Integration of Curricular and Extra-Curricular Learning Through Service

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Introduction
Industry is asking for more engineers and also different kinds of engineers that possess both strong technical skills and a broader set of capabilities that allow them to lead innovation, work across disciplines, and thrive on multi-cultural teams. The National Academy of Engineering’s (NAE) described these skills in their report the Engineer of 2020. These characteristics include sound technical skills and traditional fundamentals along with robust communication, teamwork and leadership skills, along with well-developed social and cultural competencies, strong creativity and wide-ranging transferable skills to address the problems of today and tomorrow, such as the NAE’s global “Grand Challenges”. The companion report Educating the Engineer of 2020 described curricular reforms needed to develop these broader sets of skills. These calls for reform are not new and are similar to those motivating the engineering accreditation guidelines that went into effect in 2000 which mandated outcomes that blend “traditional” engineering knowledge with the abilities to function on multidisciplinary teams, communicate effectively, and to understand a wide range of issues, including professional and ethical responsibility, the impact of engineering solutions in a global and societal context, and knowledge of contemporary issues.

Engineering LTS programs have generated a great deal of interest from both faculty and students. Students have initiated numerous chapters of Engineers Without Borders U.S.A. (200+), Engineers for a Sustainable World (30+), and Engineering World Health (20+). Faculty workshops on community engagement sponsored by the EPICS Program have generated waiting lists the last two year. One of the newest and fastest growing divisions of the ASEE is the Community Engagement Division. With the benefits of LTS on learning, recruitment, and retention, and the interest of students and faculty, it is surprising that the pedagogy has not become more wide spread within engineering undergraduate curricula. Engineering has been slower to adopt service-learning pedagogy than many other disciplines within the U.S.

This is particularly evident as the majority of the LTS efforts remain outside the undergraduate curriculum and are localized and non-sustainable in their current forms. Barriers to curricular change have been studied within the academy and in particular related to LTS.

This paper describes the integration of a primarily extra-curricular model with a curricular model for LTS. The results and student perspectives are discussed.

EPICS and EWB-USA Programs
Engineers Without Borders - USA (EWB-USA) and the Engineering Projects in Community Service (EPICS) are well recognized and have established best practices in service-learning, multidisciplinary project work and collaborations between industry and academia. Both approaches share the common goals of addressing compelling needs of the underserved domestically and internationally while equipping the future leaders in engineering education. Each has strengths and successes that are complementary. Both have achieved success, share values and possess complementary attributes. To achieve change in engineering education, approaches that bridge individual programs are needed to engage a broader professional community. These organizations have begun exploring collaborations to bridge their programs. The leadership of the programs have presented workshops jointly including an invited workshop at the ABET Annual...
Symposium in 2014. Both organizations are committed to engagement that addresses human and community needs through engineering design and establish and value long-term partnerships with communities and deliver real projects to their community partners. Their expertise is complementary.

EPICS has operated exclusively within the curricular setting and established a record for curriculum reform, assessment and adaptability to other institutions and into high schools. The faculty and staff have extensive experience in curriculum development, faculty and teacher development and engineering education research. EPICS has historically focused on projects within the local community but has engaged in increasing numbers of global partnerships within its university network.

EWB-USA has developed a large and extensive network of professionals and students engaged in communities in developing countries. It has created successful models for mentoring with professionals and students to address real community needs. It has extensive expertise in developing community partnerships and appropriate solutions and has become one of the most pervasive engineering organizations with student chapters on over 200 campuses. EWB-USA projects are almost exclusively outside of the curriculum. One of the reasons for this is the emphasis on student leadership and ownership which is traditionally challenging to achieve in a course.

This project is a pilot project where the EWB-USA student chapter is integrated with EPICS to give students academic credit that can be counted toward their graduation requirements. The approach taken is to leverage the curricular structure of EPICS to capitalize on the advantages of curricular experiences while maintaining the benefits of the student-driven EWB-USA experience. The project began in the fall of 2014 and is continuing into the 2015 academic year. While the experience is still relatively new, the initial successes and issues provide opportunities for reflection and discussion for dissemination to other experiences.

