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Multi-University International Collaborative Capstone Experience

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Engineering capstone programs play a critical role in preparing students for professional practice by integrating technical knowledge with teamwork, communication, and project management skills. Prior work at the University of Colorado Colorado Springs has demonstrated the educational value of both multidisciplinary capstone teams and international collaboration through sustained partnerships with Linköping University in Sweden. This paper builds on those efforts by extending international collaboration opportunities beyond a single institution through the integration of the University of Colorado Denver Senior Design program. While the University of Colorado, Denver, operates a capstone program with similar objectives, it had not previously participated in international collaborative projects. In the 2024–25 academic year, the University of Colorado, Denver was invited to join the existing University of Colorado Colorado Springs–Linkoping Uuniversity collaboration with the goal of forming tri-institutional student teams. Enrollment constraints in this initial offering resulted instead in two binational teams: one composed of Colorado Springs and Linkoping students and one composed of Denver and Linkoping students. This paper describes the structure and outcomes of these inaugural collaborations, examines lessons learned related to curricular alignment, assessment, and program objectives across institutions, and discusses adjustments made to support student success. Finally, the paper outlines the follow-on implementation in the subsequent academic year and offers insights for other institutions seeking to scale international capstone experiences through inter-university partnerships.

Keywords: International Collaborations, Multi-institutional collaboration

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Introduction

Engineering capstone design experiences serve as a culminating element of undergraduate curricula, providing students with an opportunity to synthesize technical knowledge while developing professional competencies such as teamwork, communication, and project management. Because contemporary engineering practice increasingly involves collaboration across disciplinary, institutional, and national boundaries, capstone programs can be well positioned to expose students to these realities in an authentic and structured setting.

At the University of Colorado Colorado Springs (UCCS), the Senior Design program has evolved over several years to intentionally incorporate both multidisciplinary and international collaboration experiences. Previous efforts demonstrated that integrating students from multiple engineering disciplines and partnering with foreign institutions, such as Linköping University (LiU) in Sweden, can significantly enhance students' preparedness for professional practice, while also introducing logistical and curricular challenges that must be carefully managed. These experiences established a foundation for further expansion of collaborative models within the capstone framework.

Building on this foundation, the present work extends international collaboration beyond a single U.S. institution by integrating the University of Colorado Denver (CU Denver) Senior Design program into the existing UCCS–LiU partnership. While CU Denver's capstone program shares many objectives with that of UCCS, including the opportunity for multidisciplinary teams, differences in structure, assessment, and institutional constraints required deliberate coordination. This paper documents the initial implementation of this expanded collaboration during the 2024–25 academic year, highlights lessons learned in aligning program objectives across institutions, and describes refinements implemented in a subsequent offering. Collectively, these experiences provide a scalable model for institutions seeking to broaden access to international capstone experiences through inter-university partnerships.

Background

Engineering education has increasingly recognized that technical proficiency alone is insufficient for preparing students for professional practice. Successful engineers must also demonstrate strong communication, organization, planning, and teamwork skills—competencies that are most effectively developed through sustained, team-based, real-world design experiences such as capstone projects[1]. These experiences bridge theory and practice by requiring students to manage complex projects, interact with supervisors and external clients, and acquire new knowledge as needed to solve open-ended problems. Such outcomes align closely with evolving accreditation expectations, including ABET's emphasis on lifelong learning and adaptive problem solving. Furthermore, industry demand for engineers capable of collaborating across disciplinary boundaries has elevated the importance of multidisciplinary capstone experiences, which reflect the reality that modern engineering challenges rarely reside within a single discipline[2,3].

Beyond multidisciplinary preparation, there is growing recognition of the value of international collaboration in engineering education[4]. Working on globally distributed teams introduces additional layers of complexity—cultural, linguistic, logistical, and organizational—that mirror the professional environments many graduates will encounter. Motivated by this need, the Department of Mechanical and Aerospace Engineering at UCCS sought to provide students with authentic international design experiences, leading to a collaboration with LiU in Sweden[5]. Early efforts demonstrated the benefits of international interaction and additional foreign institutions learned of this program and requested the opportunity to join. The demand for this international program was quickly exceeding the capacity of the engineering programs at UCCS. This realization motivated the subsequent collaboration examined in this paper, which builds upon prior multidisciplinary and international experiences by extending the opportunity to additional US institutions, specifically, in this case, the CU Denver.

