Preparing Undergraduates for the Medical Device Industry

Our innovative curriculum just got better for students seeking positions in the medical device industry at graduation. Landing such a job is precisely the goal for the majority of our seniors, most of whom are Minnesotans who aspire to a position in one of the 300+ medical device companies in the Twin Cities. While that goal has frequently been realized (see word cloud for historical placement data), we have just implemented several curriculum enhancements to improve the preparation of these students beyond the option of a nine-elective emphasis area, for example, Medical Devices or Biomechanics. Adjunct Professor Mark Kroll (retired CTO of St. Jude Medical) offered a new elective course last spring, Biomedical Engineering Careers and Practice in the Medical Device Industry. In this course, students learn about the most common engineering entry-level positions and general quality, testing, and regulatory standards for medical devices. This fall, three new elective courses are being offered to equip seniors with key commercial software used in the industry. Each course is being developed and offered by an engineer from a local medical device company. CAD/CAE of Bioelectrical Devices (Dr. Birin Yucesan, St. Jude Medical) will focus on simulation, analysis, and design using Altium Designer and LTspice. CAD of Biomechanical/Biotransport Devices (Dr. Paul Hattan, Devicix) will focus on device design using Solidworks. CAE of Biomechanical/Biotransport Devices (Dr. Ismail Guler, Boston Scientific) will use Comsol to simulate and analyze devices. A new elective course on Medical Device Prototyping may also be offered through our Medical Devices Center, during which students will experience the entire process of designing, rapid prototyping, and testing a medical device.

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Dr. Will Drasler

Will graduated with a PhD in Biomedical Engineering in 1983, advised by Ken Keller, Professor of Chemical Engineering & Materials Science and former President of UMN, and Dr. Clark Smith III, an MD active in clinical hematology research. His doctoral research involved discovery of membrane changes that occur in sickle cell RBC membranes and affect the hemodynamics of blood flow. Following his degree from UMN he began working at SciMed Life Systems in the early stage development of angioplasty. In 1986 he moved to Possis Medical to become VP of R&D bringing the Possis Angiojet thrombectomy catheter from concept to sales. Will also served as VP of Engineering at Lake Region Medical and as VP of Applied Research at Boston Scientific until 2008. He owns over 50 patents and over 80 patent applications for cardiovascular and neural devices. Will is currently a founder and CTO of the start-up company InterValve developing a balloon valvuloplasty catheter.

How did a PhD in BME influence your career path?
It has helped me to better solve problems by forming a solid understanding of the problem through research, addressing each aspect individually, and putting the pieces together to form a unified and complete picture. It has shown me the importance of forming a solid foundation in my understanding of human anatomy, physiology, and healing mechanisms within the body. It has allowed me to apply basic engineering principles to clinical problems. It has taught me to critically examine the goals and identify alternative ways to reach an optimal solution.

What major changes do you foresee in the medical device industry in the next decade?
As the country becomes integrated into the national healthcare programs, device costs will become an even greater consideration in the device design. Instead of the major focus being on device safety and efficacy, there will be a greater emphasis on device utility and cost effectiveness. To obtain financing for new device development, the first question by the Venture Capitalist won’t be related to its technical feasibility but rather what is the reimbursement strategy and what is its clinical path—will the device require a clinical trial and how much will the trial cost? The new devices of the next decade for an aging population will need to provide improved treatments at a lower cost. Our growing understanding of genetics and physiology combined with new technologies still unidentified will spur new medical devices.

What is your advice to BME students aspiring to careers in the medical device industry?
Formation of a solid foundation in one of the basic engineering curricula is necessary to extend into areas that are not yet known. Understanding the physiology and anatomy of our complex human body is also required to anticipate the interaction of a medical device with the body in a logical manner. Read journal articles with a critical eye, looking for gaps or misunderstandings; these errors will point you in a direction to identify new treatments and create novel medical device.

Preparing Undergraduates, cont.
Complementing those five courses, a major change recently made to our two-semester senior year Biomedical Engineering Design course provides another key element to preparation of our students for the medical device industry. Rather than give seniors a list of projects to choose from on the first day of class, they are now presented with a list of clinics in our Academic Health Center from which they choose a four-week clinical immersion experience. During that time of observing procedures and discussions with clinicians and their assistants, the seniors identify an unmet clinical need as the basis for their project. With advising from an experienced engineer from a local medical device company, they ultimately develop and test a prototype. Clinics and resulting projects last year included: Pediatrics - Supplemental feeding device, Neurosurgery - Intracranial pressure monitor, Cardiovascular - Enomyocardial biopsy device, and Emergency Medicine - Device for easy IV needle placement.

