# A New Framework for Student-Led Cocurricular Design Projects

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## Abstract

This report describes an academic framework to introduce student-led extracurricular engineering design projects to an undergraduate curriculum. Typically, student-led projects are limited exclusively to the domain of extracurricular groups with only a few examples of universities assigning academic credit value to this work. Over the past four years, the Harvard School of Engineering and Applied Sciences (SEAS) has designed and implemented a structure in which students who participate in the Harvard chapter's Engineers Without Borders USA projects have the opportunity to earn academic credit for their engineering design work. A key difference in this framework as compared to other typical capstone designs, independent studies, or research credit courses is that undergraduate TAs and project managers within the project teams are responsible for developing many of the assignments distributed to those students enrolled the course as the project progresses. The methods of student assessment within this framework include: individual or small-group weekly assignments, design notebook checks, peer and self-evaluations, participation, summative technical reports, and the *Humanitarian Library*. Additionally, unlike many traditional problem set or laboratory courses, student skills are developed through an iterative revision process on weekly assignments based on feedback given by the instructional staff after each submission, a process that produces increasingly refined deliverables that depend on work completed in the previous weeks. A similar process exists for each component of the *Humanitarian Library*. The authors believe that this process of iterative student and instructor co-creation and co-evaluation can lead to a greater depth of understanding of technical content, active engagement in real-world engineering ethics, and increased effectiveness of project outcomes.

This report will present the logistics and course administration required to design and implement such a course. It will characterize the instructional staff makeup, organization of class meetings, and the range of assignment types. Student satisfaction with the course is evaluated at the end of the term using Harvard's course evaluation scores, which can be compared to all courses within the engineering department and SEAS-wide scores. The course is also assessed via direct written feedback provided by enrolled students to the instructional staff multiple times throughout the term. The authors believe that this framework is highly applicable beyond *Humanitarian Design Projects* at Harvard and even beyond engineering-based service projects. Extracurricular projects that exhibit potential for this student-led and co-created class include the ASCE Concrete Canoe Competition, the ASME Human Powered Vehicle Challenge, the RoboCup games, the iGEM competition, etc. This framework has the potential to combine academic coursework with real-world engineering challenges in a way that challenges students to co-design and implement strategies for completing the stated learning and project objectives.


## 1. Introduction

Throughout the past three decades, application-based engineering projects have been shown to increase student learning outcomes as compared to traditional lecture and laboratory courses.[1-5] As a result of changing accreditation requirements, industry trends, and research in engineering education, most engineering programs in the Unites States have incorporated either semester-long or year-long courses focused on engineering design. Frequently, these courses are targeted toward

a single engineering discipline and utilize one of a few prescribed design methodologies. Another approach to incorporating application-based engineering projects is through Project Based Learning (PBL).[6] PBL is can be implemented by individual instructors within their own course, but multi-semester projects or competition teams such as Engineers Without Borders USA (EWB-USA), ASCE Concrete Canoe Competition, the ASME Human Powered Vehicle Challenge, the RoboCup games, the iGEM competition, etc., can also be viewed within the PBL (or Project Based Service Learning, PBSL) framework. Historically, these project/competition teams have solely been implemented as extracurricular activities, but more recently, some engineering colleges are allowing students to earn academic credit for their work on these projects. Based on the individual program, this credit bearing course is typically structured in one of the following ways: independent study, capstone design, or a stand-alone course. While historically, an independent study course has been a more common approach for academic credit, more recently stand-alone courses such as *Humanitarian Design Projects* and/or integrated programs such as the EPICS program at Purdue and other universities are becoming more common.[7-9] This manuscript presents the *Humanitarian Design Projects* course, its structure and major assignments, and provides evaluation data and reflections on the successes and challenges of implementing the course in its current form.

## 2. Course Structure

*Humanitarian Design Projects* is a two-credit engineering elective at the Harvard School of Engineering and Applied Sciences (SEAS) that challenges groups of engineering students to design and implement multi-semester humanitarian engineering projects with partner communities around the world. Undergraduate teaching assistants and student project managers are responsible for co-creating course assignments with the head instructor, which are then assigned to students each week and subsequently reviewed by the instructional staff. Each assignment must fit into a semester-long strategy that addresses the particular design prompt or need communicated by the project partner(s). Each project spans multiple years, which means that each semester of the course must result in progress toward a goal that will have many different student contributors across multiple graduating classes. Thus far, *Humanitarian Design Projects* has been dedicated to the completion of EWB-USA community partnerships in the non-profit's International Community Program; this course structure is applicable for the completion of numerous other multi-semester projects described above.