Inaugural Collaborative Experience – AY2024-25

In the 2024-25 academic year, CU Denver was invited to join the international collaboration program by offering their students the opportunity to apply to be on one of two project teams scheduled to run in collaboration with LiU. The hope was to have enough interest from CU Denver students to allow the US side of the collaboration for each project to be comprised of students from both UCCS and CU Denver. One of the critical but limiting features of this international collaboration program is the requirement that students travel to meet their project sponsor and foreign teammates at the beginning of the program, or shortly after the start of the Fall semester. Experience has shown that this opportunity to meet and get to know their foreign teammates is a critical feature, providing the team the opportunity to bond and plan for a truly collaborative teaming experience. There are many tools available to facilitate long distance collaboration, but true collaboration within a team requires a relationship among the teammates that is enhanced by meeting in person. The invitation to the CU Denver students was made after the conclusion of the Spring semester, so the number of students applying was lower than hoped. As a result, rather than having two teams comprised of students from all three institutions, we ended up forming the two teams with either UCCS or CU Denver students teaming with LiU students. All of the students, from both CU Denver and UCCS, travelled together to Sweden in September of 2024 to meet with the two sponsor companies and to spend time getting to know their LiU teammates (Figs. 1 & 2).

Figure 1. Atlas Copco team members meeting at LiU

Figure 2. Swedish Space Corporation team members meeting at LiU

The two planned projects were to address problems supplied by two Swedish companies, the Swedish Space Corporation and Atlas Copco. The Swedish Space Corporation desired that a flight qualified package be designed to safely transport biological microgravity experiments on sounding rocket flights (Fig. 3).

Figure 3. Biological Experiments Package

For Atlas Copco, the goal was to automate some of the testing of powered hand tools that are currently performed by a technician (Fig. 4).

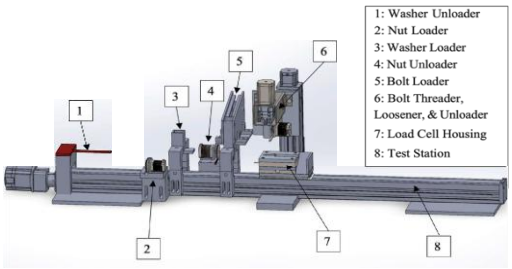

Figure 4. Automated Tool Testing Design

Lessons Learned

While both CU programs would largely characterize this first collaboration effort as a success, several challenges provided the opportunity to improve for future program years.

Coordination between CU Capstone Programs

For this initial partnership year between UCCS and CU Denver, the decision was made to have both teams participate in the UCCS program with the other UCCS projects. The UCCS program has its teams meet weekly with a faculty advisor who serves primarily the role of "supervisor" rather than teacher. There are several deliverables along the way, and CU Denver agreed to allow UCCS to be responsible for the assessment of the CU Denver students participating in the program. This, in fact, led to one of the first take aways from this experience.

The overall challenge is the difference in how capstone courses or programs are run. This is not just internationally, but also between the University of Colorado institutions. This should come as no surprise to faculty where differences in course delivery and expectations are often (and sometimes wildly) different within a single department.

For the current program year, the two programs have adopted a hybrid co-assessing model. This, however, has uncovered a different set of issues, where the participating students have sometimes felt that they were being guiding in contradictory directions. As the two programs continue this collaboration, the expectation is that we will zero in on a balance between assuring that each program is getting from the students what they are expecting, but that the students do not feel that their team is being unduly burdened with multiple sets of expectations.

Coordination with International Partners

In this international collaboration program, the foreign academic partners have maintained oversight of their own students. The students from all participating institutions work together, but each team reports to their own faculty. This has worked exceedingly well due to the extensive conversations up front to establish expectations from a faculty-to-faculty perspective.

