Capstone experiences that build discipline identity

Jennifer R Amos

Department of Bioengineering, University of Illinois at Urbana-Champaign

Corresponding Author: Jennifer Amos, jamos@illinois.edu

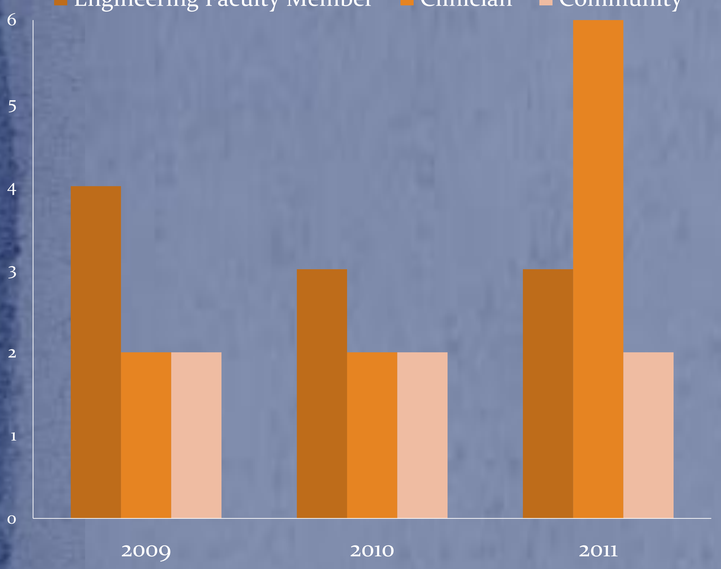
Abstract

How do we provide capstone experiences that build an identity for our graduates in a still-forming discipline where industry is still nascent? This need is consistent with our desire to develop skill-building hands-on labs that provide unique skills that this new industry needs. Our design course has undergone much iteration to address the changing market place and industrial preferences in undergraduates entering the workforce. This poster addresses the importance of undergraduate training in design concepts to help graduates remain adaptive in the changing marketplace of bioengineering.

Challenges

The first challenge we faced was, as a new Bioengineering department with fewer than 100 alumni, we are lacking industry involvement in the capstone design project market. Early design projects were research-related side projects and did not stress the importance of team work, the design process, and innovativeness in the field of bioengineering. The instructor made great strides in reaching out to the community and integrated the medical field into the design course with successful results.

Type of Sponsor by Year



During the iterations, over the last 3 years, team effectiveness has increased, design projects are becoming more relevant and innovative and, as a result, student motivation has greatly increased. The department is also raising the profile of the college through key partnerships with colleges of medicine and local and regional hospitals.

Why Clinical partnerships

Partnerships with the College of Medicine at the University of Illinois at Urbana-Champaign as well as College of Medicine at the University of Illinois at Peoria and nearby OSF Saint Francis Medical Center have proven to real world experience to our capstone course.

- We also have seen a rise in the need for teaching classrooms for medicine and veterinary medicine through models.
- Students feel an immediate connection to the projects because they see the patient body in need of a solution. Interact directly with the clinicians in the field
  - Receive feedback from users on what's "in market" that needs improvement
  - Innovate new ideas based on clinic needs

Gout Model

Problem: Available market Gout training unit is unrealistic and expensive

Version 1.0: Realistic bone structure and movable joint space – skin not realistic enough

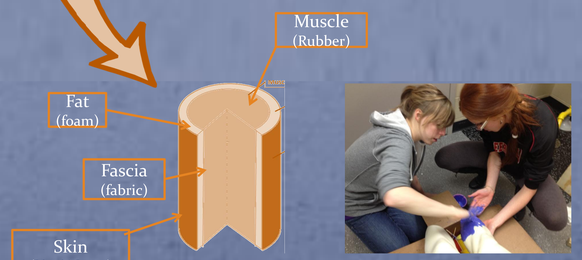
Final Product: Realistic palpable joint, skin, and removable/replaceable joint capsule for cost effective repeated use

Laceration Model

Problem: Available suture pad is a foam mat and does not replicate multi-level lacerations

Students experience hands-on suturing experience on a pigs leg

Final Product: model of lower leg complete with skin, fat, fascia, muscle, and bone for complex laceration suture practice



Version 1.0: Students create a multiple layer model combining rubber, fabric, latex, and foam

During the iterations of academic year 2009-2010, a large portion of the curriculum was changed to include an improved timeline and new emphasis on parametric or systems design, Six Sigma Design, team management and client needs.

Key changes to lecture topics

Phase I:

- Pushing up the delivery of projects
- Integrating parametric design into the lectures
  - Through parametric design, students are able to identify key variables, defined parameters (either by environmental or client needs) and boundary constraints to the system.
  - Students were also able to see the equations from previous mechanics, circuits, instrumentation in their designs or even material properties and how they would affect the design.
- Two week intensive Six Sigma training
  - Student received three lectures in key concepts including LEAN processing, design of experiment, DMAIC, brainstorming tools (Fishbone, Thought Map), and Factorial Design.
  - Students were then led through a series of simulations and mini-projects to cement the ideas.

Phase II

- Teams continue to attend class but lectures change into guest speakers on topics of interest such as
  - US Patent Officer
  - Director from our Office of Technology Management to discuss IP rules on campus
- The design team and instructor also meet every two weeks to monitor progress.
  - Before the meetings, teams are instructed to send a progress update to both instructor and client denoting what was accomplished in the last two weeks and what will be done in the next two weeks.

Fall Semester: Phases I and II	Spring Semester: Phase III
Phase I: Design Concepts – Lectures and Activities • **What is design?** • **Client Needs and constraints** • **Inputs and outputs of design** • **Configuration design** • **Parametric design** • **Evaluation in the design process** • **Team Management** • **Design of Experiment – Six Sigma Training** • **Regulatory Concerns (FDA, Patents, IRBs, etc.)**	Phase III: Product Development • Continue Phase II Deliverables • Prototype Development • Patent applications • Working Prototype • Design History File • Presentation and Vendor Fair
Phase II: Design Process – Team Deliverables • **MOU with Client** • **FMEA** • **QFD** • **Thought Maps** • **Gantt Charts** • **IRB Proposal for Testing (if needed for project)** • **Version 1.0 (Written report and presentation)**	

Phase III

The entire spring semester consists of the continuation of progress reports and meetings every two weeks and ends with delivery of the Design History File and working prototype to the client and a presentation and vendor fair open to the public.