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## Guest Editorial 2007 National Capstone Design Conference

JACK ZABLE  
University of Colorado  
Boulder, Colorado

The first National Capstone Design Conference was held at the University of Colorado (June 13–June 15, 2007). There were over 170 participants from industry, universities and colleges throughout the United States and five other countries. This conference was focused on improving the capstone or senior design course experience. This course is arguably the most important educational component in almost all undergraduate engineering curricula, and is reflected as such by the importance placed upon capstone design by the ABET accreditation criteria. Faculty from all branches of engineering, business, physics and other departments participated in the conference. Generous industry sponsorships from IBM, Ball, Boeing, Coors, Covidien, Gambro BCT, and General Dynamics, plus grants from NSF and ASEE, the Department of Mechanical Engineering and the College of Engineering and Applied Science at the University of Colorado insured the conference's economic viability. This enabled low conference fees and the awarding of conference fellowships, which in turn helped increase attendance.

The keynote speakers were Susannah Howe (Smith College), Deborah Limb (Boeing), David Holdger (ABET), and Sherri Sheppard (Stanford University). Dr. Howe described the changes that have taken place within capstone design courses over the past 15 years. Her results were based upon a survey from over 400 capstone design programs. Some interesting trends noted were; the rise in industry sponsored projects, the use of faculty (permanent and adjunct) with significant industry experience to manage and teach capstone design programs and courses respectively, and the significant growth of biomedical capstone design projects.

Ms. Limb described the benefits that Boeing has obtained by sponsoring capstone design projects. These included recruiting known, excellent students, and obtaining new ideas for product improvements and manufacturing techniques. She expressed mild concern over the attitude of some new employees whose thinking was 'what can Boeing do for me' instead of the other way around.

Dr Holdger spoke about the role of ABET's Accreditation Council in establishing policies that allow for consistent accreditation processes to be used for all engineering programs. The point was also made that almost all of the ABET individuals accrediting engineering departments come from an academic environment, and "they are us." He also discussed the unique importance of capstone

design relative to ABET accreditation, as this course is in position to determine a program's compliance with many ABET criteria.

Dr. Sheppard spoke of the need for connecting theory to practice through the use of projects in courses. Additionally, this should occur throughout an engineering student's academic experience not just in senior design. She also conveyed the need for engineering students to work with students from other disciplines such as medicine, business, biology, etc.

Workshops addressed:

- Methodologies to establish industry sponsored projects (e.g., identify potential industry partners with whom the college can establish long term mutually beneficial relationships; start an industry sponsored capstone design projects program with a small number of pilot programs).
- Improving student team performance (e.g., stages for team development and characteristics of an effective team; identifying trouble spots with capstone teams; measures to help these teams recover.)
- Methodologies to handle issues associated with operating a successful capstone design program (e.g., team selection, project selection, interaction with industry mentors, and developing faculty advising skills; faculty improvement practices.)
- Capstone design assessment instruments (e.g., proven assessment tools that the Transferable Integrated Design Engineering Education consortium has developed including metrics for design relating to professional growth, competencies, accomplishments, experiences, and integrated performances.)

Key findings and trends from the conference included:

- There has been a move toward using a greater number of industry or externally sponsored design projects.
- There is a broad range of project sponsorship fees paid by industry for project sponsorship, with the maximum approaching \$40,000.
- The common barriers that exist in obtaining industry sponsorships such as establishing lasting partnerships, establishing challenging but doable projects, intellectual property requirements of sponsors, and confidentiality issues have, for the most part, been successfully handled by many established capstone design programs.
- Non-tenured track faculty who have had significant industry experience have increasingly been employed to successfully teach in and direct capstone design programs in many engineering departments.
- There has been limited communication within the capstone design teaching community relative to best practices. (This was one of the key reasons to hold the conference.)

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- Many engineering capstone design programs are starting to use external resources (technical writing firms, university writing departments, etc.) in order to teach their students to be proficient in technical writing and oral presentations.
- From the limited data presented, on the average, the teaching load for a faculty member advising three capstone design teams per semester was treated as equivalent to teaching one three credit course.
- Many capstone design programs have established support structures for their student teams. Some schools give the capstone design teams charge cards in order to facilitate the purchase of parts and materials. Many programs have support personnel who are available to help students with the fabrication of mechanical and electrical hardware, and the development of software and instrumentation for data acquisition systems.
- The Myers-Briggs Type Inventory was one of many tools used by some departments to establish teams and assignments within those teams.
- Service learning projects, while teaching social activism, have some drawbacks. These include the lack of a qualified industry mentor, the lack of funding necessary to design, build and test 'product', and the absence of external pressure sometimes required for appropriate project completion.
- In general multidisciplinary teams were difficult to establish unless there was an overarching college wide structure in place to make this happen. There is a movement toward the greater use of multi-disciplinary teams in spite of this problem. Some multidisciplinary teams were advised by multiple faculty members with expertise in different areas.
- Newer trends in capstone design included collaborative efforts between different engineering departments at separate universities within the US, the use of international collaborative projects, and establishing design partnerships between engineering, business and health science students.
- Capstone design projects in biomedical engineering typically involved student teams interacting with medical centers and engineers in the biomedical device industry. Many of these projects also involved the establishment of manufacturing techniques that would meet industry standards and federal regulations.

The goals that were established and achieved for this conference were the development of a new, larger, and closer network of capstone design faculty, the exchange of best practice ideas, the establishment of a nucleus of faculty committed toward organizing a capstone design conference on a regular basis (the second conference will be in June 2010 at the University of Colorado), and improving capstone design pedagogy and programs. A select few papers were chosen for inclusion in this Special Issue of *Advances in Engineering Education* as a means for disseminating this

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conference's materials. All have been revised following the Journal's review process. Included in this special collection are the following papers:

1. Susannah Howe, "Where Are We Now? Statistics on Capstone Courses Nationwide."
2. Richard Bannerot, Ross Kastor, and Paul Puchhoeft, "Multidisciplinary Capstone Design at the University of Houston."
3. David W. Dinehart and Shawn P. Gross, "A Service Learning Structural Engineering Capstone Course and the Assessment of Technical and Non-technical Objectives."
4. Marjan Eggermont, Robert Brennan and Theo Freiheit, "Improving A Capstone Design Course Through Mindmapping."
5. Glen A. Livesay, Renee D. Rogge, and Kay C. Dee, "Development of a Supplemental Evaluation for Engineering Design Courses."
6. Nirmala Gnanapragasam, "Evolution of Technical Writing in Senior Design - A Case History."

Note that the Capstone Design conference will be held every other year with a planning meeting in the off year. This year's Capstone Design conference will be held at the University of Colorado in Boulder from June 7th-9th. The website for this conference is <<http://www.capstoneconf.org/>>.