### 2.1 Project Scope

The EWB-USA International Community Program (ICP) consists of 450 partnerships between engineering teams and self-identified communities that are in need of civil infrastructure to meet their basic needs. These partnerships are a minimum of a five-year commitment between community leaders and the U.S.-based engineering teams and result in the collaborative construction of infrastructural projects such as borehole wells, water distribution systems, school buildings, and health clinics. In order to fulfill a partnership, these chapters are responsible for completing the documentation, designs, calculations and construction plans for each infrastructure project in addition to 95% of project and travel fundraising needs. These tasks must be completed in collaboration with the chapter's partner community, who is in turn responsible for participating in the design process, mobilizing community members for project construction, ensuring long-

term maintenance is completed, and raising 5% of the project's funding requirements. Chapters typically complete the majority of their design work in the U.S. and then travel once or twice per year to the partner community, implementing in phases that range from weeks to months.

In the context of *Humanitarian Design Projects*, student members complete EWB-USA ICP project work for course credit and then travel with faculty and technical mentors to implement their design work from the academic year. Student chapters typically travel to partner communities during university breaks, which makes January and May-August common travel times for the project teams at Harvard described in this paper.

A typical ICP partnership results in the completion of multiple projects or a phased implementation of a system that is fully functional at completion, which makes the typical cadence of a project an excellent fit for students to complete multiple semesters of *Humanitarian Design Projects* due to the variable work required to complete each project on a month-to-month basis. For instance, a chapter may drill a borehole well during the winter and then return in consecutive summers to add water storage or extend water access to additional neighborhoods. Similarly, a community partnership may result in the construction of a health clinic building in the summer, and then a water catchment system and latrines at the same facility during the following winter. This project process results in highly variable work over a five-plus year cycle, requiring students to develop new technical skills as the project evolves. In addition, students will refine more frequently used skills such as technical writing, presentation of calculations, and creation and iteration of drawing using CAD or 3D modeling packages. This cycle also challenges students in leadership positions to design assignments for their peers on a variety of topics and for a variety of project phases. These students must critically assess the project's scope and fit the work to be done into week-by-week assignments.

Though the projects completed in *Humanitarian Design Projects* are community-based infrastructure in nature, the model described in this paper has significant potential for implementation with other PBL opportunities that are typically excluded from the classroom, such as extracurricular engineering project and competition clubs. The application of EWB-USA projects in the classroom is described in this paper to illustrate the mechanics of applying the co-creation framework in a particular instance, but does not reduce the suitability of this model for other design challenges such as the ASCE Concrete Canoe Competition, the ASME Human Powered Vehicle Challenge, the RoboCup games, or the iGEM competition.

### 2.2 Staff/Course Instructors

*Humanitarian Design Projects* is led by a member of the SEAS faculty and is supported by an instructional staff of undergraduate students, each of whom is a leader and/or an experienced participant of an EWB-USA project team.

The course's success in advising technical projects across a large range of disciplines is due to the combination of the head instructor's experience with community-based infrastructure projects and that of an extended mentorship team made up of working professionals in various disciplines. Core members of the mentor team are practicing civil engineers who frequently attend project meetings and are involved in the review of all major project submissions. Their involvement typically

includes comments on technical documents, guidance and review of calculations, one-on-one work sessions with students, project-wide instructional sessions, etc.

The structure of the teaching and mentoring team is advantageous as compared to solely an academic instructional team for a number of reasons. This assignment co-creation method offers student leaders an opportunity to work directly with a faculty member to create a shared product, a process that frequently leads to productive relationships that often result in letters of recommendation for jobs and graduate school as well as informal academic and career advising. Additionally, the external mentorship team provides all student participants the opportunity to interact with both young and established industry engineers that are currently employed in fields of interest. These individuals often provide windows into the professional world to the students who have yet to enter it as well as a wealth of practical knowledge that can be challenging to find in an academic context. This is particularly true for a liberal arts university such as Harvard, where professional preparation is not as heavily empathized as compared to other universities.

## 2.3 Assignments

Team-based design courses typically require a different set of evaluation methods as compared to traditional lecture or laboratory-based courses in order to effectively measure the attainment of learning outcomes. Within the *Humanitarian Design Projects* course, the instructional staff uses the following evaluation methods to evaluate students: Weekly/Biweekly Milestones, Design Notebooks, Peer & Self Evaluations, Summative Design Documents, and the *Humanitarian Library*. Each of these assignment types are described in greater detail below in addition to the grading principles used to evaluate the assignments.

*Weekly/Biweekly Milestones*

Milestones are weekly or bi-weekly assignments that are authored by undergraduate TAs and project managers under the guidance of the course's head instructor. They are intended to relate directly to project work and typically have very concrete goals. Milestones typically consist of individually tailored or small group assignments that contribute to a team's larger deliverable. Many of the weekly milestones include tasks for which students may have little or no relevant experience. These types of milestones consist of a draft submission on which the instructional staff leaves feedback and direction on how to improve the work product. This is so that students engage in the learning that happens during the "getting started" phase but are not left to flounder if they do not know how to complete the task. This process maximizes learning but protects the team from getting behind schedule due to incomplete assignments, which often build on one another. Enrolled students then have two days from receiving feedback to incorporate it into their revised deliverable before a final grade is assigned.

