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Biomedical Engineering Capstone Design Virtual Senior Showcase and Evaluation

ELLEN P. BRENNAN-PIERCE

MICHAEL NGUYEN-TRUONG

TARA WIGMOSTA

STUART A. TOBET

KETUL C. POPAT
Colorado State University
Fort Collins CO

ABSTRACT

Due to COVID-19, in-person senior capstone design work was truncated in March. The traditional in-person Senior Showcase was canceled, so a Virtual Senior Showcase and evaluation was planned and executed. Students created posters by virtual collaboration and recorded video presentations, which were posted on a webpage. A panel of industry judges, course instructor, and Teaching Assistants reviewed the posters and presentations in advance of the live question and answer judging session. To provide peer-to-peer engagement, discussion threads about each presentation were created. Based on the benefits to this format, we will likely continue practices from this year into the future.

Key words: capstone, design, virtual

INTRODUCTION

The Engineering Days Senior Showcase and Senior Design Evaluation is a long-standing annual tradition in late April at Colorado State University (CSU), which allows senior undergraduate students an opportunity to showcase the completion of their capstone design projects to faculty, family, industry representatives, and peers. Due to COVID-19, all units in our college of engineering truncated in-person senior design work in March coincident with Spring Break. The traditional in-person Senior Showcase was ruled out, but similar to many scientific conferences [1], the School of Biomedical Engineering (SBME) planned and executed a Virtual Senior Showcase and evaluation.

Our primary goal was to provide most of the important elements of the traditional Senior Showcase: poster presentation with demonstration of working prototype (if applicable given the truncation of physical project work), student interaction with a panel of industry judges (many from the SBME's Industry Advisory Board, IAB) to determine the top three projects for awards, assessment of Accreditation Board for Engineering and Technology (ABET) learning outcomes by the judges, grading by course Instructor and Graduate Teaching Assistants (GTAs), and sharing the projects with faculty, family, and peers. An additional challenge was to accomplish this goal with limited planning time and minimizing the potential for technical difficulties.

METHODS

Planning for the virtual Senior Showcase began in early April, about two weeks after transitioning to remote instruction and two and a half weeks before the date of the Showcase. Three planning meetings were held, and many emails were sent to organize and set expectations of all participants. Personnel planning and executing the virtual Showcase had basic knowledge of remote meeting platforms and the capacity to create a basic webpage.

Asynchronous and synchronous methods were used, since both methods offer benefits and drawbacks [2]. The students created poster files by virtual collaboration and then recorded virtual video presentations, typically using Google Meet or narrated PowerPoint. The video presentations and poster files were posted on a Virtual E-Days Senior Showcase webpage several days in advance of the Senior Showcase date (URL provided below). As the students were putting together their presentations, we gathered a panel of industry judges for an introductory meeting with the IAB members, course instructor and GTAs, and SBME directors to discuss the logistics of the upcoming event and test the Microsoft Teams platform for all involved in advance of the event. The industry judges, course instructor, and GTAs reviewed the poster files and presentations, evaluating based on rubrics and noting their questions and comments for the students in advance of the event.

Participants in the virtual Senior Showcase were located all over the country, stretching from east to west coasts. The morning portion of the event was for all 14 student teams to meet with the judges for a 15-minute live question and answer session. To reduce the overall time of the event, the 14 student teams were broken into three randomly assigned groups with four judges assigned to each group. Each group had a moderator (course instructor or GTA) to regulate the timing of the questions and the movement of student teams into and out of the Microsoft Teams meeting. The judges discussed the presentations and question and answer session performance from the student teams in their assigned group, and determined the top two student team presentations in their group. These top two team presentations were then forwarded to the other judging groups to view before an afternoon

discussion including all judges. In the afternoon all judges discussed pros and cons for the top two presentations from each of the morning sessions in another Microsoft Teams meeting. The event went smoothly and the ranked top three presentations emerged for awards to be announced to the students.

To provide peer-to-peer engagement, a discussion thread about each poster presentation was created in the electronic learning management system, which at CSU is a Canvas platform. A small percentage of the final presentation grade was earned by participating in the discussion threads. Students were required to leave a question or comment on at least four digital posters and were graded on completion of this task. The discussion threads were open for one week. Students in the senior design course asked each other thoughtful questions and gave thorough answers.

PRELIMINARY RESULTS

The presentation recordings and poster files can be accessed from the Virtual Senior Showcase webpage (https://www.engr.colostate.edu/sbme/virtual-e-days-presentations/). An example poster and screenshot from a presentation recording are shown in Figures 1 and 2 respectively.

