

Guest Editorial: The 2018 Capstone Design Conference

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The 2018 Capstone Design Conference held in Rochester, NY expanded and improved upon previous conferences (2007 and 2010 in Boulder CO, 2012 in Champaign IL, 2014 and 2016 in Columbus OH) and further developed the community of educators, students, and industry members engaged in discussing, analyzing, and improving capstone design education and pedagogy. Sessions at the 2018 Capstone Design Conference enabled vibrant sharing of ideas and experiences across the capstone community via interactive panel sessions, conference-wide poster session, hands-on workshops, and many informal social activities. A special effort was made this year to improve networking and idea sharing among capstone design students, and to allow instructors to gain insight from this key group of stakeholders. This editorial discusses conference preparation, the range of conference sessions, and feedback from attendees. The technical papers that follow in this issue represent extended versions of selected papers, panels, and workshops from the conference. Topics include noteworthy capstone course innovations, pedagogical tools, effective practices for managing and assessing capstone students, and research on developing both design and professional skills in capstone students.

Keywords: capstone design courses; design pedagogy; capstone conferences; capstone community

1. Introduction

The goals of the 2018 Capstone Design Conference (CDC18) were to continue to attract capstone design community members (capstone design educators and administrators, industry sponsors, students, and other stakeholders), share best practices, and identify methods to improve capstone design education. The conference was held June 4 to 6, 2018, in Rochester NY on the campus of Rochester Institute of Technology (RIT). 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. Developing the plan: Conference design and preparation

Planning for CDC18 began formally at the end of the capstone design conference in 2016, with the creation of an organizing committee representing different institutions and a range of engineering and

related disciplines. Most of the organizing committee members had been involved with previous capstone design conferences, some newly interested participants also joined the team. The local chair for CDC18 had served as a conference co-chair for CDC16, so as to ensure continuity in planning and facilitate on-site conference logistics. The CDC18 organizing committee met regularly (biweekly and then weekly) in the year prior to the conference, soliciting and reviewing papers and workshops, planning conference activities, recruiting sponsors, and organizing an expanded student attendee program. The actualization of the conference was due in large part to the group of dedicated volunteers on the organizing committee.

3. Inspiring action: Conference keynote

The first day of the conference featured a keynote address from Patricia Moore, an internationally renowned gerontologist and designer. A distinguished RIT alumna, Moore has served as a leading authority on consumer lifespan behaviors and requirements. Early in her career she disguised herself as an 80-year-old woman and travelled throughout the United States and Canada so as to

respond to people, products, and places as an elder. In her remarks, she reflected on her journey as a pioneering industrial designer and offered inspiring examples of empathic design. Highlights of her remarks, which she reframed as an open letter to the capstone design community, are included below:

Open Letter to The Capstone Community— Patricia Moore

It was a particular honor for me to deliver the Luncheon Keynote at the 2018 Capstone Conference at the Rochester Institute of Technology. As a very proud alum of RIT, any time I am back on campus is a wonderful blend of nostalgia and gratitude. A member of the first graduating class of Industrial Designers, I enthusiastically credit the course and impact of my career on the education and experiences afforded me by an eclectic faculty and supportive staff.

In considering my comments for this all important presentation, I reflected on the entirety of my education and the critical component of my earliest childhood influences and the role of what can be called the “informal classroom” of home and community. Certainly we can all agree that more than what we know, who we are can be attributed to the essential nature of our earliest relationships and exposure to information and the forces that frame our collective lives.

As a Baby Boomer, the role of television in my early childhood development was viewed, not as a babysitter, but as a privilege, earned for eagerly doing chores and being a good girl. The memory of Sunday evenings, cuddled with my sisters, sharing a bowl of popcorn, watching Walt Disney’s latest offering. Perhaps that is where I learned about dreams and the fantastic becoming reality, but more important, that precious time with my siblings reminds me that the foundations formed in our earliest years sustain us today and always.

While my time with Walt was always a marvel, it was my relationship with Captain Kangaroo (Bob Keeshan) that still makes my heart swell. Every morning, while still in my jammies, I was allowed to sit with my breakfast and visit with Captain, Mr Green Jeans, Bunny Rabbit, and Grandfather Clock. My favorite portion of the program was when Captain read to us. His hypnotic voice embraced me and the stories he shared are parables I recognize as building blocks of community, creativity, culture.

Whenever I am invited to consult with a troubled Team, I typically share the gift of one Captain’s classics: *Mike Mulligan and His Steam Shovel* [1] or *Stone Soup* [2]. I cannot recall an instance when these precious texts failed to dissolve discord and clear log jams of stalled progress.

So too is the power of messages offered us decades ago. Among the books which were part of my development at RIT, Alvin Toffler’s *Future Shock* [3] and Victor Papanek’s *Design for the Real World* [4]. I share these fundamentals with students worldwide, in lectures and workshops, and delight at their applications to today’s challenges and opportunities.