Weekly assignments are graded on a 2-point scale. A score of 0 represents that no assignment was turned in, was turned in late, or the milestone was not properly addressed. A score of 1 represents that the milestone was addressed but the quality of work did not meet the expectations of the project leads and teaching staff. A score of 2 represents that the milestone was addressed, and the quality of work met the expectations of the project leads and teaching staff. On rare occasion, a student can receive a score of 3 which represents that the milestone was addressed, and the quality

of work exceeded the expectations of the project leads and teaching staff; this is very high-quality work. A score of 3 is not commonly given.

Below are examples of past milestone assignments divided by the five design phases found in an EWB-USA project.

- Assessment
    - Research and teach the team about a different aspect of local culture as well as articulating how it might or might not impact the success of a future project.
    - Research technical and non-technical data gathering techniques. This includes a detailed data taking procedure, required tools, a pre-made data entry log, etc.
    - Research various project types and then tabulate technical specifications that will need to be collected while assessing existing community infrastructure.
- Alternatives Analysis
    - Submit a list of questions about the community that will help inform design decisions and will be sent to the community.
    - Review similar projects in the same region and determine why a specific design alternative was chosen.
    - Brainstorm a list of possible solutions to the community's articulated infrastructure challenge.
    - Perform calculations and create a cost estimate to determine the feasibility of a design alternative.
- Implementation
    - Create CAD drawings and calculations for various system components.
    - Create a detailed construction plan, bill of materials, and health and safety plan for system construction.
    - Writing and illustrating an Operation and Maintenance Manual for the system that is to be constructed.

*Design Notebooks*

As part of training for good professional practice, students are required to keep a project/design notebook throughout the semester. Students who enroll in this course more than one time are encouraged to use the same notebook for each course offering. While CAD files and simulations do not need to be reproduced in the design notebook, to-do lists, important details, back-of-the-envelope calculations, etc. should all be done this notebook. Students are requested to use a waterproof pen or a Sharpie so if the notebook gets wet in the field, the content does not bleed. Additionally, this notebook should be bound so that pages cannot be torn out of it. Students are encouraged not to worry about errors or typos in their notebook but are instead recommended to draw a line through the errors and continue.

Examples of items that should be included in the project notebook are:

- Information central to the project
- Conclusions/takeaways from weekly milestones
- Required info in order to complete weekly milestones
- Questions that need to be answered

- Things that confused a student while they were working
- Team members' contact information
- Sketches and hand drawings

Some students prefer to use digital notebooks as opposed to paper notebooks and the instructional staff has very few issues with the use of digital notebooks as long as students include all of the required content.[1] Notebook checks occur two or three times per semester where students are provided feedback on quantity, quality, and appropriateness of notebook usage. For ease of numerical grading, the instructor evaluates each week with a simple binary score: 1 for meets expectations and 0 for does not meet expectations. Some leeway is given earlier in the semester, especially for less experienced students. Later in the semester, the instructor expects that feedback has been incorporated in the note-keeping practices and is less generous in grading of the design notebooks.

*Peer & Self Evaluation*

The instructional staff believes that an important aspect of team design work is the ability of a participant to objectively evaluate their own progress as well as the progress of other team members. As such, peer and self-evaluations are an integral part of the course and are completed two or three times throughout the semester. The course requests that "peer feedback should be honest and objective in order to preemptively address potential conflicts as well as to facilitate effective communication among the group. If feedback is not constructive, critical, and thorough, points will be lost." The staff regularly reinforces the reality that "everyone can't be doing a great job with everything all the time" and that feedback should reflect this reality. Students are graded on a 0-2 scale on their completion of the Peer and Self Evaluation. A score of 0 represents that no evaluation was completed. A score of 1 represents that evaluations were completed but the feedback provided was superficial or lacked depth. A score of 2 represents that the evaluations were completed, and the feedback contained depth and was constructive in nature.

The course staff has access to the un-anonymized responses that students provide about themselves and three of their peers, whereas the peer feedback this is sent to the recipients is anonymous. The peer and self-evaluation responses, as well as observations from the teaching staff and student project leads, are used to determine the participation portion of the grade. The complete set of questions for the Peer and Self Evaluation assignment are included in the Supplemental Information section.

