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Guest Editorial: The 2014 Capstone Design Conference

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Guest Editorial

The 2014 Capstone Design Conference

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The goal of the 2014 Capstone Design Conference held in Columbus, OH was to build upon the success of three previous conferences (2007 and 2010 in Boulder, CO, and 2012 in Champaign, IL) and expand the community of educators, students, and industry members engaged in discussing, analyzing, and improving capstone design education. Sessions at the 2014 Capstone Design Conference were designed for vibrant sharing of ideas and experiences across the capstone community via interactive panel sessions, poster session socials, and hands-on workshops. This editorial discusses conference planning, structure, and feedback. Technical papers that follow in this issue document scholarship surrounding noteworthy capstone course innovations. Most of these began as four page peer-reviewed papers included in the conference proceedings.

Keywords: capstone design courses; design pedagogy; multidisciplinary projects; experiential learning

1. Introduction

The goal of the 2014 Capstone Design Conference was to continue to attract capstone design educators, share best practices, and identify methods to improve capstone design education. The conference was held June 2–4, 2014, in Columbus, OH, with a theme of multidisciplinarity and experiential learning. Specific conference information, including the complete conference program and early versions of many papers appearing in this special issue, 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 as well as design researchers.

2. Conference Design/Planning

Planning for the 2014 Capstone Design Conference began formally at the end of the capstone conference in 2012, 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 2013. Attendees of this session were surveyed about their experiences with and motivation for multidisciplinary design. They were asked to describe the benefits and challenges of the multidisciplinary approach and let the Organizing Committee know how the Capstone Conference could help them incorporate or expand the use of multidisciplinary design in their courses.

Feedback from attendees indicated a preference for maintaining the format of the 2012 conference to allow for open discussion and networking opportunities with other capstone design instructors at the 2014 conference.

3. Conference Structure

The 2014 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 multidisciplinarity and experiential learning. Most panel sessions focused on topics addressed by authors of accepted papers. Some panels were targeted toward faculty, administrators, and industry representatives whereas others were targeted to the student attendees, although all panels included a mix of attendees in the audience. Panel facilitators engaged the panelists and the audience in discussions guided by prepared questions and issues raised by the audience. Panel sessions were clustered around several themes:

PERFORMANCE ASSESMENT
- *What I Wish I Knew on the Job My First Year*
- *Communicating Progress in Capstone Classes*
- *Student Perspectives on Multidisciplinary Capstone Design Teams*
- *Assessment Challenges in Capstone*
- *Uncommon Deliverables in Capstone Courses*

PROJECT SELECTION & ADMINISTRATION
- *Global Capstone Design*
- *Project Definition*
- *Intellectual Property*
- *Best Practices in Industry Sponsorship*

CAPSTONE COURSE DESIGN
- *Product vs Process Orientation*
- *Technical Design Reviews*
- *Infrastructure for Prototyping*
- *Nifty Ideas and Surprising Flops*
- *Case Studies in Use of Standards with Capstone Projects: A Multidisciplinary Approach*

CAPSTONE INSTRUCTIONAL PRACTICES
- *Best Practices in Multidisciplinary Capstone Design*
- *IT Nuggets in Capstone*
- *Supporting Successful Teams*
- *Teaching Capstone Design*

Rather than many short presentations, authors of accepted papers displayed posters in two conference-wide poster sessions. Forty-four posters showcased conference papers by capstone design faculty, and thirteen posters highlighted recent capstone design projects by students. Given the conference theme, many posters highlighted approaches within multidisciplinary and interdisciplinary capstone courses. Additional poster topics included design reviews, project sourcing and scoping, writing and communication, supporting capstone design teams, assessment and project scoring, sponsorship agreements and external relations, peer review and cooperative learning, intellectual property, virtual teams, and entrepreneurship in capstone design. These posters addressed both key components of cutting edge capstone design programs and current challenges faced by capstone design educators, students, and sponsors. The combination of interactive panel and all-conference poster sessions provided attendees with multiple opportunities for interaction, networking, and sharing of best practices.

