BME Elective Spotlight: Service Learning in Guatemala
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Study Abroad as a BME
FELICIA PHAN

Perspectives on BME
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An Interview with Dr. Kenny Tao
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Support VU BME

On the Cover:
Mirror Lakes in Fiordland National Park, taken by Felicia Phan.

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Vanderbilt Biomedical Engineering is, of course, always pushing for the development of cutting-edge technologies, whether that be in the realm of drug delivery or medical imaging or biomechanics, among a plethora of other fields. This past spring break, however, a group of undergraduate BME students, under the guidance of Dr. Cynthia Paschal and Dr. Nicholas Adams, explored the application of biomedical engineering in a resource-limited setting.

The BME elective course, titled “BME Service Learning in Guatemala”, focused on the servicing of faulty medical equipment with the goal of repairing broken equipment at several Guatemalan hospitals during the week of spring break.

The lead up to the trip itself consisted primarily of hands-on learning, such as using multimeters in an investigative fashion to observe voltages, resistances, and currents in devices for operational maintenance. The group of juniors and seniors also had the opportunity to learn about the proper handling and usage of an anesthesia machine in one of the teaching rooms at the Vanderbilt University School of Medicine – an especially intriguing experience for those students who are pre-med.

For non-engineering aspects, the class partnered with the Vanderbilt Center for Latin American Studies (CLAS) to gain some insight into and understanding of the standing culture as well as the current economic and political status of Guatemala. Dr. Avery Dickins de Girón and Dr. Ted Fischer from the CLAS gave three mini-lectures prior to the trip and helped the students grasp what kind of impact they would be able to make on the trip with their efforts.

With engineering preparation and cultural awareness in hand, the team of engineers was ready to move forward and put their new knowledge to work in Guatemala.

The Guatemalan service trip is offered every 2 years. This is the fifth offering of the course. Enrollment was limited to 12 students selected through applications evaluated by a selection committee composed of faculty members. For more info: vubme-guatemala.blogspot.com
Along with their new skills, the students brought replacement parts for machines Dr. Paschal had identified on a trip to Guatemala earlier in the semester. The students then either distributed or implemented those parts as needed during the trip.

Ryan Spears and Yucely Beb building a bilirubin light at las Obras Sociales del Hermano Pedro in Antigua.

Claire Lafferty, Alison Williams, and Sami Kopinsky work on a noninvasive blood pressure machine at the Moore Center in Guatemala City.

Vanderbilt and Universidad del Valle students work together at las Obras Sociales del Hermano Pedro in Antigua.
The first couple of days in Guatemala were spent filming instructional videos for blood pressure monitoring systems and anesthesia machines. Once all of the materials were collected for the videos, the remaining days were spent working in other hospitals and medical centers around Guatemala City and Antigua. This included the Moore Center, Hospital Infantil de Juan Pablo II, Hospital Nacional de Palin, and Obras Sociales del Hermano Pedro.

Under the guidance of Dr. Paschal and Dr. Adams, the students were able to work on everything from autoclaves to surgical irrigation systems. Throughout most of the trip, students from the Universidad del Valle de Guatemala were able to join the Vanderbilt team in the hospitals and even in making the instructional videos.

This well-coordinated, cooperative experience led to the repair of many machines vital to the medical centers of Guatemala.

The students spent their last day sightseeing in Guatemala, but upon returning home, they spent the rest of the semester finishing their instructional videos to be used as an online resource for Spanish-speaking medical technicians and students.
I never considered studying abroad. I've always wanted to, but I always thought the cost and graduation requirements for BME wouldn’t allow me to do so.

First semester of junior year arrived and as I left for Nashville, many of my friends from Vanderbilt were leaving for other countries. I decided it wouldn’t hurt to look into studying abroad so I made an appointment with the Vanderbilt Global Education Office (GEO).

My GEO advisor was specifically for engineering students and introduced me to a list of schools that were particularly compatible with Vanderbilt’s BME curriculum. She also told me that financial aid would apply to studying abroad – an important feature that does not apply to Maymesters. Often, the study abroad programs would cost less than Vanderbilt’s cost of attendance, resulting in a refund that could be used for plane tickets, meals, and other traveling expenses. This fact alone had me sold on pursuing studying abroad.
I chose University of Auckland because it was the only New Zealand school on the VUSE Abroad website that had BME as a major. Since New Zealand universities allow you to graduate in three years, there were very few BME classes. Three BME classes were offered in the fall semester and only two were offered in the spring (and this was before course evaluations so they might not even count!). Of the two, I had already taken the equivalent version of one of them at Vanderbilt. I decided that I would finish my SEM (Science, engineering, math) electives, liberal arts core, and open elective requirements abroad. I ended up not taking any BME classes abroad, though BME undergraduates should consider taking 1-2 BME classes abroad since it greatly reduces the workload senior year.

