
BMESPulse
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The official newsletter
of the
Biomedical Engineering Society
at Vanderbilt
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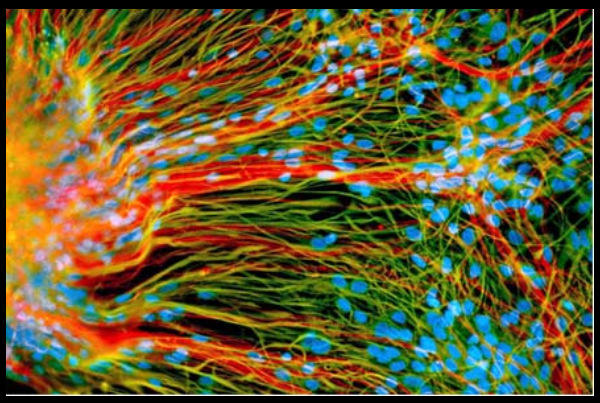
Inside this issue:



~Stem cell photo courtesy of Vanderbilt Medical School archive (used in cover and within issue)

Our Mission:

Vanderbilt's Biomedical Engineering Society (BMES) is an academic society whose goal is to provide pertinent information and resources about biomedical engineering to the biomedical engineering community at Vanderbilt. Our objective is to help our members network with as many professionals in the field of biomedical engineering as possible to further their understanding of all aspects of biomedical engineering. Our ultimate goal is to assist members in securing internships, research opportunities, and industrial positions in biomedical engineering.

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Senior Sendoff

While many may associate this past April 15 with the feverish delight of filing tax returns, BME students remember it as the first annual BMES sponsored Senior Sendoff Party in Featheringill atrium. A number of society members planned and coordinated the event in an effort to give the graduating class an opportunity to say goodbye to friends and teachers. The party was catered with food and drinks and featured a running slide show with BME faculty trivia including news like Dr. Anderson has triplets, Dr. Gore holds a law degree, and Dr. Paschal ran a marathon for charity. When seniors arrived, they were given a survey and a coffee mug printed with Vanderbilt BME. Professors Miga and Giorgio then stepped in front of the podium and bid their farewells to the graduating seniors followed by BMES President Morgan Folus who gave a final speech covering this year's progress saying, "Before I became BMES president, the society was very young. I knew there was much room for it to grow and reach out to more students studying biomedical engineering. Overall we've become more organized, gathered a stronger following and have been able to host more events. I hope our society continues to grow with great success." It appeared that most graduating students knew where they would be heading. Despite the market climate many students were fortunate to have jobs lined up while others will be attending graduate or medical schools next fall.

The sendoff also provided a venue to turn over society leadership positions following the recent elections. For the upcoming year Jeff Turner will take over for Ayo Ositelu as VP Internal, Sean Miller will replace Elizabeth Provenzano as VP external, Troy Brown will assume Jim Clear's role as VP of Finances, and Trip Cothren will replace Morgan Folus as Society President. This past administration has set precedent with marked improvements in membership, events, and overall structure. There are now over 90 members with a growing number of students regularly attending the BMES meetings in addition to dues being collected which have funded events including the sendoff event. They have also structured elective seminars for the students and established contact with the VU medical center to offer students an opportunity to shadow medical personnel. It is anticipated that the new administration will follow this year's direction in taking steps to foster growth of the society to better reflect the presence and strength of the BME program and community on campus.

Senior Design Spotlight: An Alternative Wheelchair Propulsion System

Wheelchair dancing. Can you do it? Children and adults with physical disabilities are proving the world wrong. Being in a wheelchair far from limits one's abilities to maintain an active lifestyle. Participation in the Paralympics games, National Wheelchair Basketball Association, and activities like wheelchair dancing have provided the physically handicapped with an opportunity to show off their skills. Though much progress has been made in providing increased options for the disabled, a lack of technology to assist with overuse injuries for wheelchair users still exists.

Many wheelchair users experience overuse injuries, primarily in the shoulders and wrists. Imagine traveling around in a wheelchair and having to cope with carpal tunnel syndrome at the same time! Unfortunately, existing wheelchairs that address these ailments are either entirely electric models or manual models with electric assists. These are costly (wrap your head around $7500), heavy (upwards of 130 pounds), and are not always successful in preventing injuries.