EPICS is an NSF-supported program that was initiated at a large Midwestern university to address the dual needs of teaching engineering design and meeting community needs for access to expertise in engineering and technology. EPICS has been recognized for its curricular innovation by the NAE with the Bernard M. Gordon Prize for Innovation in Engineering and Technology Education, 2004, and as an exemplar of programs “Infusing Real World Experiences into Engineering Education (2012); by NSF’s Corporate Foundation Alliance as an Exemplar Program (2002); and by the American Society for Engineering Education with the Chester Carlson Award for Innovation in Engineering Education (ASEE) (1997 and 2012). EPICS was recognized as a signature program of the IEEE Foundation (2013).

In EPICS (www.purdue.edu/epics), teams of undergraduates partner with local or global not-for-profit community organizations to define, design, build, test, deploy, and support engineering-centered projects that significantly improve their ability to serve the community. EPICS integrates highly mentored, long-term, team-based, multidisciplinary design projects into the undergraduate curriculum. Data have shown EPICS meeting the engineering accreditation goals of effectively teaching the broad set of professional and design skills that are required for success in industry, but which are difficult to teach in a traditional classroom setting. With its focus on engineering in context and strong emphasis on teamwork, communication, and commitment, EPICS is also proving to be an especially effective vehicle for encouraging women and under-represented groups in engineering.
EPICS has grown at a large Midwestern university to over 400 students from more than 50 majors and 30 teams per semester. The success of EPICS motivated the dissemination of the model to 22 other universities. Further expansion of the model into high schools created the EPICS High program that now have more than 50 high schools in the U.S. and over 30 abroad through a partnership with IEEE.

**Extracurricular Learning to Serve Model (EWB-USA)** is a nonprofit humanitarian organization established in 2002 at a large public university to support community-driven development programs worldwide through partnerships that design and implement sustainable engineering projects. Since its founding, it has seen explosive growth. EWB-USA currently has more than 12,400 members. EWB-USA has 93 professional chapters and student chapters in 201 institutions across the U.S. Each chapter works on programs in the developing world under the guidance and approval of EWB-USA.

Using student chapters as extracurricular activities has allowed EWB-USA to spread rapidly with student interest. Results of the EWB-USA experience have been widely lauded from industry and within academia. Student leaders in EWB-USA have been recognized with awards including recent recipients of Rhodes scholarships in 2011 and 2013 and Marshall Scholarships in 2012. A team won a prestigious EPA Award for Sustainable Erosion Control in Developing Countries Using Industrial By-Products. EWB-USA founder, Bernard Amadei was inducted to the NAE for his contributions.

**Creation of the Course**

EWB-USA student chapter is organized and governed by the student leadership. This idea of integrating EWB-USA and EPICS had been discussed by the directors of the respective national programs for more than a year. However, when approaching the idea locally, we needed to partner with the student leaders and they were approached with the idea. It turns out that the leadership team included some students who had experience with EPICS and this concept had been discussed prior to our own discussions. The students had struggled with accountability among members of the club and the idea of a course to help accountability had been discussed.

The Director of EPICS met with the student leaders and discussed the idea of integrating the two approaches. The students asked detailed questions about how the course would be structured. We laid out a framework that established goals and a philosophy for the integration and committed to working out the details as partners, faculty and students. It was important to maintain the student leadership and ownership of EWB-USA and including them in aspects of the structure was consistent with this approach.

The students took the concept back to the whole leadership to weigh the proposal. After their meeting, they indicated that they were interested in the opportunity and the course was set up.