Undoubtedly, my two most personal literature tipping points were the impact of reading *Black Like Me* [5], with the encouragement of my Grandfather, even

though my Mother protested at the time that racism was not a subject for childhood, [Her opinion had completely changed when I began my Empathic Elder research, and in light of the on-going forces of “isms” in our lives and politics, I would offer that we are never too young to learn the importance of equality and inclusivity in all things.], and Raymond Loewy’s *Never Leave Well Enough Alone* [6].

To have begun my career in industrial design with its “Father” still has me pinching myself, and to have been the first female product designer at Loewy International, serving as a role model for subsequent generations of women, brings me great personal pride. Noah had it right. Representation is the foundation of creating exemplars.

As that solitary voice, I often found myself asking colleagues, “Why not?” when told we couldn’t pursue a concept or a direction for a project, and even with push-back, I would persevere and offer the position of “What if?”

I remain adamant that the responsibilities of Design are the opportunities provided by the influence and insistence that with creative understanding, empathy, and universality in our thinking and actions we can achieve the global equity we all crave and deserve for a quality lifestyle and span. When we provide consumers with choices, we support their control for the challenges we will all encounter.

As we face the ever-evolving opportunity to respond to this world’s imbalance, inequality, and insecurity, we do our best work arm in arm, head and heart, in balance. I remain a hopeless Pollyanna, convinced that when we remember that just as snowflakes, no two of us are alike, but that uniqueness makes us all the same, in our desires, our hopes, and our dreams.

May your life be long in years and great in the joy of creative solutions,
Pattie.

4. Sharing ideas: Conference activities and sessions

The 2018 Capstone Design Conference built on the format and tradition established by previous capstone design conferences. In contrast to the traditional podium presentation format found elsewhere, this conference instead featured two conference-wide poster sessions (including both posters *about* capstone design and posters *by* capstone design teams) to encourage vibrant and extensive sharing of ideas and experiences. Based on themes that emerged from the selection of 2018 Capstone Conference accepted papers and posters, the CDC18 organizing committee created a series of interactive panel discussion topics related to capstone design. In addition, a range of workshops provided attendees hands-on opportunities to learn new skills and strategies to improve their own capstone design programs.

The 2018 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 of interest to the capstone design community. There were a total of 19 facilitated and interactive panel sessions. 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, as noted below:

Models for capstone courses

- *Multidisciplinary Models for Capstone Success.*
- *Systems Thinking.*
- *Design for Non-profits in Capstone.*
- *Capstone 101.*

Specific ideas for capstone courses

- *What I Wish I Had Known Before My First Job.*
- *Safety and Risks in Capstone.*
- *Entrepreneurship in Capstone.*
- *International Design Teams.*

Nuts and bolts of capstone design courses

- *Corporate Sponsorships.*
- *Grading or Evaluating Progress in Capstone.*
- *Professional Skills in Capstone Design.*
- *Encouraging Creativity in Capstone.*

Managing capstone courses

- *ABET 1–7: How is Capstone Design Affected?*
- *Nifty Ideas and Surprising Flops.*
- *Team Formation.*
- *Difficult Conversations.*

Student issues and design research

- *Roles and Responsibilities on Teams in Capstone.*
- *What I Wish I Had Known Before I Took Capstone.*
- *Performing Design Research in Capstone Classes.*

The panel sessions were particularly useful in connecting new capstone faculty with seasoned instructors with an aim toward helping new instructors get up to speed with known best practices so they do not feel they need to reinvent the wheel. Another key feature is allowing both old and new capstone

instructors to hear directly from capstone design students about what works and what doesn't work for them. The other common theme was concrete, useful and practical tips for solving common capstone design problems.

Rather than many short presentations, authors of accepted papers displayed posters in two conference-wide poster sessions. A total of 29 posters showcased conference papers by capstone design faculty, and 20 posters highlighted recent capstone design projects by students. Poster topics included leadership and entrepreneurship in capstone, incorporating humanitarian concerns into capstone projects, best practices for assessment, and multi-year and interdisciplinary courses. 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. In addition, student posters showcased the range of possible outcomes from capstone courses including projects which solve medical problems, public infrastructure projects, and even capstone course improvement. The wide diversity of student projects gave a complete spectrum of what is possible when a capstone team is motivated and well guided.

The conference featured 4 workshops spread across the conference, some over boxed dinners and others in the morning run concurrently with optional tours. Some workshops focused on specific skills and capstone topics including Modules for Demonstrating the New ABET Criteria while Infusing the Entrepreneurial Mindset and Practical Project Management Instruction in Your Capstone. Others gave instructors broader ideas for improving their capstone courses, such as Assessment of Motivation in Capstone Design and Quick and Easy Idea Generation Techniques. Sponsors such as Beagle Learning, Altair, and Texas Instruments provided workshops such as Collaborative Problem Solving with Beagle Learning and Rapid Prototyping the IoT with Texas Instruments which exposed educators to new technical solutions to common capstone problems. All the workshops allowed participants to work collaboratively to learn new skills, methods, and tools for improving capstone design.