Five BME seniors decided to conduct their senior design project in hopes of developing an electrically driven add-on system that would be relatively lightweight, less costly, and capable of being easily produced and attached to a variety of manual wheelchair frameworks. The team was sponsored by Max Mobility, an R&D firm whose goal, as its name suggests, is to maximize the mobility of the disabled.

For engineering seniors, the senior design project culminates four years of grueling physics, biology, chemistry, and engineering coursework. According to David Salvetti, one of the five group members, the most helpful courses to his work on the project were physics, biomechanics, and Electrical Engineering courses. "Most of our calculations in the project centered on the electrical side of the device. We needed to match resistors to the power consumption so we wouldn't blow anything up. We did some mechanical calculations, but on that side we used our intuition more than anything," said Salvetti.

As with any prototype, the alternative wheelchair system was both a success and a marker for future consideration and research in the area. The final model uses a small electric drill motor that produces sufficient torque to propel the wheelchair, eliminating the need for...

...the arcing arm movement required of manual wheelchair users. The control system involves two electrical relays, one for a "high" speed and one for a "low" speed, and a toggle switch to alternate between them. For both convenience and safety purposes, the switch was mounted on the frame of the wheelchair and can be simply controlled by thumb. Thus, to make turns, one simply needs to "brake" by grasping the appropriate wheel. The entire attachment is nicely contained within the footprint of the wheelchair. Although time constraints and available materials placed limits on various aspects of the model, the fundamental message is that more easily accessible wheelchair systems can certainly be produced, which will significantly reduce the incidence of injuries among wheelchair users.

Engineering Week: Egg Drop Bonanza

Engineering Week: Egg Drop Bonanza

During the week of February 16, the halls of Featheringill were bustling with students participating in the 58th annual National Engineering Week hosted by the Vanderbilt University School of Engineering. Sponsors included the Engineering Council, FedEx, Dell, Tau Beta Pi, SHPE and ASCE among others.

Traditionally, National Engineering Week is held the week of President's Day because George Washington was considered the first engineer, primarily because of his survey work. The purpose of this week is to make note of the things engineers do as well as to emphasize the importance of math and sciences.

A wide range of activities were held including an obstacle course for robots, a computer assembly competition and a faculty appreciation luncheon. In the middle of the week there was an Ice Cream Social where students could make their own ice cream out of liquid nitrogen. On the last day graduating seniors had to take an ethics oath to be inducted into the Order of the Engineer and receive their Engineer's Ring. To close off the week the Computer Society hosted a LAN Party and Halo 2 Tournament including games such as Rock Band and Halo 3.

What follows is an interview with Wern Ong, a sophomore biomedical engineering student who participated in the opening event: the egg drop competition.

How does the egg drop competition work?

The egg drop competition is judged using two criteria. The main goal is to create a device that keeps an egg from breaking when dropped from the roof of…

Featheringill Hall. The second criteria involves a target. When you drop the egg from the building, you have to try and make your design land as closely as possible to a target on the ground. The competition is sponsored by FedEx so you have to incorporate a FedEx box into your design. You are given a variety of other supplies including paper tape, rubber bands, straws and cotton balls. The teams are composed of two people and there are cash prizes that go up to 400 dollars for the winners.

What did your design look like?

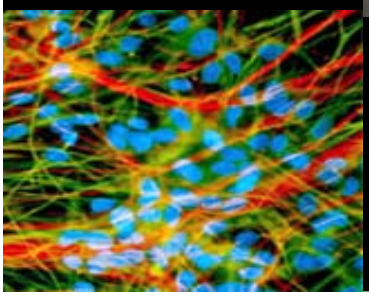
Our design looked like a rocket with a cylinder shape. The egg was suspended in the middle so it had room to move up and down while it was falling and so it would not break when it hit the ground. When we dropped it from the building the egg did not break, but our design did not hit the target close enough.

What are some of the other events?

There is a tower building competition in which you try to build the highest tower out of popsicle sticks. Other events include building a computer or robot but the egg drop competition and tower building competition are the most popular events.

Do you think Engineering Week has a big impact on engineering students?

E-week is just a lot of fun for engineering students or any kind of student for that matter. It shows that there is some levity to being an engineer and but that you can also do cool things as an engineer. The cash prizes are also a nice incentive for people to participate. I think the main reason E-week is held is to get people excited about Engineering.



