

Guest Editorial

The 2010 Capstone Design Conference*

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The goal of the 2010 Capstone Design Conference held in Boulder, CO in June 2010 was to build upon the success of the inaugural 2007 conference and grow the community of educators, students, and industry members to discuss, analyze, and improve capstone design education. Focused around the primary theme of capstone pedagogy, the 2010 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, short courses, and working groups. This editorial discusses the conference planning, structure, and feedback. The subsequent papers in this issue document some of the outcomes of the conference, highlighting best papers and selected panel discussions.

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

1. Introduction

The goal of the 2010 Capstone Design Conference was to build the network of capstone design educators, share best practices, and identify methods to improve capstone design education. The conference was held June 7–9 in Boulder, CO, with a primary theme of capstone pedagogy and a new frontier theme of international teams. 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 the best of the accepted papers based on the conference peer review process and summaries of several panel sessions from the conference. As such, they represent a cross-section of topics related to capstone pedagogy including industry sponsored projects, global virtual teams, assessment of student performance, intellectual property issues, idea generation, development of professional skills, coaching teams, service learning, entrepreneurship, and faculty roles.

2. Conference design/planning

Planning for the 2010 Capstone Design Conference began informally at the precursor (and first ever) capstone conference in 2007, and then formally in

fall 2008 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 at a special planning session at ASEE 2009. Attendees of this session brainstormed topics within the conference themes, suggested keynote speakers, and discussed session ideas. Feedback from attendees indicated the desire for open discussion and networking opportunities with other capstone design instructors at the 2010 conference.

3. Conference structure

The 2010 Capstone Design Conference contained many of the standard conference components, such as papers, posters, panel discussions, and short courses. All of the submitted papers underwent a thorough peer review process. The conference was intentionally structured to enable and facilitate more discussion and interaction than typically occurs at many academic conferences. The bulk of the conference consisted of highly interactive, facilitated panel sessions on topics connected to the conference themes. Most panel sessions focused on topics addressed by authors of accepted and related papers. The panel facilitators engaged the panelists and the audience in discussions of pre-

pared questions as well as issues raised by the audience. Panel sessions included *Student Perspectives on Pedagogy*, *Nifty Ideas/Surprising Flops*, *Capstone Project Management*, *Documenting Design Development*, *Teaching Entrepreneurial Capstones*, *Teaming/Coaching Practices*, *Service Learning Capstones*, and *Industry Partnerships*, among others.

Rather than many short presentations, authors of accepted papers displayed posters in a conference-wide poster session. The combination of interactive panel sessions and poster sessions provided attendees with multiple opportunities for interaction, networking, and sharing of best practices. Sixty-five posters were presented by faculty and/or industry participants and twenty-five posters describing recent capstone design projects were presented by students. Poster topics ranged from lessons learned, sustainability, and commercialization to engineering/industrial design collaborations, project teams, and course grading. These posters touched on many of the overarching topics that are critical to a strong and healthy capstone design program.

Conference short courses also focused on pedagogical issues in capstone design courses. Short course topics included assessment instruments for professional development, tools for forming and evaluating teams, strategies for planning and managing projects, supporting industry involvement, and coaching and managing teams. Pre-conference and evening short courses provided opportunities for in-depth learning of new tools, methods, and best practices.

Each day of the conference featured a plenary session with a keynote speaker. The opening speaker Bill Grogan (Dean of Engineering Emeritus, Worcester Polytechnic Institute) provided a historical perspective on capstone design and experiential engineering education. The following day, Alice Phinney (Senior Engineering Manager, Ball Aerospace) offered her insights on industry involvement in capstone design and student learning, based on her experiences as a frequent project sponsor and liaison. The final plenary session, led by panelists Alan Parkinson (Dean, Brigham Young University) and Dave Wilson (Director of Academic and University Relations, National Instruments), addressed opportunities and challenges with international teams and projects, as a lead-in to the new frontier theme for the conference.

One new addition to the 2010 Capstone Conference was the introduction of 'working groups' to enable interested attendees to begin discussions of and contribute to ongoing collaborations on specific topics related to capstone design. The working group concept recognizes that conferences, as a gathering of many interested and experienced peo-

ple, provide a valuable opportunity for productive face-to-face collaboration. One of the goals of the 2010 Capstone Conference was to identify relevant working group topics, solicit people to join working groups on these topics, and plan for how to continue collaborations after the conference. The larger vision was for the working groups to provide connectivity and activity between conferences, perpetuating and sustaining the network of capstone educators and producing useful strategies, white papers, and valuable tools for the capstone community. Initial topics for the working groups were presented at the opening plenary conference session. Three open working group sessions were held during subsequent conference days. Representatives of the working group discussions reported the results of their sessions at the closing conference plenary, identifying several groups that had formed and sharing plans to proceed.