The conference featured nine workshops spread across the conference, some over boxed dinners and others in the morning run concurrently with optional tours. Workshops ranged from the broad (*Framework for Engineering Design Learning and Assessment*), to the specific (*Biomimicry = Engineering + Biology: Tools for Capstone Design*). Three workshops focused on training and support for capstone faculty: *I Didn't Sign Up for This: Dealing with Difficult Students and Problem Teams, Coaching the Client: Collaborating with Sponsors to Maximize Student Learning,* and *Formation and Deployment of a Capstone Course 'Blue Collar' Industrial Advisory Board.* Two workshops addressed resources for capstone design teams: *Using Requirements for Project Health Monitoring* and *Task Planning – a Management Toolbox for Team Projects.* Two workshops provided hands-on exposure to specific technical or pedagogical tools: *Rapid Design of Embedded Systems with NI myRIO* (led by National Instruments representatives) and *Using CATME to Assign Students to Capstone Teams.* All workshops provided opportunities for in-depth learning of new tools, methods, and best practices.

The 2014 Capstone Conference included many sponsors and exhibitors including American Society for Engineering Education—Design in Engineering Education Division (DEED), ASTM International, IEEE, MathWorks, National Collegiate Inventors and Innovators Alliance (NCIIA), National Council of Examiners for Engineering and Surveying (NCEES), National Instruments, Seelio, Stratasys, and Texas Instruments. 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 workshops and participated in panel discussions and networking activities.

The first day of the conference featured a keynote panel called *Industry Perspectives on Multidisciplinary Design*. Susan Finger, a program director in the Division of Undergraduate Education at the National Science Foundation, moderated a lively panel discussion featuring four panelists from industry: Christopher O'Keefe (eNNOVEA), Duane Detwiler (Honda Vehicle Research), Robert Priest (Coltene-Whaledent), and Andrew Watchorn (National Instruments). The panelists provided their insights on the value of multidisciplinary capstone design experiences in preparing students for careers in a multidisciplinary world, within and outside of engineering.

The 2014 conference continued the tradition of student involvement, reflecting students' key role in capstone design. Based on a successful 2012 conference, the organizing committee created two main paths for student participation in the 2014 conference: 1) capstone design project posters and 2) student panelists. Thirteen student projects, representing a breadth of engineering disciplines, were selected from a pool of nominated projects. Additionally, eight students served as panelists on the conference panels, one of which was entitled *Student Perspectives on Multidisciplinary Capstone Teams*, and featured students exclusively. Student involvement was again 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. On the morning of the first day, the conference opened with a plenary session including a team-based design activity; the first day ended with an informal social gathering over microbrews to connect newer members of the capstone design community with more seasoned colleagues. The next morning featured two optional tours, one of the L Brands DC5 distribution center in Reynoldsburg, OH, and the other of Honda of America's manufacturing facility in Marysville, OH. Lunch on the second day was conducted in "Birds of a Feather" style, in which attendees joined groups according to topics of interest proposed in advance by session attendees. The third morning started bright and early with an optional run/walk along the nearby Olentangy River. The conference concluded with an all-conference session (featuring an inaugural ″hat swap″ of hats from attendees' institutions) that recapped the key points in all the panel sessions and began a discussion of next steps.

4. Conference Attendance and Feedback

The 2014 conference was attended by approximately 210 people, including faculty, students, administrators from nearly 90 universities, and representatives from industry, government, and other interested organizations. Multiple engineering and other technical disciplines such as aerospace, biomedical, civil, chemical, computer, electrical, environmental, industrial, mechanical, and software engineering were represented, as well as industrial design, computer science, business, and others.