**Organization**

In the spring of 2014, a basic framework for the course was established through joint meetings of the EPICS Director, who would become the faculty advisor for the team, and the student leadership team of EWB-USA. A course time needed to be established. Traditionally the EPICS classes operate between traditional hours of 8:30 a.m. to 5:20 p.m. and involve one two hour lab meeting per week along with a common lecture hour on Mondays for all sections. The EWB-USA club’s traditional meeting time was on Wednesday evenings. It was decided to have the lab time scheduled for 6-8 p.m. on Wednesdays to overlap the club meeting time that would run from 7-9
It was the intent that the leadership that needed to run the club meeting would start with the class and transition into the club. It was also hoped that the overlap could facilitate the interaction of the club and class members since the class was a subset of the club. In the second semester, the club meeting was moved back to 7:30 to give more time for the course work.

Enrollment for the course we restricted to the core leadership and the design team members. These were positions that students earned by coming to the club meetings and demonstrating interest and dedication over the previous semester or year. The course was listed as zero enrollment which meant we added each student individually based on the list provided by the leadership of EWB-USA. 15 students were registered for the Fall Semester of 2015. The number expanded to 19 in the spring of 2015 to accommodate younger students who had shown significant dedication and interest in the design activities.

The assessment process for individual students is designed to customize the assessment process to each student and is modeled after an industry performance appraisal system. Students establish goals and expectations for the semester with guidance from their faculty mentor. Once the goals have been determined, progress toward the goals is documented and evaluated. Expectations are communicated with rubrics. Table 1 shows an example of the individual evaluation rubric that students complete to identify and summarize their accomplishments and learning. Students are assessed over five dimensions of accomplishments, process, critical thinking, communication and leadership/teamwork. Documenting these outcomes required students to maintain an individual notebook or blog, which was new for the EWB-USA students. It also requires documentation of the project but that is already managed by the EWB-USA systems.

The curricular structure of EPICS allows the project timelines to be decoupled from the academic calendar so students may start the semester with a new project or they can be picking up a project that was not completed in the previous semester. This allows students to plan their work based on the needs of the project. This structure allows projects from EWB-USA to be supported in any stage of development, from early assessment, to development and design and eventually support in the field. The structure assesses teams and individuals based on their progress on the project in that semester as well as how they function as a team and communicate with each other and their community partner. Peer evaluations facilitate the evaluation of teamwork and help to delineate individual contributions.

While most of the grading rubrics and core assessment process of EPICS was used in the same manner as other sections, the team reporting documentation and requirements were taken mostly from the requirements of EWB-USA. These met or exceeded the requirements for the EPICS processes and maintained the consistency with the EWB-USA students.

**Team Structure**

EPICS and EWB-USA both had student leadership roles and these were combined. We delayed how these were split up until the first class and spent a great deal of time with the whole team laying out the structure. Table 1 shows the organization structures of EPICS and EWB-USA. EWB-USA officers were selected in the spring so those officer positions were already decided before the semester. In the first week of the fall semester, the team elected leaders for the EPICS team. We talked about how to structure the team. Table 2 shows how the structure was created.
Figure 1 shows the intended flow of students into the club initially and toward the class when they have experience and have proven their commitment for the project. The roles and duties for the EWB-USA club and the EPICS were distributed and in some cases combined as noted in Table 2.

Table 1 Individual Grading Rubric

<table>
<thead>
<tr>
<th>Contribution/Learning (e.g., completed analysis, data analysis, DFM/FA, or prototyping, programmed microcontroller, learned CATIA)</th>
<th>Where documentation can be found: (include page no. if in notebook and URLs if online)</th>
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<tbody>
<tr>
<td>Accomplishments: Individual contributions to the project and impact on design and/or deliverables. Understanding of relevant discipline-specific issues related to the project. Documentation of individual work and incorporation into project documentation.</td>
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<tr>
<td>Process: Documented understanding the processes inherent in design and an ability to employ these processes in the development of the project.</td>
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</tr>
<tr>
<td>Reflective/Critical Thinking: Demonstrates ability to think critically about many of the disciplinary, social, ethical, personal, and interpersonal aspects of the project, project partner, and their relationship.</td>
<td></td>
</tr>
<tr>
<td>Teamwork/Leadership: Demonstrate participation in class and group work. Works with and helps other team members, within and/or outside of formal team roles, to accomplish team goals. Lab and project meeting attendance: If applicable, leadership and fulfillment of responsibilities associated with team position.</td>
<td></td>
</tr>
<tr>
<td>Communication: Written and oral communication, both formally and informally, to all audiences: Are you familiar with project, and those who are not: Are there good background; to novices and to external people; to those who will be asked to continue your project in the future.</td>
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Directions: Students mark an “X” and Advisors/TAs mark an “O” in the aggregate box for each criterion. Each of the criterion should be evaluated considering the student’s course level, major, semester in EPICS, and number of credits.