That the University of Minnesota is located in the heart of LifeSciences Alley and its array of medical device companies makes this combination of courses and experiences truly unparalleled. Along with our eight foundational lecture-lab courses (Cell and Molecular Biology for Biomedical Engineers, Physiology for Biomedical Engineers, Biothermodynamics, Bioelectricity/Instrumentation, Biomedical Transport Processes, Biomaterials, Biomechanics, and Biomedical Systems Analysis) taken before the senior year’s emphasis area electives and design, our seniors will be more prepared than ever for these companies!
Sarah Vanderheiden

Sarah just graduated with a Bachelor of Biomedical Engineering degree from the University of Minnesota, summa cum laude with high distinction and an emphasis in Biomechanics. In her time as an undergraduate, she participated in research labs at the University of Minnesota and University of California - San Diego, had multiple internships, served as Vice President of the Society of Women Engineers (SWE), and competed as part of the Minnesota Rock Climbing Team. She will be continuing at the University of Minnesota in the 5-year combined M.S. program in Biomedical Engineering.

What was the highlight of your research experience?
I participated in a REU program at the University of California San Diego, where my project was to develop a protocol for collecting and analyzing data to map the distribution of proteins in heart ventricles. It was a tremendous learning experience in that I was tasked with independently developing an experimental protocol in a subject that I knew nothing about. It took me until the end of the summer to get a single set of usable data, which I was proud to present at the annual BMES meeting in 2012.

What was the highlight of your experience as a SWE officer?
SWE helped me to feel as if I was part of a community, both within CSE and with engineering professionals around the Twin Cities. Everyone stresses the importance of networking, and SWE allows you to build and sustain relationships your peers and your potential employers at conferences, lunches, and outreach events.

Why did you opt for our 5-year M.S. program?
After talking with engineers in the medical device industry, it seemed to me that advancing in either engineering or management positions required a degree higher than a B.S. The 5-year M.S. program is a way for me to get an advanced degree quickly and at less cost. Seeking an entry-level position with a more advanced degree will also give me greater opportunities and allow me to find a job that more closely aligns with my interests.

What is your advice for our current BME majors?
Don’t be afraid to apply for opportunities even if you don’t feel you are a strong candidate. When I first started tensile testing in the lab of Professor Barocas as a freshman, I had no idea what stress or strain meant much less how to analyze any of the data I was collecting. I found that as a student, the ability and eagerness to learn is much more valued than extensive experience.
We often associate bacteria with infection and disease, but these microbes are also essential in regulating human health. An average human body consists of ~40 trillion human cells, but it also houses ~100 trillion bacteria, most of which reside in the gut and play vital roles in regulating digestion, obesity, and immunity. In Professor Casim Sarkar's Molecular Cell Engineering Laboratory (http://sarkarlab.umn.edu), one of the major research thrusts is to use synthetic biology approaches to engineer new bacterial therapeutics to improve treatments for diabetes, cancer, and infectious diseases. Why use bacteria for this purpose? Because, unlike traditional protein or small-molecule therapies, bacteria have the ability to respond to their surroundings in a highly complex and dynamic manner. Thus, a bacterial therapeutic could be genetically programmed to carry out a user-defined set of instructions only in response to very specific environmental conditions. Professor Sarkar's group has engineered ingestible bacteria that can produce insulin on demand for diabetics and they have also created bacteria that can secrete a tumor-killing protein in response to light (see figure). His laboratory is further pursuing applications of synthetic biology that will enable more effective killing of antibiotic-resistant microbial pathogens.

Synthetic biology research also has applications beyond medicine. Professor Sarkar is a faculty advisor for the University of Minnesota's International Genetically Engineered Machine (iGEM) team (http://2014.igem.org/Team:Minnesota), which is constructing a new bacterial strain that can eliminate toxic mercury compounds from the environment. This interdisciplinary team of undergraduate students will present its design at the worldwide iGEM competition in Boston this fall.