*Summative Design Documents*

In *Humanitarian Design Projects*, summative documents are large, group deliverables that serve as design benchmarks. These are based on existing design documentation required by EWB-USA and correspond to various stages in the design process. Summative documents are typically broken down into smaller assignments (milestones) throughout the semester by the undergraduate TAs and project managers and synthesized periodically for submission to EWB-USA program engineers for review. The summative design assignments typically experience an internal multi-

[1] With adoption of America Invents Act and change from First to Invent to First to File some individuals believe that keeping a paper-based notebook may provide more sustentative evidence in the event of legal proceedings.[10]

week review cycle that involves waves of feedback from the instructional staff as well as the technical mentors. This cycle creates an opportunity multiple times per semester for students to engage in dialogue directly with project mentors before submission to guarantee the highest quality end result.

Each major design document is graded on a 5-point scale in which numerical scores are equivalent to: 5 = A+, 4 = A, 3 = B, 2 = C,1 = D, and 0 = F. The first draft of an Implementation Pre-Trip plan is externally reviewed by at two least practicing engineers in the relevant project discipline. As part of the revision process, the project teams must specifically address the feedback provided by the reviewers, similar to a journal review process. The project team's specific response to the reviewers is graded on a 2-point scale similar to the Weekly/Biweekly Milestones and applies to all members of a project team.

*Humanitarian Library*

The *Humanitarian Library* is an assignment designed to allow students to explore themes and challenges that are related to their project work but may not fit well into the weekly or bi-weekly milestones. The spirit of the *Humanitarian Library* is to challenge students to dive deeply into controversial topics, challenges, and failures that exist in the humanitarian and international development world and then apply what they learn to the infrastructure projects in which they participate. The format of the *Humanitarian Library* involves a submitted abstract, a set of draft slides, an in-class presentation, and the construction of a communal resource for the team to reference in the future. Each of these deliverables receives detailed feedback from the head instructor as well the TAs. The class has seen undergraduates tackle topics such as cultural bias, the White Savior Complex, failures in a humanitarian or international development intervention, etc. These pursuits have resulted in webinars, guides, and phrase books for future project teams to use.

Grading for Humanitarian Library is philosophically similar to many other assignments in the course. The abstract, draft slides and team resource are each out of 2 points where a score of 0 represents that no assignment was turned in, was turned in late, or did not address the prompt. A score of 1 represents that the assignment was turned in, but the quality of work did not meet the expectations of the teaching staff. A score of 2 represents that assignment was turned in and the quality of work met the expectations of the teaching staff. The in-class presentation is out of six points with the following grade equivalencies: 6 = A+, 5 = A, 4 = A-/B+, 3 = B, 2 = B-/C+, 1 = C/C-, 0 = D/F. For the in-class presentation, the students are evaluated on the quality of their presentation, justice to the topic chosen, as well as incorporation of instructional staff feedback which was provided on both the abstract and the draft slides.

## 2.4 Placement Within the Curriculum

The *Humanitarian Design Projects* course has been approved as an engineering elective for each of the four engineering disciplines offered at Harvard: bio, electrical, environmental, and mechanical. As *Humanitarian Design Projects* is a two-credit hour course and most courses at Harvard are four-credit hour courses, students who wish to use *Humanitarian Design Projects* to fulfill an engineering elective must take it twice in order to add up to four credit hours. While it is

strongly recommended that students take this course in two consecutive semesters if they plan to earn academic credit toward their engineering degrees, it is not required.

Looking toward the broader academic community at Harvard, the minor in Global Health and Health Policy is the school's largest. It is well known that many humanitarian design projects address public health outcomes and as a result, students from throughout Harvard have been able to use *Humanitarian Design Projects* as academic credit toward the Global Health and Health Policy minor.

While any course at Harvard can be used as general academic credit toward graduation, a maximum of eight credits of a repeatable course can be used toward graduation. This means that students can take *Humanitarian Design Projects* for four out of their eight undergraduate semesters. Unlike the EPICS program at Purdue and other universities, the instructional staff has chosen not to make this course available to first-semester freshmen. This choice was made for a few reasons. First, the instructional staff wants students to feel like they are making meaningful contributions to their project. Regardless of whether a spring semester first-year student has completed any engineering courses, the instructional staff has observed a distinct difference in academic maturity between fall semester and spring semester first-year students. Second, Harvard, has a number of General Education requirements that are required to be completed by the end of the second year. When this requirement is coupled with the foundational math, science, and introductory engineering courses required of the students who are majoring in engineering, the choice was made to prioritize other academic requirements during a student's first semester in college.