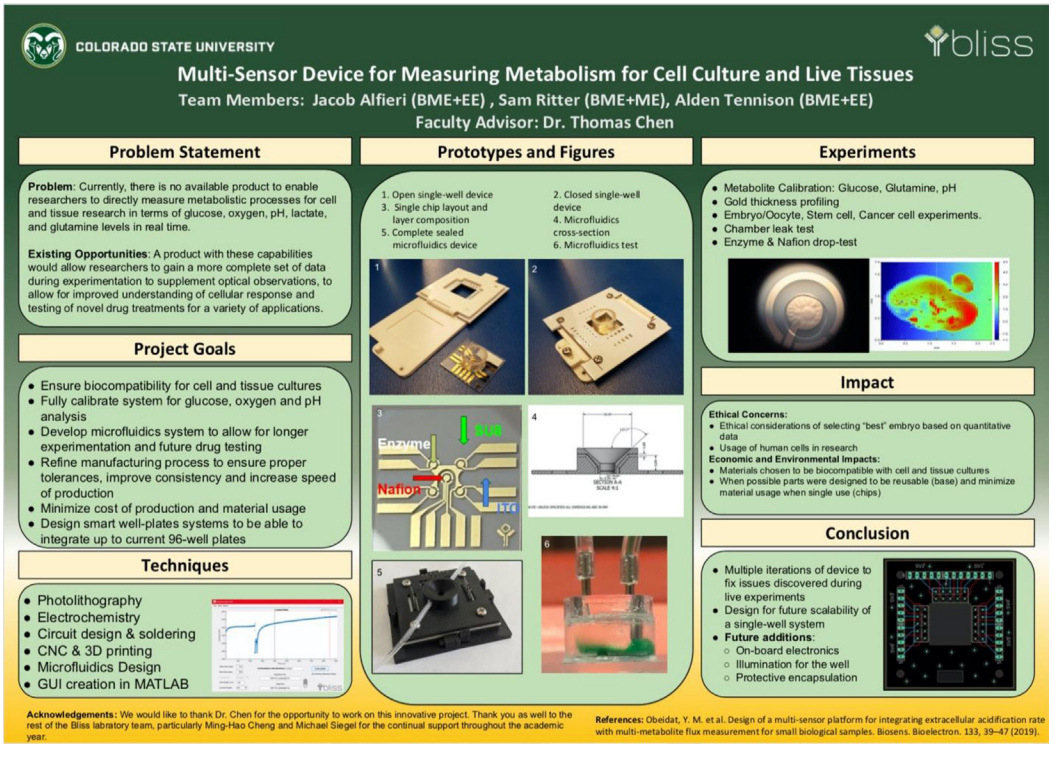

Figure 1. An Example Digital Poster.

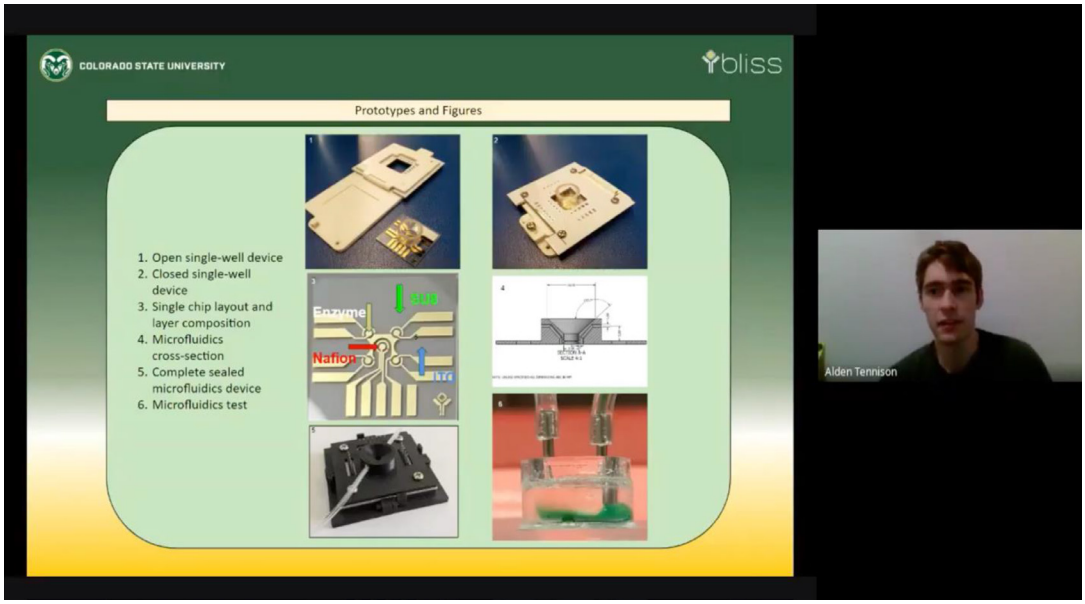

Figure 2. A representative screenshot from a presentation recording.

