

Guest Editorial

The 2012 Capstone Design Conference

SUSANNAH HOWE

Picker Engineering Program, Smith College, 151 Ford Hall, Northampton MA 01063, USA. E-mail: showe@smith.edu

JAY GOLDBERG

Department of Biomedical Engineering, Marquette University, P.O. Box 1881, Milwaukee WI 53201, USA.

E-mail: jay.goldberg@mu.edu

SCOTT PALO

Department of Aerospace Engineering Sciences, University of Colorado, Boulder CO 80309, USA. E-mail: scott.palo@Colorado.edu

PETER ROGERS

Engineering Education Innovation Center, The Ohio State University, 244 Hitchcock Hall, 2070 Neil Avenue, Columbus OH 43210, USA. E-mail: Rogers.693@osu.edu

The goal of the 2012 Capstone Design Conference held in Champaign-Urbana, IL was to build upon the success of the previous conferences (2007 and 2010, Boulder, CO) and grow the community of educators, students, and industry members to discuss, analyze, and improve capstone design education. Focused around the primary theme of “industry involvement”, the 2012 Capstone Design Conference was intentionally designed to promote vibrant and extensive sharing of ideas and experiences across the capstone community, through interactive panel and poster sessions, workshops, and informal discussions and activities. This editorial discusses the conference planning, structure, and feedback. The subsequent papers in this issue document some of the outcomes of the conference, highlighting relevant papers along with selected panel discussions and workshops.

Keywords: capstone design; design conferences; best practices; design education; industry involvement

1. Introduction

The goal of the 2012 Capstone Design Conference was to continue building the growing network of capstone design educators, share best practices, and identify methods to improve capstone design education. The conference was held May 30–June 1, 2012, in Champaign-Urbana, IL, with a primary theme of industry involvement. Specific conference information, including the complete conference program, is available at the Capstone Conference website (www.capstoneconf.org).

The papers in this special issue represent a cross-section of best practices and topics of interest to capstone design course stakeholders in addition to summaries of several panel sessions and workshops from the conference. On the whole these papers provide an overview of current topics related to industry involvement in capstone design education.

2. Conference design/planning

Planning for the 2012 Capstone Design Conference began formally at the end of the capstone conference in 2010, with the establishment of an organizing committee representing different institutions and a range of engineering and related disciplines. Following good design practice, the Organizing Committee solicited input from capstone design instructors and representatives from industry at a special planning session at ASEE 2011. Attendees of this session brainstormed topics within the conference theme, suggested keynote speakers, and discussed session ideas. Feedback from attendees indicated a preference for maintaining the format of the 2010 conference to allow for open discussion and networking opportunities with other capstone design instructors at the 2012 conference.

3. Conference structure

The 2012 Capstone Design Conference contained many of the standard conference components, including papers, posters, panel discussions, and workshops. All of the submitted papers underwent a peer review

process. The conference was intentionally structured to enable and facilitate discussion and interaction beyond what occurs at many academic conferences. The bulk of the conference consisted of highly interactive, facilitated panel sessions on topics connected to the conference theme of industry involvement. Most panel sessions focused on topics addressed by authors of accepted papers. The panel facilitators engaged the panelists and the audience in discussions of prepared questions and issues raised by the audience.

Panel sessions related to industry involvement in capstone design included the following:

- *Intellectual Property for Industrial Projects*
- *The Value of Capstone Design to Industry*
- *What I Wished I Learned in Capstone Design: An Industry Perspective*
- *Strategies for Attracting Industry Projects*
- *The Importance of Technical Standards: An Industry Perspective*
- *Best Practices for Industry Sponsored Projects*
- *Effective Collaboration with Company Mentors*
- *Student Reflections on Capstone Design*

Panel sessions related to capstone pedagogy more broadly included the following:

- *Multidisciplinary Capstone Design*
- *The Art and Science of Problem Definition*
- *Assessing Capstone Design*
- *Required Resources for Capstone*
- *Global Projects in Capstone Design*

Rather than many short presentations, authors of accepted papers displayed posters in two conference-wide poster sessions. Thirteen of the posters represented collaborations between academia and industry, thirty-six posters showcased conference papers by capstone design faculty, and twelve posters highlighted recent capstone design projects by students. Poster topics ranged from lessons learned, case studies of industry/academia collaborations, meeting industrial and academic requirements in capstone design courses, teaching market assessment and needs identification, management of industry sponsored projects, adopting best corporate practices for capstone courses, enhancing industry collaboration, benefits of industry involvement in capstone design, and best practices in industry sponsored projects. These posters addressed many of the overarching topics that are critical to a strong, successful, and relevant capstone design program. The combination of interactive panel and poster sessions provided attendees with multiple opportunities for interaction, networking, and sharing of best practices.