There are still complications that arise, however. One unavoidable complication is the academic schedules of the participating institutions. LiU allots a single semester for their capstone program, whereas both CU programs have a two-semester model. That means partnering with them means clearly establishing a hand-off point at the outset of the project. This has been very doable, as the end-point for the LiU students is an approved concept. This means the CU students are in position to take the reins after the LiU students have stepped aside to do the necessary analysis, building, and testing necessary to complete the project and deliver their design to the customer.

This year, we are teaming with students from Bialystok University of Technology (BUT) in Poland for joint projects, as well. The students from BUT are participating on the project for both semesters, but their first term doesn't start until October 1, whereas both CU programs start in August. This has made coordination challenging, but the compromise that has mitigated this schedule issue somewhat has been the BUT students' willingness to come to their campus prior to the start of their academic year in order to meet with CU students and get going on their projects.

These kinds of issues will always be areas of concern when trying to coordinate between multiple academic programs, but clear communication at the outset has allowed these collaborations to work very well. With more international institutions wanting to join up, more and different issues will arise. The experience gained thus far will allow those issues to be dealt with and productive collaborations to ensue.

Travel

As stated earlier, a necessary feature of this program includes international travel, which comes with its own challenges. The most obvious is finances. To date, the UCCS Capstone Program has paid a significant portion of the international travel of the students and faculty on

the kick-off trips to Sweden and Poland which reduces the financial impact on the participating students, but they are still responsible for getting to the foreign country. Many students at both CU Denver and UCCS are first generation students and/or students without significant financial means. Even heavily subsidized, the financial obligation of participation dissuades many students from participating.

This year, CU Denver was able to offer some need-based scholarships to help students with financial need consider participating in the program. Nevertheless, finances at both CU institutions is an ongoing limitation on the program. Alternative funding streams are being sought to provide financial stability of the program and to allow more students from both CU campuses to participate in this valuable and enriching program.

Financing the trip is not the only complication. Logistics can be equally problematic. It is not unreasonable to contain these kick-off trips to one lost week in the semester when the partner institution is in Europe. Travel there typically arrives in the morning of the day following departure, and the return trip typically arrives home the same day as the departure due to the time zone impact. Students have shown tremendous resilience, both in terms of their ability to be productive on the trip and in their ability to jump back into their classes upon their return. And the faculty on both campuses have been accommodating the traveling students. The strain of travel is felt more by the accompanying faculty. Academic City University in Ghana is interested in joining the program, too. It is not reasonable to contain a trip to Ghana to one missed week of the academic calendar. It typically takes two full days in both directions of travel, so going for only one week would mean four days of travel for four days in country. Instead, the plan for this collaboration will be to travel before the start of the semester, requiring students from both countries to commit time before semester starts. This could limit participation from US students heading into their senior year and planning on spending the summer at an internship.

Conclusion

The UCCS International Collaboration program within their Capstone Design program has been going strong for 6 years with two continuing foreign collaborating institutions. With the desire of additional foreign institutions to join the program, CU Denver was invited to extend the Colorado student pool in 2024. That first year proved very effective and provided a unique opportunity for students from our two campuses to learn from each other even though they were not teamed together. The joint kick-off travel cemented their relationship and was a great experience for all students involved.

These kinds of collaborations are never without challenges, however, so that first year experience also provided an opportunity to identify and learn from some unexpected issues as well as to continue to improve on issues that were previously known. Now in the second year of this venture, we collectively have four teams participating in international collaboration projects, two with LiU in Sweden and two with BUT in Poland. And this year, we were also able to form teams that include students from three institutions. While two of the teams are exclusively CU Denver students with their foreign counterparts or UCCS students with their foreign counterparts, the other two teams contain students from CU Denver, UCCS, and their foreign counterparts. This has been an exciting development, and one that is opening up even more learning opportunities for our students. We look forward to continuing this collaboration, improving the experience for all involved along the way.

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