to insulin shots and prepared them for distribution to Nigeria. From just a mile off campus, these students assisted in providing hospitals on the other side of the world the supplies they lacked so they could care for people they would have otherwise been forced to turn away.

Over the past 25 years, Project C.U.R.E. has delivered medical supplies to more than 130 countries around the world, totaling to well over four billion dollars in medical supplies. Despite its vast success, Project C.U.R.E. has maintained the same simple system since its foundation: every dollar donates sends twenty dollars of medical supplies to people in need. For more information about how to donate, how to volunteer, or the company itself, please visit www.projectcure.org.

projectc.u.r.e.

IMAGE COURTESY OF WWW.PROJECTCURE.ORG

BIONANOVATIONS

THE NANOSCALE REVOLUTION

RYAN SPEARS

Rapid detection of infections has been a common science fiction motif for years, but a Vanderbilt PhD student is bringing it to life. Based on technology developed in Dr. Todd Giorgio's laboratory, Charleson Bell founded a company with Giorgio called BioNanovations centered on the development of nanotechnology systems that detect potentially life-threatening bacterial pathogens in minutes, a vast improvement to the days it takes current tests.

PHOTO COURTESY OF VUSE

Charleson Bell: CEO of BioNanovations

BioNanovations was accepted to Memphis Bioworks' ZeroTo510K medical device program in early summer, through which Bell first participated in a series of NewME (NewME Accelerator, LLC., San Francisco, CA) programs. In total, BioNanovations has won nearly $200,000 and the chance to participate in the final three-month NewME Accelerator program in Palo Alto, California, where he has been working to develop the company's business model, strike a healthy balance between business and science, and get preliminary Series A funding. With plenty of other ideas for viable products, Bell and Giorgio are at the forefront of the bionanotechnology community, a field on the verge of redefining the medical practice from infection detection timelines to FDA regulations.

With the introduction of the nanoscience and nanotechnology minor offered by the School of Engineering and the College of Arts and Science and supported in part by the Vanderbilt Institute for Nanoscale Science and Engineering (VINSE) this year, Vanderbilt is in a prime position to be a major contributor to the nanoscale revolution. As an interdisciplinary institute, VINSE allows labs from a wide range of departments to share resources they would otherwise be unable to afford. With these powerful tools at their disposal, Vanderbilt researchers are no longer limited by the materials they can afford within individual labs, allowing them to explore the bounds of their creativity.

It is an exciting time in the field of nanotechnology as startup companies like BioNanovations and research universities like Vanderbilt lead the innovative surge that is changing the face of the scientific community. With his longstanding involvement in research and his recent introduction to business, Dr. Todd Giorgio holds a unique perspective on the field of nanotechnology. According to him, the most difficult part of the transition was recognizing and accounting for the "additional boundary conditions out there in the real world that make the best solution different than the best solution in the laboratory." He went on to advise those pursuing the entrepreneurial path to "be ready for the unexpected" since they will likely need to make pivots to cater to the market and investors. Overall, he said it has been an empowering experience, and that he is eager to see what the future holds.

IDEAS WORTH SHRINKING

NATE BRAMAN

Vanderbilt's Dr. John Wikswo brings the miniaturized future of medicine to the big stage at TEDxNashville

PHOTO COURTESY OF TEDX NASHVILLE

Dr. John Wikswo takes the stage

"How many of you realize humonculi are next?" began Dr. Wikswo as he took the stage at the Tennessee Performing Arts Center. He surveyed the sold-out crowd of Nashville's TEDx talk. "Okay. I'm here to fix that."

It was a fitting start to Wikswo's speech, one of the event's 17 lectures centered around the "NEXT" theme. The seven hour series featured experts covering a myriad of specialties, each with a unique interpretation of the theme. Among a day filled with big topics such as immigration reform, education overhaul, and space exploration, Wikswo took a turn for the microscopic.

"The reason we need humonculi is that it's very hard to hear what organs are saying when they're talking to each other," Wikswo explained. Organs-on-a-chip, or humonculi, are microcosms of the human body contained within "chips" no more than an inch or two across. Unlike a silicon computer chip, these devices are comprised of three dimensional microfluidic cell-culture chambers. The type of cells and conditions within each chamber are designed to mimic a specific organ. By interconnecting these chambers, researchers can simulate the natural interplay between organs of the human body. Brain chips with functioning blood-brain barriers and beating heart chips were just a few of the examples Wikswo presented during his lecture.

The benefits of organ-on-a-chip technology will be numerous. They hold promise as a revolutionary new tool of drug design and environmental toxicology. For the first time, researchers will be able to screen a compound for safety in a system of interacting organs composed of human cells without putting a patient at risk. However, Wikswo believes humonculi's largest contribution will be to our understanding of physiology and systems biology.

"The more I read, the more convinced I am that three dimensional tissue culture is absolutely critical," Wikswo told BME Pulse. "[Humonculi are] really going to help us understand physiology."

Humonculi weren't the only focus of the 20 minute speech. Wikswo also stressed the importance of interdisciplinary collaboration and communication. "You have to have people who can speak more than one language," he told the crowd. "It's not necessarily mutli-tasking, but you have to be able to move between disciplines." Like the miniaturized organs on one of Wikswo's chips, the interaction of skills and specialties yields new possibilities.

"There are problems, like organs-on-a-chip, that are so big, so hard, and so complicated that one person can't solve them," added Wikswo during his interview with BME Pulse. "If you don't do collaboration, you're limited to smaller problems."

Wikswo is the director and founder of Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE), a multimillion dollar interdisciplinary systems biology research organization. He is also currently leading the development of ATHENA, a complex organ-on-a-chip featuring working two-chamber heart, lungs, kidneys, and liver.

SUPPORT VU BME

The Biomedical Engineering Program at Vanderbilt is continually striving to be the very best biomedi-cal engi-neering program in the country. Your support will help us achieve that objective. Please con-sider donating to the program—this will directly impact the resources for our undergraduates, the quality of the cutting-edge research taking place here in our laboratories, and ultimately the visibility of this very unique program.

Todd D. Giorgio, Ph.D., Chair of Biomedical Engineering

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