Capstone Design CONFERENCE 2022
JUNE 6–8, 2022 ▸ DALLAS, TEXAS

Inter-Collegiate Capstone Project Collaboration: A Case-Study

Michelle Clauss[1], Shraddha Sangelkar[2], Jim Mayhew[2], and Vern Ulrich[1]
[1]*Grove City College*
[2]*Rose-Hulman Institute of Technology*

Keywords: collaboration, cross-university, inter-collegiate, long-distance collaboration, joint-project model

Corresponding Author: Shraddha Sangelkar, sangelka@rose-hulman.edu

Extended Abstract

Developing a vibrant Senior Capstone Design program requires a lot of work and time. Making the projects not only exciting to students, but applicable to today's needs can be certainly challenging. As choices are made, consideration of project difficulty, appropriate application of knowledge acquired over the last three years, and team formation are all critical. Still one more area many ponder is how can the experience be created such that it mimics "real-world" engineering teams. This can be achieved by involving multiple disciplines, members with differing levels of experience, and even team members located at different sites.

In many institutions, the first two are easily met. Projects often require a minimum of mechanical and electrical engineering students. Computer science and physics majors can also be thrown into the mix. As for differing levels of experience, there may not be large age differences, but the knowledge and experience can vary enough to replicate the strain introduced by "differing levels of experience" found in the industrial setting.

As mentioned, the third element, coordination of projects when team members are not at the same location, is not so widely seen. Most see this as too difficult to manage and achieve. Gaining experience in coordinating and collaborating over distance is crucial. Most finished products are not produced in one facility. Many components are designed at one site, manufactured in one or more countries, and shipped to another country for assembly. Engineers must assure all the components are properly designed to fit and operate as expected. They must develop fast and efficient ways to manufacture, build, and package the product. The real-world works over distances, so capturing this learning objective through a capstone project makes sense. Thus, intercollegiate collaboration was conceived and tried. Lessons learned, issues which should be considered before trying, and trial results are summarized.

Some capstone instructors in the past have tried collaboration between campuses located in different parts of the world. McAdams and Linsey presented a globally distributed capstone engineering design experience where collaborating students were split between the two campuses of Texas A&M; one located at College Station, Texas and the other located at Doha, Qatar[1]. A different model involving a joint project was presented by Aidoo et. al. where Rose Hulman Institute of Technology (RHIT) initiated international collaboration with the Kwame Nkrumah University of Science & Technology (KNUST) in Ghana[2]. Knudson and Grundy shared how an international capstone exchange experience occurred between North Dakota State University (NDSU) in Fargo, ND in the USA, and Swinburne University of Technology (SUT) in Australia[3].

While most of the related literature was themed around globally-separated teams, a few examples of collaboration within continental United States were shared by Denzer[4] and Goldberg and Howe[5]. The importance of periodic in-person meetings was emphasized by Denzer when long distance multi-disciplinary collaboration occurred between students at the University of Nebraska-Lincoln, Montana State University, and the University of Wyoming[4]. Goldberg and Howe co-advised two virtual capstone design projects between Marquette University and Smith College[5]. They emphasized the importance of conducting frequent meetings with the entire team, including all students and both faculty advisors[5].

The COVID pandemic brought with it many challenges and concerns. Teaching and learning modes were altered, and new approaches were quickly developed. One of the developments was the forced reliance on remote meetings and brain-storming sessions. Faculty as well as students became comfortable with talking with groups via the internet. Good communicate and a new level of listening had to be honed. Each of these elements were crucial as the intercollegiate collaboration concept was conceived. Expensive travel was no longer needed. A simple video call could be used not only for discussing ideas but also for seeing the progress at both sites. From this, the "forged" Senior Capstone group became a reality. Therefore, real-life engineering teams can be more easily simulated in a capstone program.

Since this was the first attempt to collaborate, two schools separated by less than 500 miles (one in Pennsylvania, the other in Indiana) were selected instead of schools located in different countries. Leveraging the strengths of each of the institution was also considered. The client supporting the project was also located in a different state and a different time zone, Idaho.

