During April, the School of Engineering holds a senior design day which showcases the design projects of every senior engineering major. Design day is the culmination of nearly a year of work for the teams presenting. It is also an opportunity for various companies and individuals to come and see the multitude of projects. In addition, it is also the day that design awards are handed out to certain projects and teams. This year, BME took home two out of three AT&T Innovation awards.

Seniors Aditya Karhade, J.R. Peacock, Madeline Tolish and Fletcher Young took home the second place $1000 prize for their Hysteroscopic Surgery Simulator (HSS) project. The HSS provides a lower-cost alternative to current hysteroscopic training systems and will be tested by Vanderbilt medical residents. The design features a 3D printed uterus to create the environment and featured haptic feedback and quantitative feedback about various skills associated with tasks a trainee is instructed to perform.
The winning team, 3DMD, was another four person team whose members are Nathaniel Braman, Attiyya Houston, Melena Mendive and Simeng Miao. The winning team took home $2,000. Their project utilized smartphone imaging and 3D printing to create castings to correct clubfoot, which is a congenital deformity in infants. With the smartphone app, parents are able to take an active role in their child's treatment by taking photos at several angles and using the app to predict the next cast the child needs. Unlike most of the projects presented, Team 3DMD’s project was conceived entirely by the students whereas other projects are generally chosen by a mentor.
Each May a new class of biomedical engineers graduates from the Vanderbilt University School of Engineering, ready to move on to the next phase of their lives. Undoubtedly, the Class of 2015 is a talented and diverse group: while they have all taken the same core classes, these students have found many different outlets in which to apply their biomedical engineering knowledge.

“I picked biomedical engineering because it gave me a broader perspective of engineering, and allowed me to understand how whole systems work,” says Mary Kate Hardy. As part of a biomedical engineering service class, she traveled to Guatemala last year to repair medical equipment. Kristin Barth also spent time studying abroad as an undergraduate. “I know many engineers at other schools can’t fit study abroad in their schedule, so it’s nice that Vanderbilt offers it as an option,” says Barth. She spent a semester in Dublin, Ireland, where she took a variety of classes, including a food process engineering course.

As the year comes to a close, seniors reflect positively on their past four years at Vanderbilt. “I’ll miss being surrounded by people who like to work hard, but also like to have fun,” says Hardy. “I’m consistently being challenged in class and in the environment of learning that Vanderbilt builds,” adds Jevin Tzeng. After graduation, Tzeng will be working as an assistant in an oral surgery office before attending dental school. Other seniors are planning careers in business school, graduate studies, and industry (Hardy recently accepted an offer from Rice 360 Institute of Global Health Technologies; Barth will be working at Cerner Corporation, a major company in healthcare delivery).

Aditya Karhade, a biomedical engineering and neuroscience double major, will be attending Harvard Medical School in the fall. His advice for incoming students is to find mentorship opportunities and to form meaningful relationships. “When you come into college, you have interests, but you don’t necessarily have passions,” says Karhade. “As you form relationships with professors as mentors, you can learn from other people who have tested their interests to develop their passions.”
One of the ways Vanderbilt helps develop engineering students’ passions is through Design Day, a capstone project where groups of students gain experience working on real-world projects. “Senior design allows us to work in a team without direct supervision from a professor, and we’ve had to work on pacing ourselves and determine the direction of our project,” says Barth. “This has been truly the first time that I have been able to make prototype iterations of a device that could actually be marketed,” agrees Tzeng.

“You get used to talking about problems with other people, and there’s a sense of ‘taking care of your own’ among biomedical engineers.” —Karhade

The seniors all agreed that what makes the biomedical engineering major unique is the collaboration and camaraderie between students. With difficult classes and weekly homework, students quickly learn that excelling in engineering requires communication and mutual support. “The problem sets are so tough that you have to work together to solve them,” says Karhade. “You get used to talking about problems with other people, and there’s a sense of ‘taking care of your own’ among biomedical engineers.”

The Class of 2015 will graduate on May 8th, 2015
This year the BME department is saying goodbye to long-time faculty member Dr. Robert Gallo- way. Dr. Galloway has been at Vanderbilt since January of 1985 - the longest continuous time any BME faculty member has been at Vanderbilt. Dr. Galloway currently holds three titles: Professor of Biomedical Engineering, Professor of Neurological Surgery and Professor of Surgery. During his time at Vanderbilt, he has made several contributions including providing an instrumentation focus to the BME department and starting the popular BME elective Therapeutic Bioengineering. As we say goodbye to Dr. Galloway, this article will explore his life and provide an idea of who he is outside of a professor.