Electives at a Glance:

Fall 2009 Insider

Service Learning Project

Dr. Cynthia Paschal (Dr. P)

- MWF 1:10-2pm
- 3 hrs
- In class work and out of class projects
- Mentor, grant proposal, few HW assignments
- Pick a project
  - Project CURE
  - Siloam Family Health Center
  - Institute for Global Health
  - Design your own

Signal Measurement and Analysis

Dr. Mark Does

- Modeling measurement with linear systems
- Extending concept to nonlinear systems
- Fourier Transforms
- How to use all of the above in problematic sense
- Analytic and computer approach
- Use Matlab exclusively
- No required textbooks
- 5 assignments TOTAL
- Time and frequency domain
- Midterm in class
- Slides during class of matlab functions

Quantitative and Functional Imaging

Dr. Adam Anderson

- TR afternoons
- How is biomedical imaging used to measure structure and function in the body? (CT, PET, US, MRI)
- How tissue properties affect image intensity
- Tissue microstructure

Quantitative and Functional Imaging (cont)

Dr. Adam Anderson

- Metabolic imaging
- Molecular imaging
  - i.e. drug abuse
  - heart disease
  - Parkinson's
- Goals
  - understand how biomedical imaging is being used in medicine
- Prereqs
  - BME 258
  - Working knowledge of MatLab

Therapeutic Bioengineering

Dr. Bob Galloway

- Engineering Description of Normal Anatomic or Physiological Function
- Engineering of Diagnostic Processes
- Goal
  - Differentiate between design and discovery from an engineering perspective
- Some questions
  - Cut tissue with knife and bone with saw
  - Cockroach has circulatory system and ant doesn't
  - Cryostorage vs cryoablation
- Structure
  - No textbook but lots of reading and in class participation
  - 3 HWs and one 20 page paper due before thanksgiving
  - Max 30 in class

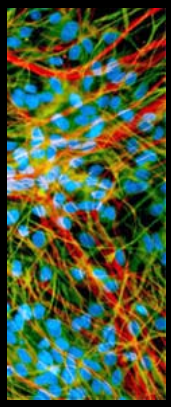
Introduction to Biomedical Optics "Light for Life"

Dr. Mahadevan Jansen (Dr. MJ)

- Focus on the eye is a very small portion of class work
- Use of light to solve problems in medicine and biology
- Challenge driven
- No textbooks, completely interactive
- Prereqs
  - -Freshmen physics
  - -First two weeks spent on review of physics
  - -Learn what happens to light, how to use light
  - -Laser ablation
  - -Diagnostic applications
  - -Detecting cancer, diabetes, optical imaging methods
- Goal: understand the possibilities of light in the biomedical field

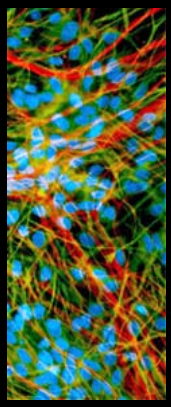
New BME Course Helps Build Students' *Corazónes y Mentes* (Hearts and Minds)

Twelve college students, a professor, and a tropical setting. Sound like a scene from *Gilligan's Island*…or an innovative approach to spring break for biomedical engineering students?



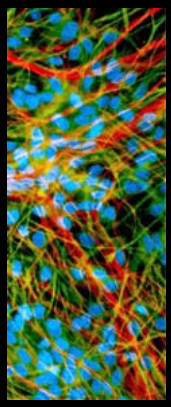
Hospitals and clinics around the world are faced with a dire equipment shortage that prevents them from providing the most up-to-date, effective diagnostic and treatment procedures. Vanderbilt University BME professor Dr. Cynthia Paschal wanted to get her students out of the classroom over spring break and into the real world of biomedical engineering to address this issue. After attendance at the Vanderbilt Symposium on Developing Sustainable Health Collaborations in Latin America, Dr. Paschal found the perfect venue for a new service learning-focused BME elective course and trip. The location and poverty in Guatemala, specifically, presented a situation where the students could make a significant positive impact.

BME sophomores, juniors, and seniors traveled with Dr. Paschal and Dr. Edward White, Dean Emeritus of the School of Engineering, to Guatemala this past March to put their instrumentation (and Spanish) knowledge to work at Hospital San Juan de Dios and Manos de Amor clinic.