Two conference workshops focused on issues related to industry involvement in capstone design courses. These included *A Professional Practice Model for Capstone Design Courses* and *Assessing Awareness of Professional Responsibility in Engineering Projects*. Other workshops focused on topics related to course management, resources, and best practices, such as *Capstone 101: Best Practices for Capstone Course Administration*, *Safety and Reliability in Capstone*, *Capstone Design Hub: Building an Online Resource Center for the Capstone Community*, and *It's All About Relationships: Understanding Their Development Inside a Capstone Clinic*. Two workshops were run by industry sponsors of the conference including *What Do You Need From Technology For Capstone Design?* (MathWorks) and *Build Your Own Embedded System: A Flexible, Open Reconfigurable Approach for Capstone Courses* (National Instruments). All workshops provided opportunities for in-depth learning of new tools, methods, and best practices.

In keeping with the theme of industry involvement, the 2012 Capstone Conference included several industry sponsors and exhibitors. These were John Deere, General Dynamics, MathWorks, EGI, The Ohio State University, AbilityOne Design Challenge (NISH), American Society for Engineering Education – Design in Engineering Education Division (DEED), ASTM International, CD-adapco, Industrial Press, IEEE, National Collegiate Inventors and Innovators Alliance, National Instruments, and Shell Eco-marathon Americas. Many of the sponsoring organizations sent representatives to the conference who not only exhibited products and services of interest to capstone design faculty and students, but facilitated evening workshops and participated in panel discussions, poster sessions, and networking activities.

The first day of the conference featured a plenary session with a keynote speaker. Larry Jutte, President and COO, Ernie Green Industries, and Managing Member, Auld Technologies, LLC used his years of executive management experience with Honda and his current experience of acquiring companies and sponsoring Capstone Design projects at The Ohio State University to describe the importance of experiential learning.

The 2012 conference continued the tradition of student involvement, reflecting students' key role in capstone design. Based on a successful 2010 conference, the organizing committee created two main paths for

student participation in the 2012 conference: 1) capstone design project posters and 2) student panelists. Twelve student projects, representing a breadth of engineering disciplines, were selected from a pool of nominated projects. Additionally, eight students served as panelists as part of two separate *Student Reflections on Capstone Design* panels to provide their perspectives on what students learn from capstone design courses and share their experiences with industry sponsored projects. Student involvement was made possible by the generosity of multiple conference sponsors. Sponsorship funds offset the costs of student travel, helped pay conference expenses, and made reasonable registration fees possible.

In addition to poster, panel, and workshop sessions, the conference incorporated a wide range of networking activities and conversations. The conference opened with a plenary session with ice-breaker activities, such as writing haiku and participating in a mini design-build activity. The next morning featured a number of optional tours and visits, including a conference run/walk around the UIUC campus, a bus trip to the Caterpillar plant in Decatur IL, visits to the Blue Waters National Supercomputer and the UIUC Research Park, plus tours of local museums. Lunch on the second day was conducted in “Birds of a Feather” style, in which attendees joined groups according to topics of interest. The conference concluded with an all-conference session that recapped the key points in all the panel sessions and began a discussion of next steps.

4. Conference attendance and feedback

The 2012 conference was attended by about 150 people, including faculty, students, administrators from nearly 80 universities, and representatives from industry and other interested organizations. Multiple engineering and other technical disciplines such as aeronautical, biomedical, civil, chemical, computer, electrical, environmental, industrial, mechanical, and software engineering were represented, as well as industrial design, computer science, information technology, and others.