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<tr>
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<td>Oral</td>
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<td>Communication</td>
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<td>Process</td>
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<td>Accomplishments</td>
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<td>Teamwork/Leadership</td>
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<tr>
<td>Understand the processes inherent in design and an ability to employ these processes in the development of the project.</td>
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### Table 2: Student Roles for Club and Class

<table>
<thead>
<tr>
<th>EWB-USA Roles</th>
<th>EPICS Roles</th>
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</thead>
<tbody>
<tr>
<td>President is the overall leader of the club and responsible for the management and leadership of the club</td>
<td>Project Manager (Team Leader) is responsible for overall operation and effectiveness of the team, provides planning, and direction,</td>
</tr>
<tr>
<td>Vice President assists in leading the club, manages the meetings for the club and recruitment</td>
<td>Design Lead (Project Leader) oversees the project design and responsible for facilitating the project through all aspects of the design process.</td>
</tr>
<tr>
<td>Treasurer is responsible for the manager of the club’s finances. This is a recognize university position and is required by the university to be a recognized student organization</td>
<td>Financial Officer manages the budget for the class and coordinates funds from the EPICS programs for their projects</td>
</tr>
<tr>
<td>Communication officer manages the communication within the university and externally</td>
<td>Project Partner Liaison Team member selected to be the main point of contact between the team and the project partner.</td>
</tr>
<tr>
<td>Events and Publicity Officer is responsible for the special and fundraising events of the club.</td>
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</tr>
<tr>
<td>Secretary takes notes on the club meetings, records them and distributes to members. She/he also completes required forms for the club.</td>
<td>Project Archivist is responsible for the team’s documentation for their project</td>
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<tr>
<td>Grants and Fundraising responsible for writing grants for travel and project funds</td>
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</tr>
<tr>
<td>Webmaster manages and updates the website for the club</td>
<td>Webmaster manages and updates the website for the class</td>
</tr>
</tbody>
</table>

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**Figure 1 Club and Class Membership**
The structure allows for both the club and the class to operate within the goals and missions of each. The design work is the common thread and that has been placed in the class. The structure has been designed so that members join the club and work on student activities, fundraising and preliminary design work. When they show that they are committed to the club, they are invited to join the class. This has been the pattern and is dependent on the EWB-USA members to identify which students should be registered in the class.

**Table 3: Combined Student Roles**

<table>
<thead>
<tr>
<th>EWB-USA Club</th>
<th>EPICS Class</th>
<th>Combined Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td></td>
<td>Coordination between class and club</td>
</tr>
<tr>
<td>Vice-President lead the club meetings, liaison with the club and the class</td>
<td></td>
<td>Coordinated the transition from the club to the class. Identified new members of the club to enter the class</td>
</tr>
<tr>
<td>Design leaders</td>
<td>Project Manager</td>
<td>Leader of the design process of the EWB-USA, oversees the overall timeline and commitments for both EWB-USA and EPICS</td>
</tr>
<tr>
<td>Webmaster</td>
<td>Webmaster</td>
<td>Maintains website for both teams</td>
</tr>
<tr>
<td>Treasurer</td>
<td>Financial Officer</td>
<td>Maintains the budgets for the club, the project and travel plans</td>
</tr>
<tr>
<td>Secretary</td>
<td></td>
<td></td>
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<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events and Publicity Officer</td>
<td>Project Archivists</td>
<td>Responsible for the completion and submission of the EWB-USA reports and archiving the results on the EPICS server system.</td>
</tr>
</tbody>
</table>
Figure 2 Organizational Structure with Class and Club