Before Robert Galloway became a professor at Vanderbilt University, he started his college career at Duke University in Durham, North Carolina. He had aspired to become an oceanographer and had been scuba diving since the age of 14. However, his plans quickly changed once he discovered the rigorous foreign language specifications a degree in marine biology required. After looking through a course catalog, he discovered Biomedical Engineering; which was right after marine biology. He decided he would give this major a shot and ended up really enjoying the field. He received his Bachelor’s degree in BME from Duke. Moving forward, he had the opportunity to go to medical school or to pursue a Masters in Engineering. Due to his fascination with watching his ideas come to life, Dr. Galloway chose to move on to the University of Virginia for his Master’s degree and finally returned to Duke for his PhD, where his research focused on ultrasound imaging.

After graduating from Duke, Dr. Galloway and his wife were both able to find work at Vanderbilt. When he first came to Vanderbilt, Dr. Galloway was mentored by Dr. Harris. Much like his time at Duke, Dr. Galloway’s initial research focus was on cardiac ultrasound. However, after MRI for lung imaging popped up as a hot topic, he discovered a new area of interest and was soon experimenting with MR images. From there, he began his work on image guided surgery, which is his current research focus.

Dr. Galloway’s retirement has brought many questions from students about what will happen to the beloved Therapeutic Bioengineering elective. In fact, the course has had so much success that it has been adopted by several other universities. Although no definitive plans have been made, Dr. Galloway says that if there is enough continued interest in the course, there should be a way to continue providing it.

When asked about his retirement plans, Dr. Galloway says he is building a house in the mountains of Virginia that is entirely his design. He plans to continue scuba diving and to work on water skiing. Although Dr. Galloway has not water skied in over 30 years, he plans on devoting time to relearn the sport. He will also be able to spend time with his dogs in the mountains of Virginia.
With new course numbering systems coming into effect for the fall of 2015, there have been questions about which courses are required for the biomedical engineering (BME) major. Although the courses have been renumbered, the requirements remain largely the same as past years. The biomedical engineering major requirements at Vanderbilt are sectioned into a major core, liberal arts core, general degree requirements, major electives, and open electives. To graduate with a B.E. in BME, 127 credits and a minimum GPA of 2.0 are required. Both new and old class numbers will be used here, with the old course number provided in parentheses. The number of credits each class provides is listed as well.

### MATHEMATICS

- MATH 2300 (175). Multivariable Calculus [3]

### CHEMISTRY

- CHEM 102A. General Chemistry [3]
- CHEM 102B. General Chemistry [3]
- CHEM 104A. General Chemistry Lab [1]
- CHEM 104B. General Chemistry Lab [1]

### PHYSICS

- PHYS 1601 (116A). General Physics I [3]
- PHYS 1602 (116B). General Physics II [3]
- PHYS 1601L (118A). General Physics Lab I [1]
- PHYS 1602L (118B). General Physics Lab II [1]

  or

The general engineering requirements draw from a variety of disciplines, all of which eventually prove useful in BME courses. For example, MATLAB, taught in CS 1103, is used in BME 2100 and BME 2200 (at the professor’s discretion). Note that many of the BME engineering requirements are also pre-med requirements, which makes BME the easiest engineering major to fulfill for pre-meds.

**MAJOR CORE**

BME 2100 (101). Introductory Biomechanics [3]
BME 2200 (103). Biomedical Materials: Structure, Property, and Applications [3]
BME 3000 (210). Physiological Transport Phenomena [3]
BME 3100 (251). Systems Physiology [3]
BME 3101 (252). Systems Physiology [3]
BME 4900W (255W). Biomedical Engineering Laboratory (Lecture and Lab) [3]
BME 3200 (260). Analysis of Biomedical Data [3]
BME 3300 (271). Biomedical Instrumentation (Lecture and Lab) [4]
BME 4950 (272). Design of Biomedical Engineering Devices and Systems I [2]
BME 4951 (273). Design of Biomedical Engineering Devices and Systems II [3]
BME 4959 (297). Senior Engineering Design Seminar [1]
Many of these courses are courses from other disciplines placed in a bioengineering context. For example, biomechanics is derived from mechanics (physics), biomedical materials is derived from materials science, and physiological transport is derived from heat and mass transfer and fluid mechanics (chemical engineering). Systems physiology uses MATLAB for modeling and simulations. For pre-meds it is recommended to push back BME 3000 to senior year, as it is a difficult class and usually taken in junior year, during which many students prepare for the MCAT.