In a group debriefing following the event, we noted the students' profound gratitude to be able to finish their senior design experience with a presentation that was evaluated by industry professionals at a capstone event. The judges were impressed by the quality of work (truncated as it was in mid-March) and the ability of the students to rise to the challenge in our suddenly remote environment. However, rubric-based presentation scores were significantly lower in several categories compared to previous years. Many of these differences can be attributed to the incomplete status of the projects and lack of validation data due to the halt of physical prototype work in March. Challenges encountered in planning and execution of the virtual Showcase are described in Table 1.

Table 1. Challenges encountered in planning and execution of the virtual Senior Showcase.

Planning Challenges	Execution Challenges
• Scheduling the live question and answer session across time zones while considering students' other classes and judge availability • Avoiding conflict of interest for judges	• Technology access: lack of access to high-speed internet or camera for recording video • Technology failure: microphone failed during the live question and answer session, lost connectivity during the live question and answer session • Technology familiarity: some participants had not used Microsoft Teams before this event, seamlessly transitioning between student teams during the live question and answer session was difficult for moderators at first

Table 2. Example question and answer exchange in a poster discussion thread.

Question	Answer
Your poster and presentation are *very* professional and clear - bravo! The fact that your project encompassed heat and mass transfer, signal processing, 3D printing, and more is incredible. I have a couple of questions about your tissue phantom. 1) How did you all end up creating your own tissue phantom and was there any surprising research behind it? 2) In your ethical considerations, you mention diverse skin tones. Did you find that there were significant differences in your results when using a variety of skin tones? How did you evaluate which tone to pursue?	Thanks for the questions! I put a lot of research into how other researchers were creating tissue phantoms (TP) and talked with a bunch of material manufactures to decided on which material to use. We eventually settled on a regular two-part silicone rubber produced by Smooth-On. The specific silicone has a very low durometer (Shore 2A) for easy of use as well as similar texture to real tissue. Silicone rubber also inherently has a refractive index value that is very similar to real tissue (RI = 1.4). Manufacturing of TPs consisted of molds that were laser cut out of acrylic sheets and glued together with a solvent adhesive. These molds had sections cutout to fit the PVA vasculature which was inserted into the mold prior to pouring the silicone. The silicone was mixed with powder makeup for color and light scattering, vacuum degassed, and poured into the molds over the vasculature. Once cured, I just peeled the TPs out of the mold and put them into a bucket of water to dissolve out the PVA. When we produced our third TP, which was much larger than the previous prototypes, we learned that the vasculature was not rigid enough to support itself within the mold and had significant sag. To overcome this, we filled the mold halfway with silicone and let it partially cure until it was firm enough to support the vasculature. We then inserted the PVA, and poured the rest of the silicone to fill the mold. Fortunately, that was really the only big struggle that we had to deal with while producing the TPs. They just require a lot of waiting time between steps. Regarding the different skin tones, we did not find a difference on how the device performed with the varying skin tones of tissue phantoms. We simply picked different makeup colors/ concentrations to get varying skin tones. This is a very limited model though because of how much real skin tone is affected by cells, namely melanocytes. In the future, it would be wise to test how these cells absorb optical signals which could introduce other barriers. Sorry for the very drawn out response! If you have any more questions, feel free to ask.

The discussion threads about the poster presentations in Canvas provided deeper engagement between students than is possible within the traditional poster session environment. The number of replies per discussion thread ranged from 13-50 replies, with an average of 32 replies. An example is shown in Table 2.

There were many additional benefits to this format of presentations and judging. Judges liked having the flexibility to re-watch presentations and having time to develop more thoughtful questions for the student teams. The online format also allowed participation of IAB members who have been unable to participate in past Senior Showcases because of their location and the time/cost of travel. Anecdotally, students who participated in this virtual Senior Showcase appeared to be more motivated and engaged with their projects after the halt of physical work compared to engineering capstone students whose physical work was halted but did not have an opportunity to participate in a virtual or in-person Senior Showcase. The students also appreciated how easy it was to share their presentations with friends, family, and even colleagues on LinkedIn.