Advisors

EPICS instructors are called advisors and function much like the technical and club advisors for the EWB-USA. The local club already had professional mentors who travelled in-country the previous summer on an assessment trip with a team of students. These mentors continued with the class and supported the faculty for EPICS who was an added advisor and managed the course and assessments along with a graduate teaching assistant. He was also added as an advisor for the club to keep him informed about activities and also to make it easier on the student members to obtain required signatures within the university system. A second club advisor was kept from the program that had overseen EWB-USA previously and still had responsibility for the organization. This shared ownership has worked well.

Student Reflections and Evaluations

The students in the EPICS course rated the course and instructor with a 4.9/5.0 in the fall semester. The experience using the EPICS structure was noted by the students as enhancing their project experience and did not seem to take away any of the club benefits. Sample comments in the course evaluations include

*I am planning on returning to EPICS next semester because I really believe in the EWB-USA project and feel like EPICS gives it a very important structure and accountability that the project was previously lacking. We accomplished more this semester than I ever thought possible.*
It has really taught me the design processes and allowed me to practice real engineering outside the classroom. What has impressed me the most is when Professor Oakes actually relates our decisions we make to actual industrial experience. I really benefited from that.

The president of the EWB-USA club was asked by an alum about the experience and sent an email to her that is quoted below. It shows his assessment of the pilot

...The partnership is that EPICS has made a course offering for our project, restricted to our chapter’s project team members, who must have first spent at least one semester as a general member in the club. As a club, we participate in EPICS so that we can get course credit for our many hours spent working on the Uganda biogas project, but also because EPICS has resources which we can benefit. They have a structure which is very helpful for undergraduates who sometimes don't know where to begin with design. In addition, they have meeting spaces and lab facilities which have come in handy for us.

It’s only been a semester of trying this out, but so far there has been no drawback to working through EPICS for course credit, and in fact there have been benefits to our work efforts on the project team. So if any university chapter in the EWB area is interested in getting course credit through EPICS, I’d recommend it!

The leader of the EPICS class is called the Project Manager. For the pilot, the project manager was a board member of the EWB-USA and had been in EPICS for two years. She was actually registered on two EPICS projects as she did not want to abandon her other team. She managed the EWB-USA team as it integrated into the EPICS program. Her assessment of the experiment are summarized as follows.

Trying to combine the EPICS and EWB-USA clubs required a lot of planning and critical decisions, and although it was and still is a challenging process I believe it is the best thing to have happened to our EWB-USA team. Prior to the EWB-USA-EPICS Team, our EWB-USA has to organize ourselves into a cohesive, yet delegating team to solve a complex engineering problem. So much time of the club was spent exhausting our resources and trying to solve the problem, through whatever unorganized means necessary. Many times the responsibility of deliverables fell onto one team member because there was not a clear set of repercussions for incomplete work aside from a delay in project progress. Having a more organized, class-setting where each team member is held accountable for their work has tremendously improved the efficiency and progress of our project. Having faculty support and guidance from the EPICS structure has aided our design team significantly as well. Having the EWB-USA meetings be for general and new members and keeping the design work of the project for the EPICS team has also contributed to the progress of our project. It allows our team to delegate the tasks easily without a lot of overlap or reiteration with the coming/going of new members. General EWB-USA members can join the EPICS team once they have been actively involved in the general meetings for a semester. As with any new project, there
are still aspects to the new EWB-USA-EPICS team structure that will be addressed but so far the transition has been very beneficial.