The major elective requirement is comprised of 12 credits of BME courses formerly numbered 203 or higher. This is where you can explore your BME area of interest - topics ranging from bioelectricity to biomedical imaging to nanobiotechnology are discussed. Note that many of these elective courses have prerequisites that need to be taken into consideration. Up to 3 credits may be counted towards BME undergraduate research (BME 3860, 3861, 3850, 3851). However, if a deeper research experience is desired, an additional 3 credit hours may count toward the technical elective requirement described in the following paragraph. Certain courses outside of BME may also count towards the elective core; students who are not double majoring in electrical engineering may take one of these courses: ChBE 4500 (283), 4810 (282), 4870 (287), EECE 3214 (214), 4353 (253), 4354 (254), ENVE 4610 (272), or ME 2220 (220).

The technical elective requirement is comprised of 12 credits derived from several sources: 1) BME electives taken above the 12 credit minimum from the major elective requirement. 2) Most courses in the School of Engineering. 3) Most courses formerly numbered 200 or higher in the College of Arts and Sciences listed in the mathematics and natural sciences AXLE distribution category. Pre-meds can fulfill the technical elective requirement with courses such as biochemistry, organic chemistry, and statistics.

The liberal arts core is required across all engineering majors. It is comprised of 18 credits, of which at 3 hours each must be from 3 different Liberal Arts core categories. Additionally, 6 hours must be from one category. Pre-meds may fulfill most of these requirements with sociology, psychology, and English writing courses. AP credit may also be used to fulfill this core.

And last but not least, there are 6 credits reserved for open electives. Any courses will fulfill this requirement, so students should use this to explore any other interests they may have.
The objectives of the undergraduate BME program are to equip graduates with the skillsets necessary to meet employer’s expectations and enable qualified graduates to pursue more advanced studies. Therefore there is merit in mentioning the postgraduate outcomes of prior BME classes. Graduation and job statistics provided by the School of Engineering are an enlightening reference for future BME graduates.

The BME Class of 2014 was comprised of 59 graduates and was the second most popular engineering major behind mechanical engineering’s class of 77. For graduates accepting domestic employment offers, the average salary was around $65,000 with a standard deviation of about $12,500. For BME graduates that expressed intention to go to medical or dental school, 90% were accepted.

In comparison, the overall engineering Class of 2014 had a medical school acceptance rate of 82%. To prepare for your future after graduation, Vanderbilt provides several valuable resources on campus such as the Center for Student Professional Development, the Health Professionals Advisory Office, and professors themselves. Here one can find opportunities for internships, shadowing, research, and coaching that prove invaluable.
Back in December, I had the opportunity to attend the third annual Surgery and Engineering Symposium, put together by the Vanderbilt Initiative in Surgery and Engineering (ViSE) Center. The symposium opened with a coffee session sponsored by ZEISS (Carl Zeiss Meditec AG, Germany), the well-known manufacturer of surgical microscopes and novel imaging systems for medical use. Then, Dr. Robert Sweet of the University of Minnesota presented the keynote address, “The Emergence of Simulation Science for Healthcare.” Dr. Sweet’s presentation focused on the development of tissue and body simulations for surgical training. His vision is to allow surgeons to practice realistic surgeries where possible complications may occur. The idea is that if a surgeon can practice what happens when things go wrong, he or she will be extremely prepared to respond in a calm and effective way.

After the keynote speech, we moved back into the lobby for the poster session, where I was able to get a glimpse into the research and developments of the campus ViSE labs. The ViSE program sits at the intersection of engineering and medicine, and it was truly incredible to see the result of direct interactions between engineers and doctors. From computational modeling for image-guided surgery, to surgical robots with steerable needles, to advanced prosthesis, the various labs and their projects exemplified the results of collaboration among the biomedical, electrical, mechanical, and computer engineering disciplines and the many clinicians who will be, in many cases, the end users of these technologies.

The symposium was not only a great experience, but it also reminded me of what attracted me to Vanderbilt’s Biomedical Engineering program in the first place: the communication and collaboration between engineers and doctors that results in safer, more effective therapeutic techniques and technologies.

Pictured above are:

Dr. Mike Miga, PhD (Vanderbilt University Department of Biomedical Engineering)

Dr. Robert M. Sweet, MD (University of Minnesota, Department of Urology)

Dr. S. Duke Herrelll, MD (Vanderbilt University Medical Center, Department of Urology)
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The Biomedical Engineering Program at Vanderbilt is continually striving to be the very best biomedical engineering program in the country. Your support will help us achieve that objective. Please consider 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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