BME 450 & 451/452: Biomedical Engineering Design
Request for External Participants

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Request:
The University of Michigan, Department of Biomedical Engineering is looking for faculty, physicians, and engineers from industry interested in participating in next year's senior capstone design courses. These courses encourage students to take a biomedical problem, design a solution, build a prototype and test it. Participants are needed for several aspects of the course including technical resources, design presentation reviewers, guest lecturers, and project sponsors/clients.

Commitment:
Level of commitment depends on the type of participation (in order from minimum to maximum commitment):

1. *Technical Resource* – Meet on a need-to-know basis with student teams working on a project in your area of expertise, providing them with information and resources pertaining to their problem.

2. *Design Presentation Reviewer* – Attend one or more of the teams' design presentations, ask questions during the question and answer sessions, and provide feedback to the teams.

3. *Guest Lecturer* – Deliver a 1 hour lecture (with recommended readings) to the class that gives the students a real-world perspective on design. Example lecture topics include converting client needs into engineering requirements, clinical considerations to design, formulation of design specifications, industry standards, engineering and project notebooks, FDA regulations, failure/risk analysis, engineering drawing, and prototype validation.

4. *Project Sponsor/Client* – Submit a project idea that you would like to have a design team work on and mentor them through the process. Students are instructed to be respectful of the client's time and understand that the client does not have all of the answers and that it is ultimately the responsibility of the team to figure out the answers. Other requirements for sponsors/clients include the following:
    a. Projects should be defined to the extent that you know the problem at hand and have some idea of the requirements of the device, but should be open-ended enough to allow the students to explore possible innovative solutions.
    b. Projects must include fabrications of a physical prototype. Software development can be a component of the project, but not the focus of the project.
    c. Sponsors are expected to provide funding for materials and fabrication costs of the prototype.
    d. Clients stay updated on the team's progress (meet roughly every 2-3 weeks), provide input to direct the team along the right track, and attend the team's design review presentations.
    e. Students are not considered employees of UM, thus they own any intellectual property they develop. See the Intellectual Property section below for more information.

Course Description:

Both BME 450 and 451/452 expose students to the entire design process from problem definition to prototype validation. The course is organized like a biomedical engineering company with projects sponsored by real clients and the primary mode of project instruction facilitated through weekly team meetings with the instructors (i.e. the teams' engineering manager). Design teams consisting of four to six students work through identification of client need, development of design specifications, brainstorming, concept generation and evaluation, detailed design, fabrication, and prototype validation. In addition to these technical concepts, students learn and practice project management, maintenance of engineering and project notebooks, budgeting, FDA regulations, and technical communications.

BME 450 is a one semester design course offered in the winter term, whereas BME 451/452 is a two semester course (fall & winter terms) that allows BME 451/452 teams more time to explore more solutions, conduct more comprehensive validation testing, and implement modifications to the prototype. Both courses cover the same concepts described above. During the first semester of BME 451/452, students are placed into teams and assigned a project, conducting the problem definition and concept generation and evaluation phases of the design process. At the end of the first term, teams propose a paper design of their solution. The second term is dedicated to the fabrication, testing, modification, and re, testing of the prototype. The final deliverables for both courses consist of a prototype, user manual, project CD, presentation, and final report.

Intellectual Property and Nonm Disclosure:

All intellectual property developed in the class is owned by the individuals that contribute to the design development – typically, the students and sometimes the client – unless the client proposes another agreement prior to the beginning of the course. Clients own a portion of the intellectual property when they make an inventive contribution to the design – a need does not constitute intellectual property. Thus, clients participating in the course should not discuss intellectual property that they are not interested in disclosing. It should be noted that in most cases, the U-M owns intellectual property developed by U-M faculty (this is not the case for non, U-M faculty).

Clients that wish to have the students sign an intellectual property and/or non, disclosure agreement must submit the agreement at least one week prior to the beginning of the term, to allow students the opportunity to review the agreement before committing to a particular project. *These agreements must accommodate the pedagogical objectives of the course, namely to permit students to discuss their project in job interviews, present the progress of their project to the university community, allow the BME Department to keep copies of documentation for accreditation purposes, and participate in the College of Engineering Design Expo.*

Past Projects and Outcomes:

In the past, projects for BME 450 have covered a wide range of areas in biomedical engineering, including biochemical, mechanical, electrical, or a combination. The following list provides project titles from past BME 450 and 451/452 teams:

BME 450 Projects

- Instrumented Speculum for Measuring Levator Ani Muscle Strength
- Pediatric Mock Circulation for Pulsatile Blood Pump Testing
- Cell Trapping Mechanism for Microwell Array

- Adjustable Robotic Ankle Exoskeleton
- Pacemaker/Defibrillator Identification Device
- CT Head Phantom for Contrast Simulation
- Bi-directional Multi-drive System for Neural Implants
- A Novel Mask to Facilitate Use of CPAP for Sleep Apnea
- Development of a Bioreactor to Grow and Harvest Human Oral Keratinocytes
- An Electronic Stethoscope for Use with MRSA patients
- Rapid Platelet Function Test
- Surgical Sponge Detector
- Veterinary Dental Material Delivery System

BME 451/452 Projects

- Hemolysis Unit for RBC Fragility Analysis
- Improved Crash Protection Systems for Wheelchair-Seated Drivers
- Automated Bronchoscopic Lavage Device
- Upright Support Device for X-Ray Imaging
- Constipation Sensor for Accurate Diagnosis and Treatment
- PET Imaging Probe for the Prostate
- Device for Faster Early Physical Rehabilitation of Critically Ill Patients
- Microfluidic Centrifuge for Blood Component Separation

Statistics of BME 450 and 451/452 Project Sponsorship and Outcomes

	2007 – 2010	AY 2010 – 2011
# of Students	215	73
# of Design Teams	36	16
# of Clients		
Faculty	14	4
Clinicians	9	8
Industry	13	3
Course Outcomes		
Journal Articles/Grants/Conference	7	6
Seeking Patents	4-5	2
Pursuing Clinical Testing	N/A	2
Continuing Prototype Development	4-5	13
# of Returning Clients	10	5