Fifteen Years of Peace Engineering:

Models of Integration into the Senior-Design Engineering Educational Capstone Experience

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***Abstract*— Programming in the field of Peace Engineering has been a part of the fabric of our work at the University of St. Thomas for over 15 years. A Peace Engineering minor is manifested in an appropriate two semester senior design project that partners with universities, non-profits, and NGO's in the U.S. and across the world. When coupled with a service learning abroad to collaborate in-person with a global community partner, these projects have been very impactful. Our work in this area is driven by our institutional principles of Catholic Social Teaching (CST) including social justice, solidarity, subsidiarity, sustainability, and the dignity of work. The paper will provide a summary of our 15 years of experience of success and failure in growing this core element of our engineering educational experience. We examine three models of credit-bearing student-community engagement: faculty-guided projects, collaborations with credit bearing study-abroad providers, and collaborations with onsite non-profit organizations that do not grant university credit. We conclude with our strategic objectives going forward including expansion of faculty involvement and development of specific curricular elements to support this effort.**

Keywords—peace engineering; senior design

I. INTRODUCTION

The senior design experience provides an apprentice-like experience for graduating seniors. Student teams work on a real-life project in an experiential learning format. Faculty advisors mentor the student team through a design and build process for a real client. Local companies sponsor most projects. The University of St. Thomas (UST) School of Engineering (SOE) has purposefully expanded the client base of our senior design offerings to include non-industrial partners. Many of our community driven senior design projects have occurred with project sponsors from different cultures and at the base of the economic pyramid. These senior design projects form an important element of the Peace Engineering minor. The projects aim to work collaboratively with the community partner, address social impact, and do no harm. Student learning is enhanced by reflecting on the experience to promote his or her own development.

Integrating a global community-based need with a study abroad experience further develops global competency. Study abroad is itself a form of experiential education and at its best, it engages in meaningful interactions and relationships with people while addressing an academic endeavor. Combining study abroad with service learning and senior design can provide a meaningful experience where engineering students are given the chance to explore creative solutions that can improve the wellbeing of people. Peace engineering strives to apply engineering principles to directly promote and support conditions for peace.

Senior-design projects in the social domain have become more common across engineering programs. Peace engineering projects examine social equity, sustainability, entrepreneurship, and community voice and engagement. These community driven collaborations help provide opportunities for intercultural engagement and meaningful exposure to global issues within the existing university framework. Participation in international service-learning projects can be a viable tool to educate students towards global competency. These senior design projects prepare graduates who can function as world citizens and who are ready to join the global workforce.

Senior design provides a structure for students to practice their design skills and technical knowledge; a peace engineering senior design project also develops an awareness of the complexity and interdependency of world issues and events. A project with a community partner also influences student attitudes. Working together with community members promotes respect for personal and cultural differences, self-confidence in handling ambiguity and unfamiliarity, and helps develop empathy.

An important aspect of Peace Engineering in Senior Design is that the projects force students to challenge a far broader array of design constraints than typical U.S. industry-based problems. Distribution networks, adoption rates, reliability, serviceability, transportation, supply chain, government structure, and cultural norms are just a few of the constraints that need to be fully explored in the design cycle. Students are forced to question basic assumptions about systems and processes that would not necessarily be vetted in a traditional design project.

The mission of the University of St. Thomas aims to educate an ethical and moral individual who can think critically, act wisely, and work skillfully to advance the common good. In addition, the School of Engineering is committed to provide an education that emphasizes curiosity, creativity and making connections. The peace engineering minor teaches students to work collaboratively and empower those experiencing injustice: to develop innovative and sustainable solutions, to serve people, and to advance the common good.

II. Models of collaborative international international service learning for senior-design capstone projects at the University of St. Thomas

Beginning in 2003-2004, the University of St. Thomas (UST) has offered senior design projects with an international service-learning component in the developing world. These projects fit with our core mission and provide many learning opportunities for our students. With 15 years of work in this area, the School of Engineering at UST has engaged with projects with multiple types of partner relationships across a range of cultures and countries in the developing world.

Our broad range of work in this area has led to a great deal of institutional knowledge on the key factors that lead to both success and failure. We have explored three different models of student-community engagement and this paper discusses the benefits and challenges of the models including; faculty-guided projects, collaborations with credit bearing study-abroad providers, and collaborations with onsite non-profit organizations that do not grant university credit.