According to responses ($n = 101$) to the conference survey distributed at the closing session and sent by email after the conference, attendee feedback was generally very positive. Attendees most enjoyed the sessions (including panels, workshops, birds-of-a-feather, and posters), as well as networking and talking with people from different organizations, and learning and sharing ideas. Many attendees specifically commented on the interactivity of the conference and the conference format/atmosphere in general. Attendees noted that they took away many new and useful ideas from the conference on topics such as pedagogy/course content, sponsors/mentors, industry involvement, funding, software tools, team management, assessment, and standards, to list a few. Suggestions to make future capstone conferences more effective included additional sessions and activities, adjusting the space and timing of some sessions, facilitating additional resource/information exchange, providing examples of very successful as well as very poor projects, and including a wider range of engineering disciplines. About 10% of respondents suggested keeping the capstone conference as is. When asked what factors would influence future attendance, attendees noted location, program, cost, and timing among other things, but more than 15% remarked that they were planning to attend regardless of these factors, which speaks to the value of this conference to the capstone design community.

5. Next steps

Future Capstone Design Conferences are planned for alternating (even-numbered) years, with the next conference to be held at The Ohio State University in Columbus, OH June 2–4, 2014. During odd-numbered years, planning sessions for future conferences will be held during the summer meeting of the American Society for Engineering Education (ASEE). During these ASEE meetings, ideas for conference sessions and suggestions to further increase the level of interaction and networking opportunities will be solicited. Feedback from previous conference attendees will also be considered to continuously improve the experience of future conference attendees. After each of the biannual Capstone Design Conferences we plan to publish a special issue of a journal highlighting the best papers and sessions from that conference, just as this issue of *IJEE* showcases the 2012 Capstone Design Conference. Our long-term goal is to grow the network of capstone design educators through continued networking, collaboration, and dissemination of best practices.

Susannah Howe is Design Clinic Director in the Picker Engineering Program at Smith College, where she coordinates and teaches the capstone engineering design course. Her current research focuses on innovations in engineering design education, particularly at the capstone level. She is also involved with efforts to foster design learning in middle school students and to support entrepreneurship at primarily undergraduate institutions. Her background is in civil engineering with a focus on structural materials; she holds a B.S.E. degree from Princeton University, and M.Eng. and Ph.D. degrees from Cornell University.

Jay R. Goldberg is Clinical Professor of Biomedical Engineering, Lafferty Professor of Engineering, and Director of the Healthcare Technologies Management Program at Marquette University where he teaches courses involving new product development and medical device design. His experience includes development of new products in urology, orthopedics, GI, and dentistry. Dr. Goldberg earned a B.S. in general engineering from the University of Illinois and an M.S. in bioengineering from the University of Michigan. He earned a master's degree in engineering management and Ph.D. in biomedical engineering from Northwestern University. Before moving into academia, he was director of technology and quality assurance for Milestone Scientific Inc. (Deerfield, IL), a start-up dental product company. Prior to that, he worked for Surgitek (Racine, WI), Baxter (Deerfield, IL), and DePuy (Warsaw, IN). Dr. Goldberg is a co-creator of the BME-idea national student design competition, and writes a quarterly column on senior capstone design courses for *IEEE Pulse*.

Scott E. Palo is Associate Professor of Aerospace Engineering Sciences at the University of Colorado Boulder. His research focuses on studying the near earth space environment, constructing small satellites to conduct space physics and developing scientific instruments for unmanned aerial systems. Dr. Palo has constructed numerous meteor radar systems, including one that operated at the South Pole, has developed instruments for use on UAS in the Arctic and Antarctic and constructed a small satellite which was launched and operated successfully in 2012. His educational interests focus around hands-on experiential learning and include both graduate and undergraduate team based design courses. Dr. Palo earned a B.S. in electrical and computer engineering from Clarkson University and M.S. and Ph.D. in electrical engineering from the University of Colorado Boulder. He is a senior member of the IEEE, an associate fellow of the AIAA and a member of URSI and Sigma Xi.

Peter Rogers is Professor of Practice at The Ohio State University. Dr. Rogers joined the university in October, 2008 bringing with him 35 years of industrial experience. His career includes senior leadership roles in engineering, sales, and manufacturing in robotics, electronics, sensors, and controls industries. He applies his multidisciplinary background to the development and teaching of industry-sponsored capstone design with a focus on product and market development. Dr. Rogers earned his Ph.D. at the University of Massachusetts, Amherst in mechanical engineering and manufacturing.