The forged-team worked on a project that was supported by Kodiak Aircraft. The project objective was to design, build, and test a flammability cabinet that met the FAA regulations for flammability testing. The team was initially comprised of 2 mechanical engineering students from Rose-Hulman Institute of Technology (RHIT) and 5 mechanical engineering students from Grove City College (GCC). Due to some unanticipated circumstances one RHIT student had to be dropped midway and the tasks were re-assigned for timely completion of the project. The instructor team consisted of three faculty members, 1) GCC capstone instructor, 2) RHIT capstone instructor, and 3) Faculty Advisor/Expert from RHIT who did a sabbatical at GCC in the same academic year. The third faculty expert acted as a liaison between the two sides.

Similarities between the two schools produced positive interactions. Both institutions are small private schools having department heads of mechanical engineering that were very supportive of the collaborative efforts between the institutions. The capstone design sequence for both programs is a one-year experience, starting at the end of August and ending in May. The instructor team easily agreed on criteria as to what constituted positive progress. Furthermore, similar holiday schedules helped along with the fact that both schools are located within the same time-zone.

Differences between the schools caused several challenges. RHIT's academic calendar is based on a quarter system, whereas GCC uses a semester-based sequence, causing the project milestones and timelines to mis-match. Likewise, the RHIT capstone sequence is 12 academic credit hours, 4 per quarter. The GCC capstone sequence is 4 credit hours in the fall semester and 3 credit hours in the spring. Therefore, the RHIT Aug-May experience is the academic credit hour equivalent of 1.7 times the GCC capstone experience. Accordingly, there is a significant difference in expectations and time commitment for students at each institution. RHIT requires students to document 12 hours/week of work on capstone-related activities. GCC students, on the other hand, are evaluated based on accomplished tasks, but are expected to spend at least 6 hours/week on projects outside of team meetings. Most GCC students spend closer to 10 hours each week to accomplish their assigned tasks.

Several positive student learning outcomes resulted from this intercollegiate experience. Students quickly learned about the struggles of distance, the problem of using different CAD software (SOLIDWORKS versus CREO), and the need to communicate effectively. Conflict resolution was handled differently due to the separation and limited prior interactions between individuals at different schools. Still, experiencing these complications helped the students gain a better understanding of team dynamics in cross-country groups. Adapting between SOLIDWORKS and CREO was surprisingly easy to work through. Students learned about and preferred using STEP files as a means of conversion. Communication is always key to project success. Linked with it is trust. Great progress was made in both areas, but certainly is an area were more improvement can be made and deliberate team-building earlier in the project could benefit the year-long experience.

Much was learned through this collaborative experience. Both students, instructor teams, and programs developed a better understanding of how forged-teams could be used in the future to better prepare students as they step into the world of cross-country teams and globally-separated groups. Giving a capstone experience that more closely models the real-world is key for programs that want to adapt to the ever-changing and evolving landscape of engineering experience.

References

1. McAdams DA, Linsey JS, editors. dDesign Education: A Globally Distributed Capstone Engineering Design Experience. The 2010 Capstone Design Conference; 2010; Boulder, CO, USA.
2. Aidoo J, Sipes S, Hanson J, Sutterer K, editors. Overcoming challenges associated with the joint project model. Proc, Capstone Design Conf, Capstone Design Community; 2014; Columbus, OH.
3. Knudson D, Grundy J, editors. International capstone exchange–The SUT and NDSU experience. Proceedings of 2016 Capstone Design Conference; 2016: ; Columbus, OH.
4. Denzer A, editor Long-distance multidisciplinary collaboration: Some lessons learned. Proceedings of the National Capstone Design Conference; 2010; Boulder, CO, USA..
5. Goldberg JR, Howe S. Virtual Capstone Design Teams: Preparing for Global Innovation. International Journal of Engineering Education. 2015;31(6B):1773–9.