



Work in Progress: International BME Capstone and Summer Design Experience

Prof. Mark A. Ruegsegger, The Ohio State University

Mark Ruegsegger is currently an Associate Professor of Practice in the Department of Biomedical Engineering at Ohio State University. He has a curricular focus on the Senior Design capstone course, which includes multi-disciplinary teams of BME, Mechanical Engineering, Occupational & Physical Therapy, and other Medical and Engineering disciplines. Each project team builds a device that provides assistance to those with disabilities, or projects with other clinical or industrial aspects. Mark received his Professional Engineering (PE) license in 2009 in the Metals and Materials specialty.

Work in Progress: International BME Capstone and Summer Design Experience

Introduction

Education that includes international experiences has long been seen as an important way to give students a unique perspective and skill set for their future career endeavors. Seldom, however, do these experiences include rigorous engineering education. This can be due to constraints of a typical engineering curriculum, the lack of equivalent courses offered internationally, or the language barrier. In this study we report the ongoing efforts to implement a unique, international capstone course, involving significant interactions between the students of both programs.

Initial discussions started when a BME faculty member at Nanjing University, China (NJU) and a BME faculty member (author) from The Ohio State University (OSU) shared ideas on capstone projects. Discussions turned into potential shared activities between the Departments, including a dual capstone. Initially, we considered having both NJU and OSU student teams make the same device simultaneously in the Senior Capstone course at their own institution. The interaction would come by sharing ideas, best practices, reports, and strategies throughout the year via teleconferencing and email. Although simple in some ways, it also included a lot of challenges. Further discussion refined the early ideas to focus on a pre-capstone experience for Junior students, where NJU and OSU students could work on teams and gain extra design and team skills, with an international perspective, before the senior capstone course. From this, the current plan is detailed here of an annual Summer Design Experiences (SDE) at both institutions, and an internationally co-mentored senior design project in alternate years at NJU.

Program Structure

The overall program structure is presented in Table 1, showing the timeline for events in a two-year cycle. The Summer Design Experience has been developed to be a 2-3 week design experience for a small group of students (10-15) traveling internationally to the other institution. Being fully in English at both institutions, language will not be a barrier, and all student teams will be a mixture of students from both universities. The summer design experience will center on hands-on training in the design of medical devices, starting with interviewing the clinical mentor, families and individuals to understand the underlying medical problem. The teams will then propose a design for the device, and finally build and test the device. Other aspects of the SDE include learning machining techniques and biological lab skills; seminars on biomedical engineering topics from the local program's faculty and invited speakers; cultural activities; lab, hospital and industry tours; and other learning experiences. We intend to have the experiences alternate locations annually, with the first design experience to take place at OSU in Summer 2014.

When the Summer Design Experience is hosted at NJU, the OSU partner will serve as a project engineering co-mentor for a team design project at NJU. The first co-mentored capstone project will take place at NJU in the Spring 2015 term, during the SDE and then continuing after the SDE has finished and the OSU students have returned home. The team of NJU seniors will initially be mentored by the NJU faculty, learning the design process and defining the problem to

be solved. A clinical mentor from a local hospital will also participate as a consultant for all medical questions pertaining to the problem. The OSU faculty will serve as a co-mentor for the second half of the project, focusing on the building and testing of the device.

Table 1: Two-year cycle for international capstone collaboration

| | YEAR 1 | | | YEAR 2 | | |
|---------------------|--------------------------------------|--|---------------------------------|---|---|---|
| | Fall | Spring | Summer | Fall | Spring | Summer |
| OSU students | Jr year courses at OSU | Jr year courses at OSU; Apply to SDE | Summer Design Experience at OSU | Capstone Design course at OSU; NEW Jr group applies for SDE | Capstone Design course at OSU | Summer Design Experience at NJU |
| NJU students | Jr year courses at NJU; Apply to SDE | Jr year courses at NJU; | Summer Design Experience at OSU | Sr year courses at NJU; | Capstone Design course at NJU; NEW Jr group applies for SDE | Summer Design Experience at NJU |
| OSU Faculty | Sr Capstone course at OSU | Sr Capstone course – OSU; Prepare for SDE at OSU | Summer Design Experience at OSU | Sr Capstone course at OSU; Analyze data from SDE | Sr Capstone course at OSU; Prepare for SDE at NJU | Summer Design Experience at NJU; Co-mentored project at NJU |
| NJU Faculty | Teach BME courses at NJU | Teach BME courses at NJU; Prepare for SDE at OSU | Summer Design Experience at OSU | Teach BME courses at NJU; Analyze data from SDE | Teach BME courses at NJU; Prepare for SDE at NJU | Summer Design Experience at NJU; Co-mentored project at NJU |

For the duration of the SDE, each day will be broken down into morning and afternoon sessions. The morning session will include the machining and lab skills training, biomedical engineering seminars, and meetings with clinical mentors to define the problem and ask daily questions about the design. The afternoon sessions will be dedicated to team design work, building, modeling, and testing. The projects will be a combination of new ideas, that have been previously vetted to be ready for the design phase, and partially finished projects from the previous year’s Capstone course. This will give teams the opportunity to see projects at various stages of completion, and allow them to focus on various aspects of the design process. At the end of the SDE, teams will have an opportunity to report on the process and outcome of their device design and activities.