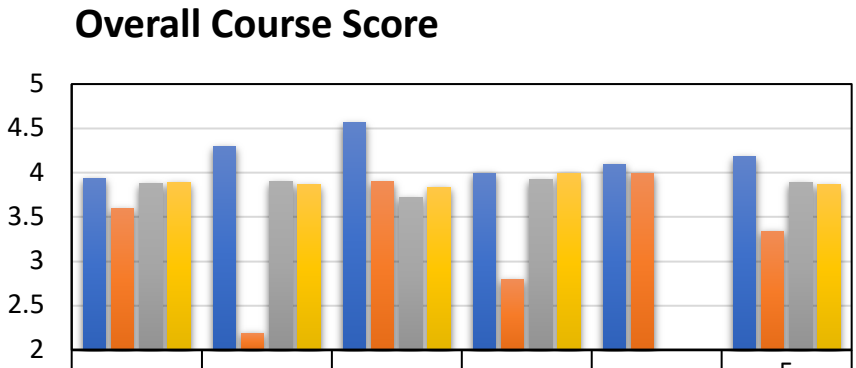
Though the authors believe that *Humanitarian Design Projects* would be a valuable addition to course offerings at most engineering schools, it is of note that it fits particularly well into the liberal arts curriculum at Harvard. This General Education requirement at Harvard states that each student completes a number of courses outside of their major to "demonstrate the value of embedding what students will learn in their [majors] within the broader context of the liberal arts".[11] Though this philosophy encourages interdisciplinary enrollment and project work such as the work completed in *Humanitarian Design Projects*, it is conceivable that the course may be more difficult to implement at an institution with more rigid graduation requirements. Similarly, the course's integration with the Global Health minor would be of less value if engineering students were unable to complete a minor or were encouraged to pursue a more technical minor. If this course were to be offered at an engineering school with a civil engineering program, which Harvard SEAS does not have, the distribution of student majors may be less varied, as civil engineering students would have course-related experience which is directly applicable to civil infrastructure projects, and may thus constitute a large majority of the class.

## 3. Course Evaluations

Student satisfaction with *Humanitarian Design Projects* and its method of instruction has been captured in a number of ways: Harvard's end-of-semester course evaluation system, direct written feedback from students, awards received by the instructional staff, and feedback from the instructional staff. While data from each of these methods does not have quantitative statistical

significance, this information does provide feedback to the instructors about student satisfaction, attainment of learning outcomes, and ideas for iterating on future courses.[2]

End-of-semester course evaluations are used to compare student satisfaction with *Humanitarian Design Projects*, an open-ended design course taken in the junior year by all Bachelor of Science engineering students, the average of all Engineering courses (Biomedical Engineering, Electrical Engineering, Environmental Science and Engineering, and Mechanical Engineering), and the average of all courses in the School of Engineering and Applied Sciences (the aforementioned engineering courses plus courses in Applied Computation, Applied Mathematics, Applied Physics, and Computer Science). Over the past five semesters data has been recorded, the overall course score for *Humanitarian Design Projects* has been higher than average for Harvard Engineering and SEAS courses and in most cases significantly higher than the Junior Design Course. While the end-of-semester scores for the Junior Design course certainly may raise questions which are not germane to this report, data for this course was included, as it is the only other regularly offered semester-long open-ended engineering design course at SEAS. End-of-semester course evaluation results from Fall 2017 through Fall 2019 are shown below in Figure 1.




| | Fall 2017 | Spring 2018 | Fall 2018 | Spring 2019 | Fall 2019 | 5 Semester Average |
|---|---|---|---|---|---|---|
| Humanitarian Design Projects | 3.94 | 4.3 | 4.57 | 4 | 4.1 | 4.18 |
| Junior Design Course | 3.6 | 2.2 | 3.9 | 2.8 | 4 | 3.34 |
| Engineering | 3.88 | 3.9 | 3.72 | 3.93 | | 3.89 |
| SEAS | 3.89 | 3.87 | 3.84 | 3.99 | | 3.87 |

*Figure 1:* Harvard's *end-of-semester course evaluation results for Humanitarian Design Projects, Engineering Sciences 96, Engineering department average, and SEAS average. In Fall 2019, data was not reported for the semester average of Engineering and SEAS courses.*

As part of the end-of-semester course evaluation, students can also provide free response feedback. In addition, the Peer and Self Evaluation assignment asks students about their experience in *Humanitarian Design Projects*, how it compares to previous semesters when they have taken *Humanitarian Design Projects*, and asks for any other comments that students would like to share. In general, students' comments have been quite positive, but some students have expressed specific

[2] Though *Humanitarian Design Projects* is a two-credit class as of Fall 2018, in the past, it has been offered as a four-credit course with the same structure. Some analysis of course reviews and feedback referenced in this paper will refer to class offerings at a different credit rate but the same structure/instructor/project scope.

frustrations with draft/revision structure of the milestones, design notebooks, and the *Humanitarian Library* assignment. Selected excepts from student feedback are listed below:

*What were the strengths of this course? Please be specific and use concrete examples where possible.*

1. There was a lot of room for collaboration, and we had a lot of control over the direction in which we wanted to focus our efforts.
2. Having the class be different and new every single day. Everyone was in charge of something different in the project and as the project changed and our needs changed, the work would also in turn be different.
3. This course lets students explore learning in a way no other course does. By focusing on hands-on teamwork on real-life projects students get a course of what real engineering work feels like.
4. The biggest strength of the course was the independent learning aspect. I was lucky to have an experience where I had to research and learn on my own. This can often be a double-edged weapon where independent learning can leave the student feeling discouraged and frustrated with no sense of direction. Despite some very open-ended milestones I feel like the course luckily never ventured into the extreme of a feeling of pointlessness or silliness in the face of having to do a lot of independent learning.