According to responses to the conference survey collected after the closing session, attendee feedback was generally very positive. Attendees enjoyed most the sense of community (including informal discussions and exchange of ideas), interactive panels and diversity of panels/workshops, networking (especially during the poster sessions), organization of the conference, and tours. The most often cited new and useful ideas that attendees stated they would take away from the conference and implement were as follows: assignment ideas (topics, formats, etc.), assessment/evaluation strategies, strategies to interact with clients, ideas for multidisciplinary approaches, and team building tools. Attendees cited multiple ideas for even more effective meetings, including shortening the day/panel sessions a bit to leave more time between events, avoiding overlap of popular topics and/or creating a more formal system of minutes for those missing a session due to schedule overlap, and providing a separate discussion for projects without a prototype requirement. Attendees also suggested screening panelists more carefully to avoid "gripe fests" and/or helping prepare the panelists better, formalizing the "Birds of a Feather" sessions, and providing structured time to meet and exchange ideas beyond social events that can be hard for new attendees.

5. Next Steps

Future Capstone Design Conferences are planned for alternating (even-numbered) years, with the next conference to be held again at The Ohio State University in Columbus, OH on June 6–8, 2016. During odd-numbered years, informal gatherings of the capstone design community will be held during the summer meeting of the American Society for Engineering Education (ASEE). These informal gatherings at ASEE will include opportunities for networking within the capstone design community and discussion of future conference sessions ideas and structure. Feedback from previous conference attendees will also be considered to continuously improve the experience of future conference atten-

dees. After each biannual Capstone Design Conference 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 2014 Capstone Design Conference. Our long-term goal is to grow the community of capstone design educators, reflective practitioners, and design researchers.

Steven Beyerlein is a Professor of Mechanical Engineering at the University of Idaho where he has played a leadership role in the development of an inter-disciplinary capstone program over the last twenty years. Dr. Beyerlein earned a B.S. in Mechanical Engineering from the University of Massachusetts, an M.S. in Engineering Science from Dartmouth College, and a Ph.D. in Mechanical Engineering from Washington State University. Since joining the University of Idaho in 1987, Dr. Beyerlein has been an active participant in a long line of engine development and demonstration vehicle realization projects supported by the National Institute for Advanced Transportation Technology. He has also been highly engaged in a variety of research teams focusing on assessment of design learning, peer mentoring, active learning pedagogies, and faculty development for project learning.

Jay R. Goldberg is a 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*.

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 University, and M.Eng. and Ph.D. degrees from Cornell University.

Scott E. Palo is the Victor Charles Schelke Professor of Aerospace Engineering Sciences and the Associate Dean for Research in the College of Engineering and Applied Science 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 worked closely with student design teams to design, build, test, launch and operate multiple small satellites. 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.

Renee Rogge is an Associate Professor of Applied Biology & Biomedical Engineering at Rose-Hulman Institute of Technology. She has been teaching at Rose-Hulman since 2004, and her research interests lie in the areas of assessment of engineering design and orthopedic biomechanics. Dr. Rogge is one of the course coordinators for the Biomedical Engineering design sequence and is an active member of the Design in Engineering Education Division of the American Society for Engineering Education. She received degrees in Biomedical Engineering from Tulane University and the University of Iowa.

R. Keith Stanfill is the Director of the University of Florida's Integrated Product and Process Design Program–an industry-sponsored multidisciplinary capstone design and build course. IPPD is celebrating 20 years of success, with 14 of those years under Dr. Stanfill's leadership. He received his B.S., M.E., and Ph.D. degrees in mechanical engineering from UF in 1985, 1991 and 1995, respectively. He joined the UF Industrial and Systems Engineering faculty in 1999 as the IPPD Associate Director and was promoted to IPPD Director in 2001. In Fall 2013, he joined the Engineering Innovation Institute. His interests include technology transfer, entrepreneurship, product development, design education and Design for X. Dr. Stanfill has over ten years' industrial experience with United Technologies Corporation and is a registered professional engineer in the state of Florida.