Trying to organize the logistics of the combined EWB-USA and EPICS team has proved to be an exciting and challenging process that I have enjoyed being a part of. Having been heavily involved with EWB-USA and EPICS separately, I facilitated the transition of the EWB-USA members into their new EPICS roles. As the project lead I also had to make sure all teams were keeping up with their semester plans to ensure that all deliverables were met by the end of the semester. Working as the project leader, I realized more just how much I enjoy working with other teams. I enjoy being the project leader because I get to lead all these unique projects and work with all the team members. I check on their progress, see if they need any help along the way, and make sure all operations are running smoothly. I love seeing a team thrive and become more self-sufficient, which has made me realize how much I want to work with people and in management when I enter the work force. I may not have the highest level of technical knowledge for the team, but I can lead and manage people to ensure that the technical knowledge is made into a tangible deliverable. That is where I excel for my team. Trying to facilitate a group from just being a club to being held responsible in a class setting, I had to work with the whole group to make sure everyone’s needs were met and there was not much confusion. By doing this, I realized just how much I enjoy working and managing groups of people and want to do so in the future.

Reflection is a requirement of the EPICS courses, both as a weekly activity and a summative learning activity. One student commented in the final reflections on the transition to the EPICS-EBW_USA integration

Working on this EPICS project, which was previously simply a student-run club on campus, has made me realize that time management is crucial to success. Before my team became an EPICS team the workload was much less, and the atmosphere was much more easygoing. This was all nice, but it wasn’t really making us productive. Since becoming involved in the EPICS program on campus, I have found myself having to prioritize more and manage my time if I want to accomplish everything I have to do and still meet the EPICS requirements. I learned that my weaknesses lie in my ability to judge how long a certain task will take me, and I have been working on this characteristic this semester. On the other hand, I realized that I am skilled at leading other members of my team and helping others stay on task. Being on the design team helped me to develop organizational skills and team leadership skills. I want to someday be project manager, and being on a team that constantly has a lot of work to do helped me to anticipate the workload of a project manager.

Students are given the option of recording reflections in a notebook or on a blog with most students choosing a notebook. The reflections are a dimension that was added to the EWB-USA experience. Some students complained about the perceived “burden” but also found that it helped their learning and their organization. Sample quotes from their reflections showed an appreciation for the discipline and benefits of the reflection.
Another very vital skill I picked up is the skill of documenting your work. Initially I found the design notebook documentation very unnecessary, and I didn’t do a great job of putting everything I learned into the notebook. Eventually, I noticed that since I was so busy from my other classes, my mind would forget minor details that I could have otherwise remembered if I noted it down in the design notebook. In addition, documentation helps you understand the progress you have made with a project. You can skim through the book and see the activities you have been making good enough progress or if you need to speed up your work. In future, this skill would be very important to stay focused and to remember all the minor details. In other words, documentation has the potential to optimize your performance as a professional engineer.

I was able to relate it to my major, which showed me how easy it is to relate projects focused on serving others to what I am interested in. When being in a service-learning environment, I was more focused on reflecting on my actions. By taking the time to reflect on the work I was doing and how this related to other parts of my life, I understood how my other classes and major in general can tie into these aspects as easily. EPICS taught me what Human-Centered Design inherently creates an added incentive to the task that is being completed. I hope to continue to work on projects where the stakeholders are the focus. I have learned how to apply the project design process to a variety of cases and will continue to apply it to my other classes and other parts of my life.

I learned a lot about myself this semester. I learned that one of my weaknesses is being organized. It was hard for me to continually remember to write down all my progress in my journal and make sure all my work was documented. Having to document all my work in this way was different than any other class I had been in before so it was a hard adjustment.

EPICS teaches a user-centered design approach that is consistent with the goals of EWB-USA. The course structure allowed students to learn a framework and reflect on how that approach applied to their project work. Several students identified the user-centered approach in their reflections on their learning.

This semester was an extremely useful experience in the social aspect of my understanding of engineering. Working with our project partners in Uganda and developing a solution with cultural aspects in mind has helped me to develop a much more broad scope of my cultural understanding. Working with both the EPICS department and Engineers Without Borders had taught me to strive for a higher standard of work. This does not just mean the quality of the deliverable, but also how well the deliverable fulfills the needs of the specific community. The biogas digester that we are developing for the community of Nakenyi is meant to be a pilot project to exemplify future projects of the same nature. At the same time, however, the digester needs to be functional to the school for which we are building it. The needs of the community as a
whole differed slightly from the needs of our specific client, but we eventually determined a solution that compromised and fulfilled the needs of both stakeholders. The process of evaluating the stakeholders’ needs is an extremely important skill to develop. There will rarely be only one client for whom any given deliverable will be designed and it’s important to consider all parties affected by the project. In the future I will take what I’ve learned about community integration to work that I would like to undertake overseas.