In New Zealand I was able to take classes that I would not have been able to take at Vanderbilt or any other American university. I ended up taking Intro to Marine Science, Intro to Pacific Studies, Sociology of Aotearoa/New Zealand, and Turning Points in Western Music. The first three classes are specific to New Zealand and the Pacific – regions of the world that American history classes do not elaborate on.
The most important thing I’ve learned while abroad is that it is crucial for us to get out of the country for a different perspective. Submerging myself in New Zealand’s culture allowed me to learn more about the United States and the rest of the world than I could have ever learned by taking a history class at my home university.

One of the best parts about studying abroad is travelling. Perhaps I don’t live in the right region of the United States, but New Zealand set a new standard for beauty. My expectations for my abroad experience were surpassed time and time again.

I had the chance to surf in the blue waters of Te Arai, eat fresh sea urchin during an overnight cruise in the Bay of Islands, see the Milky Way on a nightly basis, swim in six-tier waterfalls, and be within an arm’s reach of wild penguins, among many more amazing experiences. Simply driving from one location to the next had beautiful landscapes, often as the result of driving through valleys.

There’s a reason why people return from their semester abroad and gush over it like it was the best thing that ever happened to them.

Studying abroad is a once in a lifetime chance. Being a student in another country allows you to be more than a tourist – you become a part of their society and you leave with a piece of their country.
Blue waters at Te Arai.

The summit of Roy’s Peak in Wanaka.
Waterfalls in Milford Sound.

A collision of weather above Lion Rock in Piha.
Coming into Vanderbilt as an engineer, I had to declare my major when I accepted my offer of admission. I wrote Biomedical Engineering in the blank space with hardly a second thought.

There is a common engineering track through freshman year and switching majors within the school is an easy process (and switching out of the school still isn’t difficult, just more lengthy), so it wasn’t like I was making an irreversible decision.

Still, though, I knew that I didn’t understand the field well enough to be sure it was what I wanted to do. I had researched it and read about the courses, but I couldn’t manage to develop a full, clear picture of BME, and every description I came across was too broad to help me add resolution to that image. So I came to Vanderbilt as a BME major not really knowing what BME was.

Four years later, I feel far more comfortable with that question. Of course, having taken the courses required to get a diploma with biomedical engineering written on it, you would hope I know what it means now.

With that experience, though, I understand the difficulty in describing it. How do you capture something so broad, especially when it feels like if you go into enough depth in any facet, you’ll find yourself in another field?

Nearly every time I tell somebody my major, I’m asked what biomedical engineering is. Do Economics majors meet the same question? Surely English majors don’t, right? I’ve developed a stock response over time: biomedical engineering is anywhere technology meets medicine or biology, from hospital beds to tissue engineering. Sure, it’s not a perfect response, but I’m comfortable with it, now—I wasn’t, though, when I first developed it, back before I had a firm understanding of the field.

So if I still have difficulty with the question, why do I feel more comfortable with my answer? Is it that I’m more comfortable with an understanding I already had, that I’ve now justified the description? Have I plotted enough data points on the spectrum of “What is BME” to wrap my mind around the field as a whole? Is it just that you can convince yourself of anything by saying it enough times?

I don’t have the answers of course, but I was curious, so I asked some undergraduates inside and outside the major some questions about it. Of the 29 responses, 13 came from Biomedical Engineering majors and the other 16 from Vanderbilt undergraduates of various majors inside and outside the School of Engineering. These responses don’t fully represent the Vanderbilt student body and are inconclusive, but they can give some insight in how the field is perceived by people with different degrees of experience with it.
BME Student Responses

**Q1: How would you describe BME?**

“An integrative field that brings together multiple engineering fields with a focus on medicine and its related practices.”

-Senior

“...To most people, I describe [BME with] robots doing surgery and Star Wars-like prosthetics.”

-Junior

“It is a fulfilling major with a lot of challenges. It’s very difficult, but it’s a way I can seek to help people and fulfill my love for science and technology.”

-Junior

“Biomedical Engineering is a broad STEM field that focuses on any application of technology into the medical field.”

