Head Lines:

Bob Tranquillo, Distinguished McKnight University Professor and Head

Two more faculty members joined us this summer, Associate Professors Brenda Ogle and Casim Sarkar, so the department continues to grow in size, with 18 full-time faculty members presently. A faculty search is also underway in neural engineering and biosensors, related to the college’s cluster hiring in Robotics, Sensors, and Advanced Manufacturing.

The department added additional research space, now occupying the top two floors (40,000 sq ft) of Hasselmo Hall, a biomedical research facility located at the intersection of the College of Science and Engineering and the Academic Health Center. The lead story describes a fantastic phototyping facility for our senior design teams. Featured inside are stories on summer internships, the first professor from our undergraduate program, and faculty research on biomicrofluidics. As always, we look forward to more talent joining our department this year and contributing to our mission!

University of Minnesota opens state-of-the-art Medical Devices Laboratory

On June 4, 2013, the University of Minnesota’s Medical Devices Center (MDC) officially opened its new 8,000 sq ft state-of-the-art medical devices laboratory. The facility was specifically built for designing, prototyping, and testing medical devices. Located in the heart of the University’s Academic Health Center, it will foster even greater collaboration between the University’s College of Science and Engineering and Academic Health Center units in Medicine, Pharmacy, Dentistry, Nursing, and Veterinary Medicine. The MDC mirrors this multi-disciplinary environment by housing many different state-of-the-art labs. These resources are used by University researchers, graduate students, and undergraduates, especially the Biomedical Engineering Senior Design Teams.

The Mechanical Prototyping Laboratory features typical machine-shop resources, including a milling machine, drill press, lathe, and bandsaw. Other notable equipment includes a micro-welder and an MTS 858 Mini Bionix II System, donated by Boston Scientific, to characterize mechanical properties of materials and tissues. The newest addition to this lab space is the Objet260 Connex multi-material 3D printer from Stratasys. The printer boasts 16-micron accuracy and the ability to print with over 100 different digital materials.

The Electronic Fabrication Laboratory houses a variety of tools necessary to build and test electrical circuit designs. Multiple signal generators, power supplies, oscilloscopes and digital multi-meters are available for use, as well as microchips, LabVIEW data acquisition hardware, and a host of other...
Summer Internships

Summer internships provide great experience and often lead to employment offers, so we feature below several BME majors with very different internships.

**Jenna Zimmerman – Replenish (Pasadena, CA)**

“I met Replenish my sophomore year at the Design of Medical Devices career fair. I had been volunteering in the Visible Heart Lab since freshman year so when I would help them set up for the DMD, I would get free admission into the conference sessions and the career fair (nice perk). There, I met and talked with the Replenish project manager and it turned out that because of my experience with both large animal studies and implantable devices in the VH lab, she thought I was a good candidate to intern and help them with their pre-clinical studies… so I applied and got the job! Through my first summer with Replenish, I learned all about good laboratory practice for the animal studies as well as V&V processes. I also helped the engineers design some “peripheral” instruments needed to help the surgeon implant the device, like an introducer and a drug refill device (I really liked that part). Then my second summer got really interesting because everything that I did for the animal studies was actually implemented in the human studies! That was very cool and satisfying for me to see. After the 11 implants were completed (and successful!), I focused more on learning Solidworks and the mechanical side of device design for the rest of the summer.”

**Danesh Bankwala, Maria Crandall, David Moreno, Uyen Truong – DesignWise Medical (Minneapolis, MN)**

DesignWise Medical is a volunteer-based, technology-driven, child-focused, non-profit organization. These four seniors worked together this summer on a non-contact oxygen delivery system called the OPOD. Described by Maria, “It is designed for children with chronic lung conditions who would otherwise require the use of a nasal cannula or face mask during the night.” According to Danesh, they essentially had a senior design experience before their senior year, integrating knowledge from their core BME courses in an open-ended project. “It’s been an exhilarating experience coming up with ideas, implementing them, and testing them,” says Maria. Characterizing the oxygen concentration profile at the patient after ejection from the OPOD nozzles, David remarks, “What excites me the most is the application of [what else?] transport phenomena to a physical and designed system!” Uyen conveys a shared sentiment, “The thought that one day my contribution to this device may be out there in the world helping children makes me excited and makes my work seem meaningful, which encourages me a lot to work harder.” Their advice for finding an internship? “Check GoldPass frequently, apply everywhere and email everyone you can, network in the fall and make contacts early in the spring.”
electrical components donated by Texas Instruments Inc. This lab has a medical adhesives workstation with a variety of cyanoacrylates, epoxies, and UV cured epoxies donated by Henkel-Loctite. It also provides 4 CAD workstations for students and researchers to use.

The Imaging and Anatomy Laboratory contains multiple imaging modalities including x-ray, fluoroscopy, endoscopy, and ultrasound. This lab houses several plasticized organ systems for educational use in the medical device design process. It also has a large collection of donated and expired medical devices for researchers and students to analyze and use for design and research purposes.

The Virtual Prototyping Laboratory is dedicated to the MDC’s research focus on medical device design in a virtual environment. A custom-built Multitouch VR Table can read MRI and CT scanned images, as well as CAD files, and allows the user to easily manipulate the objects in the 3D environment and run virtual testing of multiple virtual prototypes inside the anatomical geometry.

The Medical Devices Center is part of the University of Minnesota’s Institute for Engineering in Medicine (IEM) established in July 2007. IEM is an initiative jointly sponsored by the University’s College of Science and Engineering and Academic Health Center. IEM fosters a wide range of high-level, goal-oriented interdisciplinary research, uniting faculty in health sciences and various engineering, science, and mathematics departments.

Additional information about the Medical Devices Center can be found at www.mdc.umn.edu/index.html.
In the Living Devices Lab, we use tiny tools to do big things in biomedicine. Our lab creates microdevices that incorporate biological components such as cells, biomaterials, and biological fluids with the goal of recapitulating physiologic tissue function \textit{in vitro}. The challenge is to bridge \textit{in vitro} models, which often do not incorporate relevant physiologic cues, and animal models, which are costly and do not readily allow high spatiotemporal resolution imaging of dynamic events such as cell migration. Microfluidic tissue engineering offers the ability to create \textit{in vitro} models that replicate the length scales and transport phenomena of living tissue while allowing quantitative imaging of dynamic processes.

One focus area of our lab is to recapitulate pathophysiologic processes in order to study basic mechanisms of disease and to develop new therapies. We are particularly interested in how sickle cells occlude blood vessels and how cancer cells spread from primary tumors to sites of metastasis. In addition to studying disease, we also use microtechnology to develop novel tools and assays to probe biological phenomena. We are trying to construct large-scale vascularized tissue constructs that could be used in regenerative medicine, and we are developing a new assay for 3D cell migration that will help us understand how microenvironmental factors such as extracellular matrix and stroma affect tumor cell migration.

Our work integrates a range of tools and disciplines including tissue engineering methods and materials, microfluidics and microfabrication, and molecular transport and fluid mechanics. Our mission is to engineer small devices that will have a huge impact on human health.