A. Faculty-Guided Projects

In a faculty-guided project, the faculty member champions the relationship with the community partner and travels with the student team. This model of service learning is often built on a close meaningful relationship between the faculty person and the community partner. The faculty member manages the relationship and communicates directly with the partner. There may be other people at the university involved with the community partner. For example, a staff person in the office of community engagement, or multiple educators might be involved with the same partner, but the relationship is unique and dependent on the university champion. Most of the Peace Engineering senior design projects at UST have been faculty-guided.

Our most successful faculty-guided capstone experiences have been structured to include interdisciplinary collaborations with multiple departments across campus. To better reflect the interdependent nature of the real world, engineering student teams worked collaboratively with students from business, sociology, French, and communications and journalism. In this model, the students register for a capstone experience in an experiential course associated with their discipline. In the case of the engineering students, they register for senior design, which is conducted in its regular way. The only structural difference is that the subset of students involved in the international community based project meet regularly for a seminar-style meeting and the different groups of students travel together to an international destination. Senior capstone and independent study classes have been used and lend themselves to the model because they incorporate inquiry and are by nature project-based. The supplemental seminar meetings are used to study the country's culture and current political and economic situation, to exchange project information between teams, and to discuss trip logistics. By working together in the seminars and on-site, the students are introduced to different disciplines and skill sets. The collaborative team works well within the senior capstone model because the students involved have the relevant disciplinary expertise to work independently on their portion of the project and are mature enough to appreciate different disciplinary perspectives. Important 'soft skills' such as teamwork are learned and practiced. These projects have the added benefit of internationalizing the atmosphere at the home campus. The non-traveling students enrolled in the capstone courses who opt to work on more traditional projects, hear about the issues of a resource poor country, issues not usually covered in the traditional curriculum.

There are many benefits to the faculty-guided project model. The model can enable a long-term and meaningful relationship between the university (students, faculty, and staff) and a community, promote interdisciplinary cooperation at the university level, and support additional student learning through a managed seminar. From a financial perspective, because it can recruit senior level students across several disciplines, it can provide sufficient student participation to bring costs down. Depending on the community partner's infrastructure, long-term stays can be quite affordable. Finally, the credits for the experience are easily managed by the university.

There are also several challenges to faculty-guided project model. Often this model is too dependent on the faculty champion and it is not easily scalable to new locations or to new faculty champions. Expansion of the model encourages important self-reflection questions. What is the role of the faculty? Does a faculty person need to be onsite with the students? Few faculty can or want to spend an extended period of time abroad and one can question if it is appropriate to add the faculty's travel costs to the students. Do the students have a direct relationship with the community partner, or does the presence of the faculty person disrupt that direct relationship? What does the faculty know about culture learning? How does the faculty address issues of social injustice? Does the faculty have training outside their technical or disciplinary expertise to address the teaching and learning of topics such as cultural competency or economic disparity? Our experience having engaged many faculty in these projects was that there were

striking differences between faculty backgrounds, with some faculty having no training in working across cultures and economic classes. Thus, we have sought to improve this training for both the faculty and the students.

Logistical challenges cannot be understated. Either the faculty person or the community partner is responsible for arranging room and board, local transportation, risk management, and technology transfer. Much depends on the community partner infrastructure and organizing the project logistics can be very time consuming. Without a university level commitment to manage the interdisciplinary faculty and student recruitment, or provide the faculty with high quality culture training, we found the faculty-led model difficult to sustain and observed a high level of faculty burn out.

B. Collaborations with Credit Bearing Study-Abroad Providers

A second model that we have piloted this past summer relies on a direct relationship with a study-abroad provider. In this model, the study abroad company manages the relationship with the community partner and is responsible for arranging room and board, local transportation and risk management. Credits are transferred from the study-abroad provider to the university, through a pre-existing agreement.

There are many benefits to this model. Much of the logistical details become the responsibility of the study-abroad provider. The students communicate with the community partner through the faculty employed by the study abroad provider.

The faculty person at UST is introduced to the community partner and the project separately from the students. This eliminates the possibility that the faculty- community partner relationship is so strong that it affects the student-community partner relationship. The UST faculty does not travel with the students but connects remotely once a week. The UST faculty ensures that the objectives of senior design are met.