Unexpected conditions greeted them. Basic machines were broken and tools common in the United States were scarce. "Spare wire and electrical tape were unavailable there, which made fixing some simple problems much more complex," says student participant Lauren Nichols, '10. The students often had to put on their *Inspector Gadget* hats to find the root of the problems. Paul Guillod, '10, remarks, "We were presented with anything from broken vital signs monitors to feeding pumps. In most cases the only explanation to the problem came from tape across the front marked with '*no functiona.*'" The group spent one week attempting to repair medical supplies, meeting with many successes along the way despite the technical shortcomings, including repair of a Bovie® electrosurgical generator that had not worked for years.

The students also had the chance to interact with community members and local engineering students at the Universidad del Valle de Guatemala. By sharing not only their skills and knowledge, but also their compassion, the "human element" was integrated into the BME curriculum. The students realized the impact they as BMEs can have on people's lives and wellbeing. Guillod observes, "For the first time it wasn't just our grades at stake, but actual patients. ... This is a level of responsibility unfamiliar to the average engineering student."



The group also gained an appreciation for the health care system in the United States. Nichols learned "how lucky we are to be blessed with great technology and first class hospitals and how much we take for granted every day."

The elective course BME 290F: "Service Learning in Guatemala" will be offered again next spring. Dr. Paschal is continuing to develop her contacts and relationships with Guatemalan universities and hospitals in the hopes of bringing about significant change to the quality of rural Guatemalan medical care. Involvement of Guatemalan BME students will help to create an international partnership dedicated to improving health and medical technology.

MoneyTalk

The rich aroma of coffee wafts from an all too familiar bongo java cup. Black top, brown slip, quirky saying "we appreciate your addiction." That addiction cost me $4.27. I would say a fairly decent price for a cup of joe from Fido's in Hillsboro Village. The caffeine counters the wearying effects of sifting through countless credit card specs online…my excuse for not studying crystal lattice structures. Rubbing my eyes, I try to figure out why fixed interest rates or APR's matter when it hits me. I have no idea what the real world is like and how I will fit into the workforce post graduation. How will the job market receive a freshly minted Biomedical Engineer from Vanderbilt? What options are available to me and how am I going to pay for that coffee? $4.27 is starting to seem a little steep.

Determined to sort through these worries, I approach Dr. Giorgio, head of the BME department for some answers and guidance.

Me: Dr. Giorgio. The economic crisis of 2008 has had a detrimental effect on the job market, loans, and funding across the board. How has the BME department at Vanderbilt felt its effects?

Dr. Giorgio: This year has been an opportunity for the BME program at Vanderbilt to propel itself forward. We have a high quality program with financial strength in times of economic turbidity. Three new faculty have been hired this year in the face of financial distress at many other institutions where new faculty searches were cut. In fact, the NIH is using money from the stimulus package to support many such schools.

However, the department, like many others across campus, pulled back on initiatives in October and November of 2008 during the height of the crisis.

Me: In what capacity will the new faculty help propel Vanderbilt's program forward? And what are some examples of the BME department's financially conservative practices?

Dr. Giorgio: Staff positions were left unfilled and there were fewer entertainment events. For example, an external advisory board flies in annually to evaluate our program; however, this year limited entertaining and, instead, conducted the evaluation through conference calls and emails. A large portion of the department budget is earmarked for salaries so control of the overall budget is only moderately impacted, primarily changes in discretionary spending.

We are fortunate to find three great new faculty members. Dr. David Merriman from the University of Alabama at Birmingham will transfer here in the fall as an associate professor. Dr. Hak Joon Sung from Rutgers University of the Center for Biomaterials will join us in the fall. Dr. Craig Duvall from the University of Washington (Seattle) will join us in the Spring.

Me: What direct or indirect effects have there been on funding for graduate school programs and undergraduate curriculum?

Dr. Giorgio: They have remained essentially unchanged. The budget for graduate students and teaching assistant positions is the same. Faculty have successfully competed for stimulus package resources. For example, Dr. Mark Does received a two year grant from stimulus money with which he can support new students and research programs.

Me: So the stimulus package has had a significant impact?

Dr. Giorgio: There is a lot of competition for this money; only 3 percent of the applications will be funded.

Me: There is a sense of anxiety in the class of 2010, especially since many 2009 graduates had difficulty getting into graduate programs and landing jobs. What are the post grad prospects for BME students now?

Dr. Giorgio: The trend is toward industry positions rather than graduate school or medical school. A couple of our award winners are going to Harvard medical school, University of California at Berkeley and University of Pennsylvannia graduate school, and some have positions at Roche.

