



## **Engagement in Practice: Lessons Learned While Developing Community Partners (and a New Engineering Program) for Service Learning**

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## **Background and Motivation**

Service learning as a pedagogical strategy is well documented. At its best, service learning allows an opportunity to bridge technical education in the classroom to practice. Additionally, it encourages student development of communication skills, leadership, critical thinking, active learning, and cultural understanding [1]. These skills learned through service learning benefit students upon graduating, as they will be expected to interact with people from diverse backgrounds in order to solve complex problems. For engineering students, these goals and needs are no different, as engineers work on multidisciplinary projects that requires the skills listed above to succeed. Programs such as the Engineering Projects in Community Service [2], and Engineering Without Borders [3] have demonstrated that the service learning is also valuable to the community partners. The goals of this paper are to communicate how Abilene Christian University (ACU), a medium sized (approximately 4000 residential undergraduate students) faith-based liberal arts university developed a service learning course and community partners during its first years as an engineering program.

ACU began offering a degree in General Engineering in the Fall of 2012. While students share a common core in the general engineering degree, they are able to gain more discipline specific expertise through upper level technical electives and through capstone projects. As a part of the curriculum, students participate in a three semester capstone sequence that consists of a project based junior design course, followed by a yearlong industry sponsored design experience. Originally, the program proposed a capstone model of incorporating Junior students into one semester of the senior capstone course, but quickly determined students (Juniors and Seniors alike) were not well prepared to interact with industry clients (whom are financial sponsors and act as clients for each project). As a result, the Junior semester of the capstone course is now its own standalone course that is taught during the spring semester each year.

## **Course Design and Execution**

The junior level course in its present form has been offered two semesters. For the Spring 2016 and 2017 courses 18 students have enrolled in the course. All were junior engineering majors, five were female.

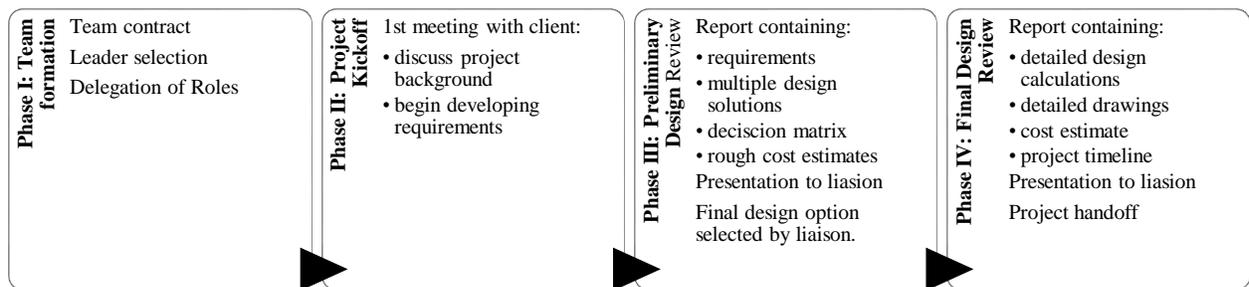
The course is a project based, service learning course where students use the engineering design process to develop solutions for community partners. While developing the course the instructors investigated a variety of sources including but not limited to: senior capstone instructors at university, EPICS course syllabus [2], and the Capstone Hub website [4] to determine best practices and develop course objectives. Upon examining the best practices, the instructors set the course objectives for the course:

1. Teamwork- students will display an ability to function of multidisciplinary teams, as well as understand and appreciate the importance of various roles of teammate.
2. Design under constraints: Students will display an understanding of the engineering design process from start to finish for real world applications.
3. Lifelong learning- students will understand where to search for appropriate background references, as well as, discern what appropriate and acceptable sources are.
4. Professional Skills- students will develop an ability to communicate effectively through both written and oral communication to a variety of audiences (academic, client, etc.)

Through these learning objectives students learn professional skills such as written and oral communication, leadership, planning, and teamwork in preparation for a more successful industry sponsored senior capstone course. In the course, students enter knowing little of what engineering writing looks like, where to go for engineering background research, how to scope projects, create project timelines, etc.