*If you have taken this class in previous semesters, when did you previously take this class? How does your experience this semester compare to previous semesters?*

5. I feel like everyone is more integrated this semester than last. I am also excited because I think that people are more independent this semester and this is absolutely a direction I want to be heading in.
6. I took this class [last] fall. While my personal performance this semester has been severely lacking, the overall class seems to be even better than before. A productive team dynamic has formed and the [TAs] have definitely hit their stride.
7. It feels like [this course] has encompassed more and more busy work each semester. Talking to other members, it feels like the notebook keeping, final summative design document, peer evaluations, occasional deliverables of low relevance to the project … and now the *Humanitarian Library* has made project work a bit more cumbersome. It seems that more time is spent documenting our work and doing little side-projects than the actual work itself, which is not bad at all for the long term, but it certainly cuts down on project enthusiasm in the short term.
8. It feels as if we are more independent and student-led this semester than in the past which is nice but also overwhelming at times.

*Please include additional comments not included elsewhere.*

9. This class involved a level of teamwork that I had never experienced before. This team-wide commitment to a single, altruistic goal was one of the most affirming experiences of my Harvard career. Additionally, I deeply valued the time that we spent pondering the social connotations of our work and have a new understanding of the responsibilities we take on by involving ourselves in this community.

10. I feel like the work across teams is sort of distributed unevenly. I see some groups have deliverables that don't take as long as other teams, and I feel like they should somewhat be equalized, or the hard work should be shared by more people.
11. The strengths of the course are that it provides incentive for EWB members to do their best work. The required group meetings are also beneficial to keep everyone updated on the progress of the project.
12. Learning how to use Revit to make projects that actually matter; this is the first class I've taken where my knowledge has actually made an impact in the world.
13. Please take the course as many times as you can. The experience is different every semester.
14. It seems like some of the milestones are unbalanced in terms of workload. I find that I spend hours and hours doing CAD, but if I am doing [certain non-technical] milestones, I can get them done in less than two hours. The class also seems like it exists in an ambiguous state between being really serious/intense and being fun/lighthearted.
15. I am not very fond of how much time the *Humanitarian Library* is taking. I think there is some value in the types of topics that pairs choose to present, but I also think that we might not be benefiting as a club as much as we would hope that would come out of these presentations (e.g. people not really paying attention, not applying this in-country, may not affect top-down decisions that are made).

In addition to course evaluations and written feedback from students, Harvard uses results from the end-of-semester course evaluations to give the *Certificate of Teaching Excellence* from the *Derek Bok Center for Teaching and Learning*. In the three semesters that the *Humanitarian Design Projects* instructional staff has been eligible to receive this award, members of the instructional staff have received the *Certificate of Teaching Excellence* all three semesters.

## 4. Discussion

### 4.1 Benefits of Co-Creation Methodology

In implementing the above-described methodology, the teaching staff and students involved have found there are many benefits to be found in this framework. By inviting open-ended design challenges into the classroom, students are forced to address problems that do not have a clear answer. Many engineering courses feature problem sets, homework questions, or similarly structured assignments that do not force students to consider how to prioritize or implement multiple correct answers. Similarly, these assignments traditionally lack real stakeholders that could benefit from or be harmed by student work. However, in *Humanitarian Design Projects* students must leave behind the comfortable structure of assignments with prescribed solutions in order to tackle whatever new challenge is on the horizon for that month, week, or day. Though students sometimes struggle in the first few weeks of the semester because they are uncomfortable with the abstractness of each assignment, most students eventually begin to master a more holistic problem-solving approach and find success in future design-oriented classes taught at Harvard such as the junior design course and senior capstone project. This result could be extrapolated to the many other extracurricular engineering design projects in which students must fulfill an objective or set of specifications without any clear structure as to how they will do so.

The co-creation method of developing course material for *Humanitarian Design Projects* allows young engineers to mature into effective leaders who are comfortable collaborating with university faculty with far more experience than themselves. These undergraduate TAs and project managers are responsible for interfacing with their partner(s), gathering information for use on the project, and developing weekly assignments for those students within their project team. In order to guarantee the quality of academic work and the completion of project milestones, these assignments are submitted to the head instructor for feedback and iteration before distribution to enrolled students. Though many undergraduates do research in a university-associated laboratory during their time in college, it is rare that a student would have such regular and collaborative interactions with a course instructor. These relationships require professionalism from undergraduates that is rarely asked of them in typical course settings and result in an ownership of the entire team's results due to the effort invested in setting them up for success. The student leader-course instructor exchange at a bare minimum involves feedback on proposed assignments and project management guidance, but typically evolves into academic guidance, career advice, and personal development.