Next summer we will expand this model to include interdisciplinary collaborations across the university. Another beneficial consideration would be to collaborate across institutions. Teams of senior design students from other universities could meet together on the program. This may enable the program to be economically sustainable. Participation from only 3 or 4 universities could provide sufficient number of students to support an international location and perhaps encourage more study-abroad providers to offer international service-learning.

This model is the most expensive of the three models. The geographic distribution of projects become dependent on the study abroad provider and not the University. There are few options available at this time.

Because of the additional layer between the university and the community partner, the relationship is not as deep as the faculty-led model. Engineering faculty are involved, but are not asked to provide all the necessary cultural and justice training. We have addressed this training by mandating every student who travels internationally to complete a Global Competence certificate, and for those students completing the peace engineering minor, a seminar managed by our Justice and Peace Studies department is required.

C. Collaborations wite non-profit organizations that do not grant university credit

We are currently planning to pilot a third model of engagement next summer. With this model we plan to use the best practices and ideas from the other models. In this model, the university establishes a relationship with a non-profit organization (NGO) committed to a community. The NGO is responsible for the relationship with the partner and the logistical details of the student travel. Again, the faculty are introduced to the project and the community separately from the students and mentor the students remotely through the internet. The model can be expanded to other disciplines on campus and also to other universities. This model can be less expensive than the study-abroad provider collaboration. The fees are more specifically for room, board and transportation and onsite services and not course credits. Course credits are managed by the university as in the faculty-led model. We believe this model may be more flexible in location and type of NGO partner.

III. FUTURE PLANS

The value of Peace Engineering to our engineering educational experience can not be underestimated. First and foremost, there is the fit with our university Mission and our commitment to Catholic Social Teaching, which ties remarkably well with values that guide successful peace engineering design projects. Secondly, there is the enhanced experience of truly global perspectives, cultural competency, and the need to challenge basic assumptions in the design cycle. Going forward, the School of Engineering has initiated efforts to more systematically analyze the impact of these projects on the cultural competency of our students. Such analysis will formalize our understanding of projects driven under the three models discussed in this paper.

Plans also include strengthening the partnership between Justice and Peace Studies and Engineering through curricular revision. In fall 2018, a restructured Peace Engineering minor was inaugurated after several years of curricular design to better integrate technical education in engineering with normative education in justice and peace studies. Although students have engaged in peace engineering projects over 15 years, the number of credits required to complete an engineering major and a standard justice and peace studies minor discouraged most students from completing both programs. Over several years, we collaborated to retain the

substance of a justice and peace studies minor with an integrative - rather than additive – approach: to consolidate the number of credits while enhancing the collaboration between academic units.

The new Peace Engineering minor requires justice and peace studies courses that also satisfy other undergraduate requirements: Introduction to Justice and Peace Studies class fulfills the human diversity requirement, a course in either leadership, policy, or conflict fulfills a writing across the curriculum requirement, and Theologies of Justice and Peace fulfills a liberal arts core requirement. In addition, rather than adding two elective courses to complete the minor, Peace Engineering students enroll in special sections of the engineering senior design course. With careful planning, this "double-dipping" allows students to pursue the minor without adding many credits beyond those required by the liberal arts core requirements. Two additional components of the new minor are required but carry neither credit nor tuition: a significant experience of poverty, injustice, social conflict, or marginalization, and a senior capstone seminar on vocational discernment concurrent with a senior design course.

In the new Peace Engineering minor, students will contribute their unique technical and disciplinary perspective in justice and peace studies courses focused on descriptive and normative analysis of social problems. They will explore the implications of the engineering design process in dialogue with the justice and peace studies Circle of Praxis pedagogy. These two conceptual models both complement and challenge the other, enhancing normative analysis in engineering and practical application in justice and peace studies. Faculty, too, look forward to this challenging dynamic as an area of professional and programmatic growth with implications for pedagogical innovations in the classroom, and structural changes in the institution, all in the service of the university's commitment to "advance the common good." Beyond our own university, we will engage in dialogue with other undergraduate and graduate institutions to contribute to the development of peace engineering curricula, pedagogy, and programs.

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