“What is biomedical engineers’ role in medical technology in the developing world?”

My experiences making a difference through Engineering World Health.

By Santhi Elayaperumal

Throughout my college career, I constantly looked for opportunities to learn about global healthcare. I wanted to know what it was like to work in the developing world, where I believed my help was needed the most.

My undergraduate scholarship essay narrated the story of myself in my future. I was living with a group of doctors and engineers working to set up a hospital in central Nicaragua. It was very humbling when I had actually come home after working in a public hospital in Nicaragua through Engineering World Health (EWH). EWH is a non-profit organization committed to bringing medical technology to the developing world.

When I first heard about EWH, I saw a great opportunity for me to reach my goals. At the time I was planning to study abroad the upcoming summer in a public-health related program in the Dominican Republic. That summer’s experience not only allowed me to improve my Spanish and overcome language barriers, but it also gave me the opportunity to observe differences between public and private healthcare in the developing world. I also shadowed a rural primary-care physician, volunteered in underrepresented communities and lectured about preventative medicine in topics that covered common issues such as dengue and hypertension.

During the school year following my study-abroad in Santiago, DR, I focused on getting involved with EWH. I had heard that university chapters across the country were repairing medical equipment to send to the developing world. EWH also sponsored design projects for simplified cost-effective alternatives to complex biomedical tools such as X-ray testers, EKG testers, blood-gas analyzers, etc.

Through this organization, I knew that I did not have to wait until I was a professional to start making my contribution to the world. I got in contact with Dr. Robert Malkin, the Director of Engineering World Health in order to find out how I could start a chapter at the University of Minnesota. I spoke at an Institute of Technology Student Board meeting to determine if engineering students were in fact interested in the opportunity to repair medical equipment for humanitarian causes. I met with the student leaders of the university’s Biomedical Engineering Society to gather their support. I also had informally mentioned the idea of holding repair sessions to a few classmates, and after a few stops at the Student Activities Office and several small meetings, our chapter was founded.

For one academic school year, a group of talented biomedical engineering students and I did the administrative work of forming our new chapter. We established distinct roles within our group, determined what projects we would focus on, and worked to expand our network within the Biomedical Engineering and Material Management departments of healthcare institutions in the Twin Cities area. I had talked to a friend’s aunt, who was part of an organization that sends equipment to clinics in Bolivia, for some tips about requesting equipment donations. Her advice pushed us to make brochures, write letters, set up a website and get in touch with the right people to start getting donations.

The chapter was taking off. We teamed up with members of the University’s IEEE chapter on a joint project to design a low-cost centrifuge tester. The equipment started to roll in. We received donations from HealthEast and Children’s. However, we still needed the skills to troubleshoot the devices which were not in complete working order.

My summer in the Dominican Republic prepared me well to apply for the Duke-Engineering World Health Summer Institute. When I participated in the program in 2005, training included courses in Spanish and Medical Instrumentation which were conducted in Costa Rica. Then, students volunteered in pairs for the second half of the summer in El Salvador or Nicaragua. My assignment was at Hospital Gaspar Garcia Laviana in Rivas, Nicaragua.

The instrumentation course offered through Duke University and EWH covered major types of medical equipment which would be found in hospitals in the developing world and taught the principles of operation, typical applications, and common problems with each instrument. In the lab and discussion sessions, the activities and topics varied from troubleshooting circuit boards to defining the developing world

The most important lesson I took away from the training course was a lab session entitled "Obstacles to Medical Technology in the Developing World." We discussed what obstacles to medical technology exist in the developing world that biomedical engineers should consider in device design. Furthermore, we discussed in what ways biomedical engineers are introducing more challenges in the mission to bring medical technology to the developing world, and how, as humanitarians, biomedical engineers can do more to help alleviate such obstacles.

I understood the essay in the lab manual for this discussion after having worked in Rivas. The basis of this discussion was the question "What is biomedical engineers' role in medical technology in the developing world?" The discussion was meant to ask what engineers could do to remedy the situation of lack of adequate healthcare in underserved regions. We all had so many political and economical reasons of why certain countries do not have access to advanced medical technology, and nobody could completely see why engineers were to blame. The essay in the lab manual explained:

"…biomedical engineering has played a critical role in creating a situation where only a tiny fraction of the world's population can access what American's consider routine medical technology. For example, X-ray imaging and microscopes have existed in the clinical setting for more than 100 years. Yet the modern designs for these basic tools typically operate for little more than six months once introduced into the developing world, and design is the domain of biomedical engineering." (Engineering World Health 2005)

In short, due to design, biomedical engineers are not contributing sustained amelioration for the lack of medical advances in the developing world and have even created more obstacles in the use of modern equipment to save lives. This responsibility of good design is better illustrated with an example.