NEXT STEPS

Based on the benefits we observed from sharing the presentation recordings and poster files in advance of the judging event, we will likely continue some practices from this year into next year's

Senior Showcase, whether or not the university is able to host an in-person event due to COVID-19 circumstances. Additionally, the discussion threads about the poster presentations in Canvas add a valuable context for engagement between the students even when the in-person Senior Showcase is possible. One activity that we were not able to simulate or reproduce in the virtual Showcase was students demonstrating their physical prototype. In the future, students may be able to access their prototypes and include a demonstration in their video presentation. This rapid implementation of a Biomedical Engineering Capstone Design Virtual Senior Showcase provided a unique and fulfilling learning experience for all involved, and resulted in new approaches that will be implemented in future years of the capstone course.

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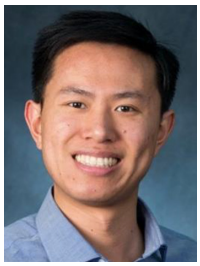
AUTHORS

Ellen Brennan-Pierce is an Instructor in the School of Biomedical Engineering and Research Scientist in the Walter Scott, Jr. College of Engineering at Colorado State University. She teaches Biomedical Engineering Senior Capstone Design, co-directs a Summer Clinical Immersion Program for undergraduate biomedical engineering students, and manages collaborative bioengineering research labs. Prior to coming to CSU in 2013, she was a Postdoctoral Research Fellow in the School of Biomedical Engineering at Dalhousie University. She received her Ph.D. in Bioengineering from University of Pittsburgh in 2009 and B.S. in Chemical Engineering from Northeastern University in 2003.



Michael Nguyen-Truong is a Ph.D. student in the School of Biomedical Engineering at Colorado State University (Fort Collins, CO, USA). He completed his B.S. in Biomedical Engineering from UC Davis (Davis, CA, USA) in 2017. Michael's current research focuses on the biomechanical properties of heart ventricles, an ovine model of right heart failure, and stem cell responses to biomimetic mechanical microenvironments. He seeks to develop a comprehensive understanding of right heart physiology and pathology from a biomechanics perspective and explore novel stem cell treatments for right heart failure. Outside of research, Michael has extensive mentoring experience and leadership from having served as a mentor to undergraduate students through his thesis research and as a Graduate Teaching Assistant for BIOM 486, the undergraduate senior design course in the School of Biomedical Engineering.

Tara Wigmosta is a Ph.D. candidate in the Biomedical Engineering program at Colorado State University (Fort Collins, CO, USA). Her current research focuses on orthopedic implants. She completed her B.S. in Biochemistry with minors in Mathematics and Chemistry at the University of Washington (Seattle, WA, USA) in 2013. Before attending CSU for her Ph.D., Tara worked as a Research Scientist at the Histology and Imaging Core at the University of Washington. She has worked as a Graduate Teaching Assistant (GTA) for multiple graduate and undergraduate courses at CSU. During the 2019-2020 academic year Tara was a GTA for Biomedical Engineering Capstone, where she helped facilitate the switch to online/remote learning during the 2020 COVID-19 pandemic.

Stuart Tobet is a professor in the Department of Biomedical Sciences and the Director of the CSU School of Biomedical Engineering, Colorado State University. His laboratory does research in ex vivo technologies and their applications to examining cellular communications and cell movements among neural, immune, and endocrine systems. His current projects are focused on cellular interactions in the gastrointestinal system of mice, pigs, and humans and include the role of the microbiome. He received his Ph.D. in Applied Biological Sciences from Massachusetts Institute of Technology in 1985, S.M. in Applied Biological Sciences from Massachusetts Institute of Technology in 1982 and B.S. in Physiological Psychology from Tulane University in New Orleans, LA in 1978.

Ketul Popat is a Professor in the Department of Mechanical Engineering/ School of Biomedical Engineering/School of Advanced Materials Discovery at Colorado State University. He is also the Associate Department Head of Mechanical Engineering and Director of Undergraduate Studies in Biomedical Engineering. Prior to that, he was working as a Research Specialist in the Department of Physiology at University of California, San Francisco. He received his Ph.D. in Bioengineering from University of Illinois at Chicago in 2003, M.S. in Chemical Engineering from Illinois Institute of Technology, Chicago in 2000 and B.E. in Chemical Engineering from M. S. University in India in 1998.