Me: Do you foresee this trend changing in the near future if the economy turns up?

Dr. Giorgio: As time progresses, there will be increased opportunity for BME students. Industry has increasingly realized the value of our skill set which is at the intersection of engineering, medicine, and biology. As the economy turns up, industry will hire more graduates.

Both the BMES and AIMBE educate industry people about what biomedical engineers can offer. Biomedical engineers are engineers first with the same training in mathematical analysis and modeling as other engineers. We focus on biology rather than chemistry. There has been an increase in biology and medicine in many fields. For example, the Chemical Engineering Department here at Vanderbilt recently changed its name to Chemical and Biomolecular Engineering.

Another example is Professor Goldfarb, who is working with prosthetic arms in Mechanical Engineering dealing essentially with biomechanics. His challenge is to interface control of the limb with the person. A possible solution is a neuro interface that is mechanical. Dr. Mahadevan-Jansen of the Biomedical Engineering Department work on optical interface with nerves. This allows control of artificial limbs through neural activity coupled with optics rather than say wires.

Me: If the department were to receive a donation of $1,000,000, what would you use the money for and why?

Dr. Giorgio: The biggest challenge in the department is space. We are continuing to grow with the addition of 3 new faculty members. The department is running out of attractive modern physical resources for these new faculty. That money could be used to find space for faculty and staff and undergrad labs such as Instrumentation 255, Optics lab, imaging, etc. If we had a million bucks, we would definitely renovate a couple new spaces.

Last fall, we were engaged with the School of Medicine to create a new space to house both programs. The facility would be shared by the Chemical and Biomolecular Engineering Department, the Biomedical Engineering Department, and some parts of medicine.

Me: Do you have any suggestions for BME undergrads pertaining to future plans? Should we stay in school while the economy is down or are grad school positions just as limited as industry positions?

Dr. Giorgio: Resist the temptation to take all electives at elementary levels! It is important to find a subset of biomedical engineering and delve deeper. Many students will take introductory courses in organic chemistry, nanobiotechnology, medical imaging, and biophotonics. I highly recommend taking the second and third courses in the sequence. Find your identity within BME.

Why Bioengineering Research?

Bioengineering cardiac muscle and artificial limbs, mimicking the echolocation of bats for medical ultrasound imaging, improving cochlear implants, creation of the bionic ear, the many uses of biocompatible and biodegradable polymers, Hemospan, artificial lungs, protein modeling, development of electro active polymers for motion and force generation…and the list goes on and on.

So how can we get involved with the invention of these very cool discoveries and research? What kind of career in bioengineering must we pursue to achieve our goals and passionate interests? Some of us may have a vague plan, others may only have their passion, and few others have a set structural plan for their future in bioengineering.

For all of us who plan to enter into this circulatory system of interactive and challenging field called Bioengineering, I grant this audience a special spy glass to peer into some brilliant bioengineers who are present around us at UCSD.

Interviewing Jake Feala, a 5th year grad student/Phd candidate in CMRG:

How do you come up with what you plan to research in the lab? What leads you to these decisions? What is it like having undergrads under your wing and advisors to guide you? I know that you work in two labs – one at the Burnham Institute and the other with the Cardiac Mechanics Research Group (CMRG) – what do you do in both of the labs?

It is the Principal Investigator (usually a professor, in my case Dr. Andrew McCulloch) that first outlines a research project. The PI will generally have decades of experience so they have a good idea of what is already known in their field, and more importantly, what is unknown. That allows him or her to come up with the best project that can generate new and interesting knowledge, and that best leverages their lab's expertise. Their search is usually funded by government grants, for which they must be constantly applying.

If the PI has money to fund a new project, then they often recruit a student (or postdoctoral researcher) to work on it. Once the student has a few years of experience with the research, they will begin to take ownership and can work with the PI to change the direction of the project according to new ideas or new experimental results. At this stage, if the researcher is a grad student, they have enough experience to get undergrads to help with different aspects of the project.

My project was already outlined when I arrived at UCSD to start my Master's degree. The basic methods for microscopic measurement of fly hearts had been established, and in the next two years (in parallel with my coursework) I added computer automation so that a user could automatically locate and measure the hearts on a slide full of living (anesthetized) flies at the press of a button. Dr. McCulloch inspired me to stay on for a PhD so that...