Program Assessment

The goal of this collaboration is to build a strong partnership where students can obtain unique team and individual skills, and be prepared for a biomedical engineering career in a more globalized market and economy. We will examine these aspects with summative and formative assessments. We have partnered with OSU’s Center for the Advancement of Teaching to

develop targeted surveys, new and modified from previously described design rubrics¹⁻⁸. The assessment tools will be used to compare learning outcomes of OSU students and NJU students that completed the SDE while on the same team. We also plan to implement surveys for students that participate in the summer design experience with and without an international cohort. Finally we will examine student outcome differences in the capstone course between the students that did and did not have the extra SDE training. We will look for differences in their experiences, team dynamics and learning outcomes in the engineering design activities to quantify the effects of the international design experience.

Program Logistics and Goals

The success of this collaboration starts with a unique “Gateway” that OSU has developed within China that promotes the accelerated development of collaborations with universities, programs and faculty. Offices are established in China (within 1 hr of NJU), to help ensure the success of our program once we arrive. This particular partnership also draws from the backing of both Departments and higher administrative levels, particularly from NJU, which, for the inaugural summer design experience at OSU in Summer 2014, is currently pledging significant funding to support the trip for the NJU students.

There are significant opportunities for career development from this collaboration. As the primary instructor of the Senior Design capstone course, I am the main resource for OSU students for learning about industry models for design, manufacturing, business models, cost assessment, medical device regulation, ethics, and global aspects of engineering. Developing this collaboration would greatly enhance my ability to teach my students, as I would have meaningful experiences with international engineering partners and global medical companies that I can use in my classroom discussions. While at NJU, I will have the opportunity to speak at several seminars within NJU and at local hospitals and medical facilities. I will also plan to meet with industries, such as GE China. All of these presentations will promote the collaboration between our institutions. Finally, I will also have the opportunity to disseminate what I have learned with the broader engineering community in national publications, such as the Journal of Engineering Education, and conferences, such as ASEE and BMES.

The summer design experience is not a registered course for credit at this time, but may be expanded to include course credit in the future. Students selected for the summer design experience will travel under a short-term visa, appropriate for the length and mission of the trip. Students will be housed in standard summer campus housing, and transportation and meals are included in the overall package. Current sources of funding include the NJU College administration’s commitment to fund the NJU students’ inaugural trip to OSU. University travel grants, administrative assistance and external travel grants (such as Burroughs Wellcome Fund) are all being considered for future trips to minimize the personal cost to the students.

The significance of this collaboration is far-reaching, for the students, institutions, and the engineering community at large. The students receive the direct benefit of the international exposure within the engineering discipline, including immersion in a medical problem; designing, building and testing with a multi-national team; and learning valuable engineering and professional skills throughout the experience. The institutions can use the SDE as a springboard

for larger collaborations of research and instruction. For example, NSF has a specific partnership with the “NSF-counterpart” in China for research grants between investigators in both countries. Finally, all engineering programs will benefit from the dissemination of the results and analysis from the assessments. Other programs can verify the difference in skills and learning outcomes of students who did and did not participate in an international SDE. This is a very exciting collaboration with many positive aspects to explore and share.

Bibliography

1. Laguette, Stephen W. Development of a Capstone Design Program for Undergraduate Mechanical Engineering. Proceedings of the 2007 ASEE Annual Conference & Exposition.
2. Dieter, George E. and Linda C. Schmidt. Engineering Design. Fourth Edition. McGraw-Hill.
3. Davis, Denny and S. Beyerlein, P. Thompson, K. Gentili, L. McKenzie. How Universal are Capstone Design Course Outcomes? Proceedings of the 2003 ASEE Annual Conference & Exposition.
4. Beyerlein, Steven and D. Davis, M. Trevisan, P. Thompson, O. Harrison. Assessment Framework for Capstone Design Courses. Proceedings of the 2006 ASEE Annual Conference & Exposition.
5. McCormack, Jay and D. Davis, S. Beyerlein, H. Davis, M. Trevisan, S. Howe, M. Khan, P. Brackin, P Thompson. Classroom Learning Activities to Support Capstone Project Assessment Instruments. Proceedings of the 2011 ASEE Annual Conference & Exposition.
6. Estell, John K. and J. Hurtig. Using Rubrics for the Assessment of Senior Design Projects. Proceedings of the 2006 ASEE Annual Conference & Exposition.
7. Brackin, Patricia and J.D. Gibson. Capstone Design Projects with Industry: Using Rubrics to Assess Student Design Projects. Proceedings of the 2007 ASEE Annual Conference & Exposition.
8. Jablovkov, Kathryn and D. DeCristoforo. Sorting Out Creativity in Design Assessment. Proceedings of the 2008 ASEE Annual Conference & Exposition.