The curricular structure of the course does not allow for long term projects as students complete two projects during the course of the semester. The first projects are developed from international humanitarian partners that the works with during the summer. Each project team consists of four to six students, an on campus faculty or staff member from a different department who is familiar with the international non-governmental organization and serves as the NGOs liaison, and a faculty “coach.” Projects consist of four phases (Figure 1), forming a project team, project kickoff, a preliminary design report/proposal, and final design report/presentation. Teams apply to projects, ranking their top choices then are selected based upon their skill sets listed in their resume.

After forming, the teams self-select a team leader who is the point of communication between the team, community partner and faculty coach. Students then schedule a project kickoff meeting, preliminary design review, and final design review with the client. In between each meeting they are responsible for developing a problem statement, requirements, multiple design solutions, and a detailed design (with cost estimate, supply list, construction timeline, etc.)

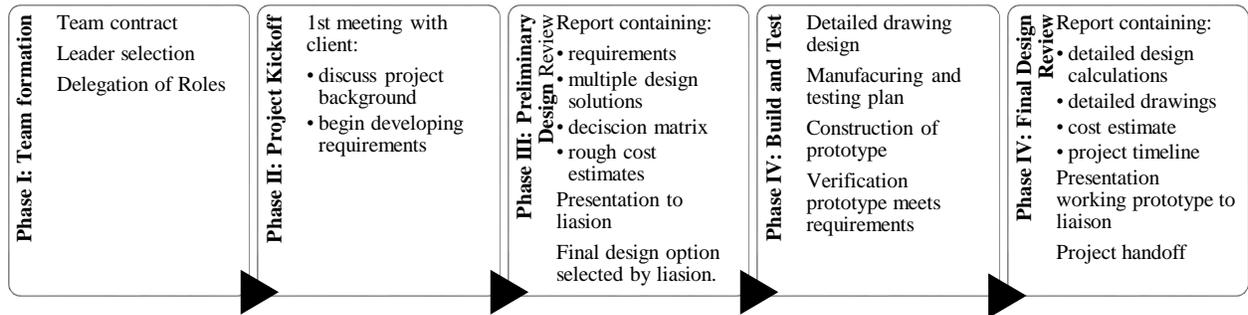


**Figure 1: Project 1 Phases**

For the first project, students do not build and test the designs, but instead take the design to final design stage and then pass them off to the liaisons and the students that will travel to the NGO location that summer. After the conclusion of the project, students participate in a performance

evaluations with their instructor in order to simulate an industry environment as well as provide them with areas they can improve upon in their next project.

The second project follows a similar process (Figure 2) as the first project. Instead of faculty liaisons, students meet with community partners in the Abilene, Tx where the university resides.



**Figure 2: Project 2 Phases**

Project statements are provided by community partners, then the students follow the same process of developing requirements, preliminary design proposal, and final design presentations. This second project allows students the opportunity for a start-to-finish project. Upon completion of the preliminary design proposal, students must receive approval from their client to develop (in addition to the detailed plans, cost estimate, supply list, etc.) a testing and implementation plan and a prototype. During the final design presentation, the students deliver the final prototype and handoff to the client.

### **Lessons Learned**

In this section of the paper, we describe how community partners were established with non-profit organizations, local professional societies, and local schools. Additionally, we share stories of successes and failures through the process with community partners as well as lessons learned from course objectives. We recognize that we are still in the beginning stages (year three) of our longest partnership, but believe there are still lessons to be shared.