Though I may not have traveled to Uganda last summer I feel like I know the community. I think that forming and attachment or bond with your stakeholders, is a necessity. It is a necessity because when you are attached to your stakeholders you keep the idea of Human-Centered Design much more in the picture while you are designing. I been on design teams where I did not have much of an attachment to the stakeholders and the idea of Human-Centered Design slowly began to slip away, no matter how much you tried to keep it. The key to making a better end product is then more meaningful and useful to the original stakeholders. This intern does not only impact the original stakeholders but it spreads and soon you have more stakeholders because of meaningfulness of your design. So it therefore all boils down to the attachment you form with your stakeholders. There for I think it is paramount that designers spend as much time as possible being with or observing your stakeholders. Being able to put a face or faces to an end user makes the designer more likely to make a higher quality product. I think this idea is illustrated well in The Wallet Exercise that many EPICS teams do at the beginning of the semester.

On previous teams that I have been on, the stakeholders were in our community so a visit to go meet them was very easy to arrange and very beneficial. An overall understanding of stakeholders and their needs cannot be done this way for this project. With this Ugandan community, we are not able to do that until our design is complete. In order to overcome this challenge, I learned that a couple of rolls are important. One is to really talk to the team members that were able to go to Uganda this past summer and had the opportunity to witness the stakeholders’ culture and daily habits. Another tool we have used this semester is creating stakeholder profiles of the main groups whose lives will be impacted by our designs. We analyzed parameters such as their role in the community, interests, needs and capacities. This proved to really help us understand who we are designing for and to keep their needs and goals at the center of our designs. It also made us really realize that even though our stakeholders have a very different culture, their interests and needs are very much like ours.

Throughout the semester, I have learned more about human-centered design by always thinking about our end user and product. For our project, we have to be very sensitive to our end user and critically think about them, even though they are so far away and it is hard to communicate with them. Remembering our stakeholders by always trying to
include them in design conversations is an important task to do so that they are always considered in the project.

The social and personal impact is another shared value of EPICS and EWB-USA. Several students commented on the impact that their work had on their view of their discipline, themselves and the integration for their careers.

When I started the project, I did not understand the scope of it. I thought the objective was just to build a biogas digester that would help a school kitchen cook food and replace firewood and that was it. Eventually, I found out that it was aimed to have a much greater social impact. The aim of the project was to create a social change in the community that we were working in. The biogas digester in the school would serve as a prototype/demonstration digester for the rest of the community and prove the viability of the technology... The impact that we could potentially make was what drove me to do this project... This is a great challenge that interested me and that is why I am a part of the project. In future, I would like to part of projects which excite my engineering mind as well as have great social impact.

Through the work done on our team it felt like we were going to be able to make a difference in people’s lives. Working on my EPICS team has solidified that I want to incorporate community service in my life, whether that being within the company I work for or outside in my personal

Living in a developed country, I have taken advantage of all the amenities I have available to me. When I turn on the burner to cook my meals, I do not think twice about how much it is costing me and there is no chance that my fuel source will run out in the process of cooking dinner. In Nakyenyi, Uganda, many struggle to afford the firewood they use as a fuel source for cooking and worry that is causing rampant deforestation around their country.

When I first decided to become an engineer, I wanted to improve people’s lives. I thought I would be accomplishing this by developing faster cars and better technology. I did not become aware of the vast application of my engineering education until my experience with Engineers Without Borders and EPICS programs.

I want to continue to work with Engineers Without Borders after graduation and possibly travel to the implementation site for a project so I can see how these people’s lives are affected. I am proud of the work that I have completed this semester and hope that the Biogas Digester works as planned and impacts the community in a positive way.