-Freshman

**Q2: When did you feel you had a firm understanding of BME?**

Non-BME Student Responses

**Q1: How would you describe BME?**

“The application of fundamental engineering principles to solve biological problems.”

-Chemical Engineering, Senior

“Think Biology plus Circuits.”

-Chemical Engineering, Senior

“It’s a good mesh of various sciences and engineering that enables people to...save lives. Unfortunately...it is very broad in its study and not extremely deep.”

-Chemical Engineering, Senior

“The study and application of how man can affect human functioning and physiology.”

-Psychology, Senior

**Q2: How does BME relate to your major?**

“Many of the same balances, controls, and techniques in BME are also found in Chem E.”

-Chemical Engineering, Senior

“There are many computational and electrical aspects required in order to successfully build BME devices, so there is a huge dependency between the two fields.”

-Computer Engineering, Senior

“BME requires a level of math ability that most majors do not require.”

-Mathematics and Economics, Senior

“BME and its subsequent products feed into the medical tech industry, which is a social factor in determining individual and population health.”

-Medicine, Health and Society, Senior
Dr. Kenny Tao is one of the new assistant professor faculty members this year at Vanderbilt and is already making a great impact on our community. Having grown up in New York, he is really enjoying southern living and the warmer weather that Nashville has to offer. But he has lived in his share of places before having moved his lab most recently from Cleveland, Ohio. Before his work there with the Cleveland Clinic, Dr. Tao lived in North Carolina where he earned his undergraduate and graduate degrees in biomedical engineering from Duke University, and then continued his research at MIT.

Throughout his undergraduate career, Dr. Tao knew that he wanted to eventually attend medical school and ultimately become a surgeon. He even began his undergraduate career as a biology major and took the MCAT his senior year. However, early on he realized that he was interested in biomedical engineering, switching his major his second semester to double major in biomedical and electrical engineering, but remaining on the premed track. It wasn’t until his second semester senior year design project dealing with biophotonics, and more specifically his advisor for it, that he considered taking a different route.

It seems to have been out of “dumb luck”, as he coined it, that he ended up doing research. While working on his senior design project, his group was struggling to produce any results. It wasn’t until the day of the presentation, just an hour before it was due, when his group was able to make the project work. His plan at that time was to take a year off before medical school and go to Columbia for research, but the advisor that he worked with for his project, recognizing his skill and aptitude, convinced him to stay at Duke, offering even to pay for his master’s degree!

With an offer that he couldn’t refuse, Dr. Tao stayed at Duke to earn his master’s and doctoral degrees in biomedical engineering, where he said he had the best time of his life.

Dr. Tao has joined the BME faculty this fall semester.
The primary focus of Dr. Tao’s research today is optical coherence tomography, which he described as “the light analog to ultrasound but with better resolution and less penetration depth.” The scan is non-contact and non-invasive and gives a 3D view of the back or front of the eye with detail of fine structures, even single cells. This scan is able to give a myriad of diagnostic information about diseases that are systemic or have primary involvement in the eye, and can show diseases at different stages of development, even before they are diagnostically relevant and before they impact your vision.

One of the main projects of the lab is to translate the optical coherence technology to transition it to the operating room from where it is now in clinical. Currently, the scan is performed and surgery is scheduled around it. However, Dr. Tao hopes to be able to provide the diagnostic information live to surgeons. During surgery, it’s the surgeon’s job to peel away scar tissue from the surface of the eye with the aid of light microscopy. However, this can be a very difficult task because the tissue is transparent and puncturing the retinal tissue can cause holes in the eye that do not regenerate. Thus, it is his hope that by attaching an imaging module to the bottom of the surgical microscope, the surgeon will be able to perform the surgery more efficiently by being able to see the different layers of tissue with respect to the surgical instruments.

Dr. Tao’s lab faces practical constraints about how the design of the module and its attachment to the microscope and the method that the information is relayed to the surgeon. However, optical imaging systems are very clearly in the future of medicine, being even one step closer to robot-assisted surgery!

Vanderbilt surely is lucky to have such a dedicated and passionate professor like Dr. Tao, both for his expertise and his humorous, genuine and kind character. He says that being involved with the students are one of his favorite aspects of Vanderbilt because he loves their creativity and energy. To BME students he says, “Leave yourself open to new opportunities. Biomedical engineering is an overview of a bunch of different subspecialties, and that needs to be embraced... You might find something that you are very passionate about!”
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.

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