#### *Corporate Partners- Year One*

The first community partner was developed from the instructor’s network in the humanitarian engineering world. A nongovernmental organization (NGO) helping homeless in Brazil had recently begun using aquaponics as a means to aid in funding the NGOs efforts and providing job skills. They desired to create an automated aquaponics unit that they might also be able to produce on site to sell to others in the urban environment to grow healthy fresh vegetables that were otherwise rare. Our desire was to videoconference in someone from the NGO to serve as a liaison, but we were unable to make the necessary arrangements. Instead, we asked local on-campus staff member to serve as the client, who had a background and interest in aquaponics, but no real connection to the NGO in Brazil. Students completed a detailed design and a

rudimentary prototype of the aquaponics system that was not acceptable to the client. While we no longer are partners with this particular NGO, we were able to learn a few lessons from them:

1. Our local liaison struggled to relate to the needs of the Brazilian NGO as they had no connection or familiarity to the NGO. The result was a project that could be assembled at a local hardware store in the United States, but little consideration was given to the needs of Brazilians. Therefore, we now choose NGOs and projects that local faculty and staff are connected to or ensure the NGO can have a representative available for the three meetings.
2. Having a project that students could “learn” from allowed students to be better prepared for meeting with face to face clients.

The second partner developed in the first year came as a result of fellow faculty member who had a child whom required therapy sessions at a local non-profit rehab center. After learning what the faculty member did while at the session, the occupational therapist (OT) shared a list of projects the non-profit rehab needed accomplished. The instructor then contacted the OT to determine if a partnership could be formed. The OT was willing to serve as the “client” and presented a list of projects that would benefit the rehab center as well as the students learning experience. An initial project was chosen to benefit a feeding program, the occupational therapist had recently started her place of employment. The program was still in its infancy, but very successful. One of the main struggles they faced was providing patients in their program with feeding chairs (similar to those used during therapy sessions) that aid in reducing outside distractions so that the focus could be on eating. Commercial options are available, but cost is prohibitive to families, thus the therapy could not continue at home. In the first year, students worked with the partner to develop two prototype solutions that met safety and durability standards for a fraction of the cost.

Following the first year, the OT used the student designed prototypes for the semester. During the fall semester, junior students worked with the department student club to produce some additional prototypes to be donated to the OT as they believed in the product they designed as well as the mission of the project. Also, during the fall semester a group of graduate students in the OT program at ACU performed a study for their classes on the students using the prototypes and commercially available chairs. The OT requested we contact her again the next year to accomplish some of the other projects.

In the second year of partnership, working together alongside the OT we determined the greatest need for the rehab center. This time students were tasked with providing an outdoor year round growing space for tower gardens the rehab center used in their feeding program. The OT was only able to grow indoors at the time and was limited on what she could grow. The tower garden served as an avenue to introduce patients to new foods through touch, taste, smell, and scents. Students again were very excited and connected deeply with the project. They added personalized touches outside the budget of the project (which they paid for out of their own pocket) to ensure the project would not only stand up to the structural loads and provide adequate conditions for growing, but was also visually appealing to the users. At the end of the project the client once again asked to be contacted the following year and also presented the program with a plaque. Some lessons learned from our first local community partner:

1. Always listen. The connection for this community partner came from a faculty member's conversation while at an appointment for his child. He was then able to connect our department with a great community partner that now benefits our program, as well as, the patients in their program.
2. Partners are great advocates to expand the reach of your program. One partner arranged for the local news stations to be at the final design presentation where the product was handed off. Our program was still in its infancy (year 5) and the news spot served as a great advertisement of our program and the engineering profession.
3. Look for community partners that are just getting their start. In our case we found them easier to work with and more willing to understand our struggles of being a new engineering program and service learning course.

### *Corporate Partners- Year Two*

In addition to a continued partnership with the rehab center from year one, the program also solicited a partnership with a local elementary school, Lee Elementary. The school the instructor contacted via a school board member in the instructors network serves as the Newcomer Center Campus for refugees and immigrants new to Abilene. That means that first through fifth grade students who are new to the United States and the community all attend this school. As a result of having these particular demographics, the school spends a large amount of time and money investing in student's language and cultural skills and less on supplies and other needed items. We connected with the school first through the principal who then put a call out to teachers for project proposals. We (the instructors) then met with two teachers on site, presented them with some frequently asked questions (below) and laid out expectations.