...the project could realize its potential for genetic screening of heart function, and in the following three years I improved the technology and built an accompanying computer model of metabolism so we could study the effect of gene knockouts on hypoxia tolerance both in computer simulations and in the live fly heart. Also, I do some work at the Burnham Institute with my co-adviser Giovanni Paternostro, using proton NMR spectra of fly muscle tissue to validate and tune the computer model.

Over the years, I have had several undergrads help me cross the fly stocks, test the automation interface, build research equipment, and many other tasks. It's generally a win-win scenario, since they gain experience in the lab and I get to focus on the higher level research planning and technical work rather than daily lab routines. Dr. McCulloch is very encouraging of undergraduate volunteering and we often have several in our lab at a given time.

-Jake Feala recently defended his thesis

Interviewing Ben Coppola, a 5th year grad student in CMRG:

What made you decide to go into the PhD program at UCSD? I remember you talking about how you initially wanted to pursue academia and then decided to go into industry after you graduated in June. What made you decide to switch your goal, and what do you look forward doing in industry, very soon, and/or in the future?

During my time as an undergraduate student in Mechanical Engineering at Lehigh University, I did two summer internships. In both instances, I felt like people with Ph.D.'s were involved in the most interesting projects. In addition, as I reached the end of my undergraduate education, I had a decent broad knowledge of engineering but was not the expert I wished to be. I came to UCSD Bioengineering to get better engineering fundamentals and also begin applying mechanics to biology. At the time of enrollment, I actually thought that I would pursue a career in academia. However, as I progressed through the Ph.D. program, I decided I wanted to go to industry for a couple of reasons. First, I wanted to work on a product, which would have short-term implications for healthcare, as opposed to the long term scope of academic research. Second, academic jobs require a lot of flexibility as to where you end up living. I wanted to have more of a choice, for example, to stay in the San Diego area.

There are other pros and cons of both academia and industry, of course, but these were some of the most important.

-Ben Coppola recently defended his thesis.

Interviewing Professor Shu Chien:

I've heard from Prof. Sung that you and several other faculty members received a PhD and MD. What was it like to be in that program and what motivated you to take this route? What advice would you give to the bioengineering undergraduate students here at UCSD?

I received my M.D. and Ph.D. separately, rather than from a combined M.D-Ph.D. program. I studied medicine in Taiwan. When I graduated from medical school, I was choosing between clinical training (internal medicine) and basic research (physiology). I liked both options and it was a difficult decision. I finally chose to receive graduate training in physiology at Columbia University in New York City, mainly because I would like to have the opportunities for innovative research, as well as teaching. When I completed my Ph.D. study in physiology, because of my interest in Math, my research became more and more quantitative, i.e., it was increasingly closer to bioengineering, and now I am a Professor of Bioengineering even though my formal training was in Medicine and Physiology. Although I have not done clinical medicine except for a year of rotating internship during my medical schooling, I believe what I learned in medical school has significant influence on my research and teaching.

The knowledge in clinical medicine is very helpful for identifying clinical relevance of research and in providing clinical examples of the applicability of basic information. My Ph.D. training provided me with the valuable knowledge on how to design experiments, solve problems, analyze and interpret data, collaborate with others, and make written and oral presentations of the research. Thus, I feel the training I received during both M.D. and Ph.D. studies are very valuable, and they are complementary.

Having said that, I think it is not necessary to go through both degrees to accomplish this, especially if one is willing and able to learn after completing one or the other degree. For example, many of the outstanding researchers only have the M.D. degree; they received research training during their years of fellowship program after their residency. There are Ph.D.'s who are very knowledgeable about clinical medicine by attending lectures, clinical rounds, and studying on their own. Since both medicine and basic research are ever evolving, the ability to learn continuously is extremely important. The formal education in a degree program only provides a starting point, what the graduates can do in their careers depends very much on the continuous learning and effective and innovative applications of their knowledge to the work they do, whatever the area might be.

Thank you to the faculty, grad students, and post grads that gave their time to make this article possible.

Supporting BME

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

A Contribution to the Biomedical Engineering Department at Vanderbilt University

My/Our gift commitment to the Biomedical Engineering Department is $_____ over the next _____years.

Year 1	**$_____** (Personal Gift)	**$_____** (Company Match)
Year 2	**$_____** (Personal Gift)	**$_____** (Company Match)
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To start my/our commitment, I/we have provided $_____.

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