One participant worked in a hospital in Managua, Nicaragua and shared this story at the Summer Institute conference in Houston. The hospital had just purchased six new ventilators which were manufactured by a world leader in medical equipment. Such an expensive investment would have merited long term use from the machines. However, in less than a year, five of the six ventilators were out of service because they needed a replacement expandable oxygen cell. The cell is not necessary in the function of the equipment, yet without it, the machines would sound an alarm and were useless. The oxygen cell is a disposable part, meant to be replaced, however the high price is not within the hospital's budget, and they could not even afford one.

Whereas the manufacturer could market the ventilators in the US and the American hospital would buy cases of replacement parts, this was not a machine that should have been sold to developing world hospitals. Who's to say that the company designed the ventilator with this marketing ploy in mind? The fact is, the poor design is not suitable for global use, especially in areas which do not have easy access to the manufacturer's maintenance services.

An even bigger problem in the developing world, than the lack of local manufacturer-based repair centers and trained professionals to work with nonfunctioning equipment, is the lack of spare parts. Until I tried to find Chamoi discs to filter a certain type of aspirator, I did not realize how difficult it would be to find certain parts. Things that seem like simple replacements were not even available in the country's capitol.

Market determines availability, and practically no medical equipment supplier will export to where there are very little pieces of medical equipment. Even when a spare part or machine reaches a developing country, because of high export taxes, the equipment is not affordable for the hospitals. My partner and I found a battery pack for an Ohmeda pulse oximeter that the hospital in Rivas needed for $40 online (excluding shipping and handling) yet it was sold for $200 in Managua.

Somewhat outside of the engineer's domain, another major problem with medical technology in the developing world lays within the organizations and individuals within the first world that donate medical equipment. Many times equipment arrives without service or user manuals, and it is difficult for hospital staff and physicians to operate or maintain the equipment without such guidance.

An even larger issue is that a lot of equipment arrives to its new destination with missing parts. This equipment is essentially useless, especially if it is a discontinued model or the missing parts are non-disposable or not easy available. While working at Gaspar García, we had encountered an old ambulatory EKG monitor sitting on a shelf in a storage room. The machine was missing the charger for its battery pack and had no external power cord. In the end we cannibalized its parts to fix another monitor; however, this machine was meant to be used on an ambulance and recharged every couple hours, it should not have been donated to a public hospital for ICU or Emergency Room use. While taking inventory of the hospital, we found many closets with equipment that was missing various sensors, tubing, and chambers.

As the President of the Engineering World Health Minnesota Chapter, I felt a greater obligation in choosing worthy equipment to send to the developing world. For equipment without manuals, I encouraged members to write simple instructions which can be easily translated. Also, even if the equipment requires disposable parts, we send complete sets of all needed parts with each machine we redistribute in order to save the receiving hospitals some time, frustration, and storage space.

Back in Minnesota, I reminisced over one of the best summers of my life, in which I had met many unforgettable people including my teachers in Costa Rica, my co-workers in the Maintenance Department, and my host mom, Doña Pepa, who makes the best gallo pinto in the world. I could not reflect on my memories for too long however, we still had a lot of work to do to get our chapter off the ground. Luckily, our network was growing. We got in contact with more and more people who wanted to help us out.

While searching for disposable parts to some donated patient monitors, we got in contact with a supplier from SpaceLabs who helped us receive more donations from the company. With his advice, we got in contact with technicians at the Fairview-University Medical Center as well as an avid volunteer whose knowledge has been vital to the success of our repair sessions. Graduate students and professionals alike have heard and read about our chapter and many have asked how they can contribute.

The repair sessions were so popular that our chapter easily had support for grants. Last I checked with the current President, Shepherd Labs was so full of equipment that they had to send another shipment to the national organization in order to make room for the next repair session.

I had gone back and looked at my lecture notes, class materials, and lab manual when testing and refurbishing equipment at the

Top: Santhi conducting a needs-finding interview with Tech. Francisco Espinosa at Gaspar García. (July 2005). *Middle:* Graduate student Paul Robinson showing students some soldering techniques. (Oct. 2005). *Bottom:* Tech. Paul Lindquist from Fairview talking about electrosurgery units at a repair session (Feb 2006).

University of Minnesota during our EWH chapter's repair sessions. I have lectured other students on how AC voltage is converted to DC voltage, and I have managed workshop stations about building power supplies and practicing soldering skills. From the knowledge I gained in the Duke-Engineering World Health Summer Institute, I have been able

to give other engineering students the opportunity to work with medical equipment and practice troubleshooting skills which will be helpful in their futures—whether they become humanitarian biomedical engineers, and/or potential designers of medical devices that may be used in the developing world.

I am pleased to hear several University of Minnesota engineering students say that they are interested in participating in this program in the future, and I hope that more students from our department continue to take advantage of this unique opportunity.

The next repair session, open to all University of Minnesota students interested in gaining hands on experience and learning more about the global community, will be held at Shepherd labs at 6:00pm on Thursday, November 7th, 2006. For more information about the chapter, please visit the website at www.tc.umn.edu/~ewh.