- How does Junior Clinic fit in the students' curriculum?
- What are the requirements of the students?
- What are the requirements to be a project client?
- When/Where do meetings take place?
- What makes a good project?

Students then met with the teachers at the campus to develop requirements and gain background information. Additionally, they attended class in order to better understand the needs of the teachers. At the last meeting they presented to projects to the class and also were able to encourage students to consider careers in engineering. Through this client relationship we learned the following lessons:

1. Cooperation in developing problem statements and managing expectations is beneficial. Had we not met with teachers before students did, some disappointment might have occurred. Luckily we were able to curb the expectations of the workload that students would provide.
2. Involvement with K-12 educators in service learning such as that described not only provides the teacher with a solution to their problem, but can also serve as a great avenue for students to begin learning how to be voices for the profession. Students were able to show students how engineers can help solve problems for their communities no matter how large or small.

### *Course Objectives*

An end of year survey was given to students at the completion of the course to assess the student's perception of their learning with regard to the course objectives. Students rated their preparedness in communication, teamwork, engineering design process, and readiness for the senior capstone course on a scale of 1-4 with 1 being they strongly disagreed they were prepared and 4 being they strongly agreed they were prepared. The results of the survey are in Table 1. From the data it is apparent that students believe the course had prepared them for the next step in their education. Students also indicated their positive view of the experience through a section of open comments with comments such as, "I thoroughly enjoyed taking this class and being able to have "real-world" type experience, and I think it has prepared me well to go into senior clinic next year."

Table 1: Results from end of course assessment

Communication	Teamwork	Engineering Design Process	Senior Capstone preparedness
3.75	3.67	3.5	3.75

From the course the instructors learned the following lessons:

1. Ambiguity is frustrating to students, but the struggle of ambiguity allows them time to learn to ask questions and being learning where to go for information.
2. Allowing students to learn from the first project (where they only proceed through detailed design) allows them to truly understand the engineering design process, and all that must be complete before actually building. The second project in turn gives them a chance to wipe their slate clean and try again correcting their previous mistakes.
3. For report writing and detailed drawings, previous projects or examples allow students to see the expectation and ultimately produce a better product.
4. Giving students language and training for teamwork is important. Use of a book, strengths, personality type is very important in giving student language to go with their frustrations and/or problems they may encounter on teams.

### Conclusion and Next Steps

Though only in its third year the junior level service learning course at our university has begun developing community partners. Through these sometimes unconventional partnerships the course has been able to build strong relationships that have resulted in projects that benefit the partners, as well as, the students learning experience.

The instructors believe that the service learning course has aided in developing students. In year three of the course will continue to operate in its current form. Two new clients will work with students to develop solutions to problems they each have. The instructor has also began talking with faculty members in the college of business administration about possible future collaborations with business students. The faculty in business offer a similar junior level course in entrepreneurship that could be integrated to provide a multidisciplinary course. In the course students would work in teams to provide nonprofits with a business plan and technical solution.

The course logistics are not yet complete, but the instructor hopes that something can come to fruition soon.

[1] D.M. Donahue, D. Fenner, and T.D. Mitchell. "Picturing Service-Learning: Defining the Field, Setting Expectations, Shaping Learning." *Journal of Higher Education Outreach and Engagement* 19.4, pp.19-37, 2015

[2] Oakes, W. (2016, July 22). EPICS Syllabus., available, [https://sharepoint.ecn.purdue.edu/epics/teams/Public Documents/EPICS\\_Syllabus.pdf](https://sharepoint.ecn.purdue.edu/epics/teams/Public Documents/EPICS_Syllabus.pdf) [Accessed January 31, 2018]

[3] A. R. Bielefeldt, K. G. Paterson, & C.W.Swan, "Measuring the value added from service learning in project-based engineering education." *International Journal of Engineering Education*, 26(3), pp. 535-546, 2010.

[4] Teaching. (n.d.), from <http://cdhub2.org/>. [Accessed on March 19, 2018]