The 2018 conference continued the tradition of student involvement, reflecting students' key role in capstone design. Based on previous successful conferences, the organizing committee created two main paths for student participation in the 2018 conference: (1) capstone design project posters and (2) student panelists. Twenty student projects,

representing a breadth of engineering disciplines, were selected from a pool of nominated projects. Additionally, eleven students served as panelists on the conference panels, one of which was entitled *What I Wish I Had Known* and featured students exclusively. Students participated throughout the conference and shared many ideas gained from their own capstone experiences. 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 that had attendees doing improvisational acting in groups; the first day ended with an informal social gathering over drinks and dessert to promote informal interactions. The next morning featured several optional local tours and activities around RIT and the Rochester region. 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 early with an optional run/walk around the RIT campus. The organizing committee also coordinated a series of “Quests” (and associated prizes) throughout the conference to support a continued spirit of play and encourage attendees to engage with other participants in fun ways. The conference concluded with a closing lunch to recap conference highlights and present awards.

5. Building the network: Conference attendance and sponsors

The 2018 conference was attended by approximately 195 people from four different countries. This included faculty, students, administrators, industry and government representatives, and other interested stakeholders. The academic participants represented nearly 60 universities. 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.

The 2018 Capstone Design Conference included many sponsors and exhibitors including Texas Instruments, Altair, ASEE DEED, ASTM International, Autodesk, KEEN, Maplesoft, NCEES, VentureWell, Beagle Learning, David Ullman,

EduSourced, and Populy. 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/or participated in panel discussions and networking activities.

6. Closing the loop: Conference feedback

According to responses to the conference survey collected live during the conference and after the closing session, attendee feedback was overall very positive. Many attendees—including faculty, students, and sponsors—commented that they appreciated the interactive conference format and the opportunity to meet and share ideas with a network of colleagues. They enjoyed the variety of panels and workshops and the range of topics covered. Multiple people specifically praised the keynote speaker for her inspiring talk. Several attendees suggested using a survey to collect current data about people’s capstone programs and others wanted a way to attend or at least capture info from parallel sessions. Some attendees requested more unstructured time for informal conversation or pop-up sessions based on topics that arose at the conference itself. A few of the specific topics suggested for future conference sessions included evaluation, ABET criteria and capstone, industry connections and engagement, multidisciplinary and interdisciplinary projects, capstone preparation, project scoping, and team formation. Attendees noted that they would take away many new and useful ideas from the conference, such as capstone roles and responsibilities, entrepreneurially-minded learning, assessment strategies, project management approaches, framing capstone as a business, engaging alumni, improvisation techniques, and capstone bootcamp. The majority of conference attendees felt that the balance of panels, workshops, poster sessions, tours, and breaks was about right, suggesting that the conference format is a good fit, but attendees also offered suggestions for alternate formats and sessions for the future. This feedback will directly inform subsequent Capstone Design Conferences.

7. Planning the future: CDC20 and beyond

Future Capstone Design Conferences are planned for alternating (even-numbered) years, with the next conference (CDC20) to be held at the University of Texas at Dallas in June 2020. Between conferences, members of the capstone design community may gather in smaller groups informally at conferences such as the American Society for Engineering Education (ASEE) or the Mudd Design Workshop

(MDW) or the New England/New York Regional Capstone Design Meeting. Such gatherings enable continued networking within the capstone design community and ideas for future conference topics and sessions. After each biannual Capstone Design Conference we plan to publish a special issue of a journal showcasing the best papers and sessions from that conference, just as this issue of IJEE represents highlights from the 2018 Capstone Design Conference. Our overarching goal is to build the community of capstone design faculty and staff, industry sponsors, and other stakeholders, so as to enable continuous improvement of capstone design education.

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 invested in building the capstone design community; she is a leader in the biannual Capstone Design Conferences and the Capstone Design Hub initiative. 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 BSE degree from Princeton, and MENG and PhD degrees from Cornell.

Bridget Smyser is the Lab Director in the Mechanical and Industrial Engineering Department at Northeastern University. She is a co-coordinator for Capstone design as well as the instructor for a required lab course. Her research focuses on lab course pedagogy and capstone design course assessment and innovation. In recent years she has been increasingly involved in the Capstone Design Conferences and spreading the word about capstone best practices to other departments at Northeastern. Her outreach efforts include sharing STEM ideas with cub scouts and supporting student club initiatives. She holds a BS degree in Chemistry from MIT and a PhD in Materials Science and Engineering from Worcester Polytechnic Institute.

Robert Hart is a Clinical Associate Professor in the Mechanical Engineering Department at the University of Texas at Dallas (UTD). He teaches the capstone design course sequence and serves as a Director for the UTDesign program, which facilitates corporate sponsorship of capstone projects and promotes resource sharing and cross-disciplinary collaboration among engineering departments. His professional interests are in the areas of engineering education, fluid mechanics, and thermal science. He is an active member of ASME and ASEE and has been a member of the Capstone Design Conference organizing committee since 2015. Before joining UTD, he worked as an engineer for 10 years, primarily at Southwest Research Institute. He is a licensed professional engineer and holds a BS and MS degree in mechanical engineering from the University of Houston and a PhD degree in Mechanical Engineering from the University of Texas at Austin.

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