Throughout this project, I have been given the opportunity to work with many engineers who are making a difference in the world. One example of this is the EPICS professors and TA’s, who are not only making a difference in the community by advising community
projects, but who are also making a difference in the lives of students they are advising and mentoring. Another great example of an engineer who has been able to use his skills to benefit the world is our travel mentor, Roger Ward. Roger is a retired engineer who worked with biogas digesters in industry, helping to promote a clean and renewable energy source. He has also travelled to Kenya to work on a successful water project. There and is now advising the Purdue chapter of EWB to help us with our biogas project in Uganda. When I chose engineering, I was worried that I was going to be working at a job that I wasn’t passionate about, but I now know that does not have to be the case at all.

Discussion

The initial offering of EWB-USA within the structure of EPICS has been a success. Progress has been made on the project itself. The EWB-USA members actually felt they made more progress with the accountability and assistance of the curricular structure. The club activities have continued and provide a proving ground for the students who take the project for credit. A challenge has been to fight the perception that the EPICS was the “real” EWB-USA. The ways to integrate those taking the class and those just in the club is an area that is still being worked on. During this pilot year, the club members were given tasks related to fundraising and working on potential new projects for the community. Some of the club members were integrated into the design team and six of them were added to the EPICS class for the second semester. Only two of the first semester’s cohort did not return and that was due to them being away from campus for the spring.

There were challenges balancing the club and the class. The idea of overlapping the club meeting and the course’s lab time disrupted the lab time. The second semester began with the club meeting time moved back a half hour to allow 1.5 hours of the lab with all of the EPICS students together. It remains a point of discussion whether to decouple the times.

One challenge that arose in the second semester was that about half of the students registered for the second semester as an audit, for zero credit. The idea of allowing the audit arose from two of the leaders who were already doing EPICS and EWB-USA and has used the EPICS course for the maximum number of credits allowed in their respective majors. The intent was to only allow this as an exception but 10 of the students registered this way. Discussions with the student leadership team this semester resulted in a change in the policy to only allow an audit as an exception. In addition to using the maximum credits, a few students reported that they wanted to avoid keeping a design notebook, which is a requirement for the EPICS class. After discussions with the current student leaders, it was determined that the actual differential of work between EWB-USA and EPICS is not that significant and the benefits of the additional accountability of being graded for credit motivated the change in policy to limit the number of audits.

The EPICS curricular and assessment processes aligned very well with the EWB-USA structure and philosophy. Both EPICS and EWB-USA promote and rely on strong student leaders. The EPICS structure did not reduce the student leadership and it allowed the inclusion of the professional mentors. The relationship between the professional mentor(s) and the faculty advisor required some conversations and iteration but has worked well. The expertise of the professional mentors allows more flexibility in the expertise of the faculty. The pilot project is a bio-digester and the faculty member’s area of specialization is fluid mechanics and turbomachinery out of Mechanical Engineering. The professional mentors were responsible for the technical
specifications, reviewing the design reports and documentation and travelling with the student team. The faculty advisor received input from the professional mentors for grading and the faculty advisor kept the team on track for the EWB-USA reports to the professional mentors.

EWB-USA projects can and often do span multiple semesters or even years. The curriculum for EPICS can accommodate projects in any phase of the design process and has supported the current pilot project over the two semesters with plans to extend into the next academic year.

Opportunities for the EPICS/EWB-USA credits to count as more, including capstone projects is under discussion. The relationship with EPICS and EWB-USA will continue to evolve and may look different at different institutions. However, it seems clear that EPICS can be a proven way for EWB-USA projects to be integrated into the curriculum in a way that promotes progress and accountability on the projects as well as student learning. The curriculum structure documents that learning so that assessments can be made and grades assigned. EWB-USA continued to exist as a student organization but the design components benefited from the course structure. The model empowers students to be in leadership and own the project and was consistent with the goals of EWB-USA.

Bibliography