In accordance with the primary theme of pedagogy, the organizing committee felt strongly that the conference would benefit from student involvement, and created two main paths for student participation: 1) capstone design project posters and 2) student panelists. Twenty-five student projects, representing a breadth of engineering disciplines and types of projects, were selected from the pool of forty-six nominated projects. In addition, six student panelists were selected from the twenty nominated; four of these student speakers served as panelists on the '*Student Perspectives on Pedagogy*' panel and the others provided a student perspective for some of the other panel sessions.

Student involvement was made possible by the generosity of multiple conference sponsors, including the American Society for Engineering Education, CaridianBCT, the Design Lab at Rensselaer, John Deere, the National Collegiate Inventors and Innovators Alliance, National Instruments, the National Science Foundation, Ricoh | IBM, and the University of Colorado. The sponsorship funds offset the costs of student travel, helped pay conference expenses, and made reasonable registration fees possible. Two sponsors, National Instruments and NASA (Lunabotics Mining Competition) staffed exhibition booths in the conference lobby, and National Instruments also hosted two workshops for conference attendees. In addition, many of the sponsoring organizations sent representatives to the conference who enhanced panel discussions, the poster session, and networking activities.

4. Conference attendance and feedback

The conference was attended by about 200 people, representing a mix of faculty, students, administrators, industry employees, and others. Multiple

engineering and other technical disciplines such as aeronautical, biomedical, civil, computer, electrical, industrial, mechanical, and software engineering were represented, as well as industrial design, computer science, information technology, and others.

Attendee feedback was quite positive in multiple areas. An interactive clicker survey was conducted during the closing plenary (75 attendees) with 78% of respondents rating the conference above average or excellent compared to other conferences. Panel sessions were rated above average or excellent by 79% of respondents; similarly, the short courses received these ratings by 63% of respondents, and the poster session received these ratings by 55% of respondents. Moreover, 82% of respondents noted that they would likely or definitely attend the 2012 capstone conference.

Qualitative feedback from attendees included strengths of the conference structure and organization, and areas for potential improvement. According to attendees, the most valuable aspects of the conference included the abundance of opportunities for interaction and networking with other attendees, the variety of topics and diversity of attendees, the panel sessions, the poster session, and the unique structure and format of this conference that helped facilitate the sharing of best practices. Suggestions for future conferences included sessions on intellectual property, projects based on design competitions, project evaluation methods, non-traditional capstone courses, presentations of case studies,

discipline-specific breakout sessions, and a database containing capstone course syllabi. Many attendees expressed an interest in sessions addressing the mechanics/logistics of the capstone course such as grading, project selection, team formation, and lecture topics.

5. Next steps

Future Capstone Design Conferences will be planned for alternating (even numbered) years, with the next conference scheduled to be held in Champaign-Urbana, IL, from May 30 to June 1, 2012. On the off-years, planning sessions for upcoming conferences will be held during the summer meeting of the American Society for Engineering Education (ASEE). During the 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 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 2010 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 the 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, and M.Eng. and Ph.D. degrees from Cornell.

Jay R. Goldberg is Associate Professor of Biomedical 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, and he holds six patents for urological medical devices. Dr. Goldberg earned a BS in general engineering from the University of Illinois and an MS in bioengineering from the University of Michigan. He earned a master's degree in engineering management and PhD 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 Palo is Associate Professor of Aerospace Engineering Sciences at the University of Colorado Boulder. His research focuses on studying the near earth space environment, specifically the mesosphere and lower thermosphere using both ground and space based techniques. Dr. Palo has constructed numerous meteor radar systems including one that is currently operating at the South Pole and he is working with two different student teams to construct small satellites for space weather applications. His educational interests are focused 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 MS, Ph.D. in electrical engineering from the University of Colorado Boulder. He is a senior member of the IEEE, AIAA and a member of URSI and Sigma Xi.

Janis Terpenny is the department chair and inaugural holder of the Joseph Walkup Professorship in Industrial and Manufacturing Systems Engineering at Iowa State University (ISU). She comes to ISU from Virginia Tech, where she was professor in the Department of Mechanical Engineering and in the Department of Engineering Education and an affiliate of the Department of Industrial and Systems Engineering. In 2010–2011, Janis served as a program director for the Division of Undergraduate Education at the National Science Foundation (NSF). She was one of the founders and has served as the director of the Center for e-Design for several years. Her research focus is engineering design (process and methods of early design; knowledge and information in design; product families and platforms; obsolescence in products and systems; and complexity of products and systems) and design education (multidisciplinary teams; impacts of project choice and context; and the retention and success of underrepresented students). She has 9 years of industry work experience with the General Electric Company (GE), including the completion of a 2-year corporate management program. Throughout her career, she has managed over \$7 million of sponsored research and is the author of 140 peer-reviewed publications. She is a Fellow of IIE, a member of ASME, ASEE, INCOSE, and INFORMS and serves as an associate editor for the *Journal of Mechanical Design* and for the *Engineering Economist*. She has received numerous awards for excellence in teaching, in research, and for service.