Though most students have not before been challenged with the task of breaking large, amorphous problems into small, concrete stages, with the guidance of experienced faculty and external mentors, students have the opportunity to take on more responsibility than they likely would have thought they were capable of fulfilling. Instead of being entirely overwhelmed by the heavy weight of a five-plus year commitment to a partner community, students have the support and continuity provided by constant mentorship. This relationship also requires that the head instructor and TAs are able to work effectively and efficiently together to respond to the frequent changes that result from working with real partner(s), another skill that is rarely tested by traditional engineering courses that have pre-written assignments and exams that are comparable from year to year.

This course also succeeds in creating a team dynamic that closely simulates the types of departments, lab groups, etc. that students will face when they graduate. The project teams formed in the *Humanitarian Design Projects* course involves students of various ages, disciplines, skills, and knowledge sets. Soft skills are emphasized by instructional staff, which means that beyond working together for shared deliverables, more experienced students must mentor newer additions to the project teams. Rarely are engineering students required to postpone their own work to help a peer, but in *Humanitarian Design Projects,* students sometimes are given an assignment to guide another student through a particularly difficult task. Less experienced students have the opportunity to gain responsibility and experience within the project in the form of becoming a task lead or eventually a project manager. Project managers are not only responsible for the technical accomplishments of their team, but also for the morale of their team: a dimension that is measured in the course's peer evaluations and is vital for the success of the project. Students leave the course having implemented their previous coursework in unique ways as compared to traditional in-class projects, and they have also learned how to acquire foundational skills in another discipline. This skillset is fostered by the teaching staff via one-on-one coaching with the head instructor, group meetings with all student leadership and teaching staff, early identification of future project leads, and pairing of young students with more experienced team members. Just like in a corporate, academic, or startup environment, every skill that an individual brings to the table could potentially be utilized by the project team in *Humanitarian Design Projects*.

One of the most significant advantages to bringing EWB-USA projects into the classroom is the ability for student academic work to positively benefit real, human stakeholders. The reality that students can learn technical and soft skills while also contributing to the availability of potable water or structurally sound school buildings exposes the grand potential that academic work has for creating positive change in the world.[12] This is unfortunately one of the less-transferable benefits as compared to many other extracurricular design projects that engineering students participate in, as few of these projects have human partners. However, even if these projects are not directly benefiting other communities, giving students the opportunity to participate in projects where they will have the opportunity to engage with partner(s) outside of their own university increases opportunities for learning from their own mistakes as well as shared expertise.

### 4.2 Challenges Arising from the Course Structure

Despite its many advantages, there are challenges for instructors and students alike in the implementation of projects that were traditionally extracurricular and are now being implemented within an academic credit-bearing framework. This tension becomes apparent when decisions are made regarding what is to be included in the scope of *Humanitarian Design Projects* versus what is to be an isolated extracurricular student group's responsibility. In the context of EWB-USA projects, fundraising is a significant task, as project teams must consistently fundraise within a range of $15k to $50k annually per project team. While this instructional staff concluded it would be better to exclude fundraising efforts from the academic assignments, it is also possible to argue that the process of writing a grant proposal can be incredibly important to engineering project work and forces students to exhibit competency in communicating the value of their work to the outside world. Currently, the chapter has an executive board whose members manage various committees that complete necessary work that is outside of the scope of the class. This includes the fundraising, social programming, media, and conference committees. Decisions as to what constitutes academic work and what should be deemed extracurricular activities are made on a case-by-case basis.

Instructors have noted that the project teams in *Humanitarian Design Projects* have a tendency to become closely-knit socially, likely due to the constant collaboration, close quarters on international trips, and the shared experience of overcoming challenges as a group. While this translates well to team dynamics, it can also foster a divide between students who focus on the hard work that contributes to the end-goal of a project and students who would like to have a fun time working with a project cohort. This sentiment is voiced many times in student feedback (see Section 3), particularly in comment 14 where the student articulates that "[t]he class also seems like it exists in an ambiguous state between being really serious/intense and being fun/lighthearted." While some students, particularly those who are project leads and TAs, understand the amount of work necessary to deliver a high-quality result to the project partners others become frustrated by heavy workload and variable difficulty throughout the year as seen in comments 10 and 14. Maintaining appropriate difficulty levels can be challenging especially because students tend to recruit their friends to take the course with them but generally emphasize the rewarding and fun elements as opposed to time commitments. This ambiguity has been somewhat exacerbated during the course's transition from a 4-credit to a 2-credit class, as students tend to assume that a lower-credit class will be half of the work of a 4-credit class. Students tend

to leave the class (and the Engineers Without Borders Chapter) when workloads are too heavy to sustain with other high-demand engineering classes but also tend to become frustrated or disinterested when team accountability is low. Though the teaching team has yet to develop a foolproof method of balancing class difficulty with fun, a few measures have been put in place to limit student attrition:

1. Reduce workload inequality between project teams by comparing weekly assignments before they are sent out to their respective teams.
2. Provide frequent student feedback and peer evaluations to allow for mid-year interventions for project team members who are working too hard/not hard enough.
3. Place emphasis on team programming such as team dinners, socials, and training activities.
4. Limit enrollment to upperclassmen as a means of reducing mid-year burnout from first-year students who are unaccustomed to the workload of college courses.
5. Make personal appeals for members to join the extracurricular board for the Harvard EWB Chapter if they cannot or do not have time to enroll in the class.

Similarly, there is some discrepancy between students who appreciate opportunities that are related to project work but do not immediately or concretely contribute to the completion of a design, and others who strongly dislike those opportunities. The *Humanitarian Library* is an example of such an assignment, as it challenges students to think critically about their work in the humanitarian and development field, but does not result in calculations or technical writing that is included in summative documents. Though some students reap the benefits of the assignment as designed by the course staff, not all appreciate the step-back that is required for such reflective assignments. Students frequently complain (as seen in comments 7 and 15) that their excitement for project work is fatigued by such assignments, but the instructional team believes that there is a balance between mission-critical work and opportunities for reflection. Without certain efforts to document a team member's knowledge before they graduate, there is significant risk of loss of institutional memory, yet with too much non-essential project work, students begin to become disinterested. The course staff attempts to strike a balance between the two by offering students more independence to select the subject and scope of their contribution to institutional knowledge-sharing through the *Humanitarian Library* project. Herein lies a tension between engineering learning and project scope.

Undergraduate TAs must learn to navigate existing relationships when evaluating student work, which can lead to personal dilemmas regarding grading fairness. It is impossible to avoid bias for any instructor, and though many schools have formal trainings for TAs, this remains a problem at many universities. With this in mind, project-based courses make it even more difficult for students to objectively evaluate the work of their peers because collaborative work often results in friendships, disagreements, and personality clashes. Thus, in a course with constant discussions, group milestones, and inter-dependence, it becomes even harder for TAs to separate the quality of a person's work from their opinion of the person and vice versa. This means that a TA may be grading friends' academic work either as a result of pre-existing relationships or simply due to the closeness of the student group. Additionally, because some subset of the student project leads are TAs, sometimes a student project lead depends directly on another student in order to accomplish a team milestone. If the student produces below-average academic work, the resulting negative impacts may be inflated beyond the scale that a poor assignment warrants. The fallout from poor

academic performance within the team could include but is not limited to: negative influence on their future assignments or their social standing within the team dynamic, or discomfort due to disciplinary action taken by instructional staff. To reduce the risk of student bias disproportionally influencing grades or team dynamics, the head instructor is responsible for all final grades as well as for fielding any grade-related questions. However, it is impossible to entirely remove the effects of having a closely-knit student project team.

Additionally, by inviting what is typically extracurricular work into a credit bearing course, this structure has the potential to exclude students who wish to participate in an extracurricular student group without enrolling in the associated course. In *Humanitarian Design Projects*, there is sometimes tension between those who wish to "audit" the course (i.e. participate without receiving any credit or grade) and the course staff. Though the instructional staff seeks to be inclusive of general membership, those who audit are not accountable for submitting any work and do not have the motivator of receiving a grade to complete their assignments. Though this reduced-accountability dynamic is common in student extracurricular groups and is not inherently bad, it can result in reduced class enrollment due to an unwillingness/inability to commit in any given semester. The addition of students auditing the course can also result in over-crowding of class meetings with too few instructional staff members, as the TA allotment is related to the number of students fully enrolled in the course. A related challenge is the possibility of burnout of enrolled student project team members due to higher academic workload and increased accountability tied to academic work as compared to extracurricular work. Though this dedicated course tends to accelerate the project design process and thus increases positive results for the partner community, it also means that student project team members may be more likely to take a break from design work after a particularly intense semester. Unfortunately, this can reduce the retention of institutional knowledge and can increase student turnover.

Though the existence of human a project partner who benefits from student success was referenced earlier as an advantage, it can also be seen as a liability or concern. Student work in an academic context rarely has real-world impact regardless of the outcome, but in the context of service-learning projects, there is risk that a student team would be unable to fulfill the needs of their partner community or, worse, design/build a solution that could cause harm. Though EWB-USA has an internal QA/QC process that minimizes the risks of inappropriate or unsafe designs, the formal association of client-based academic work with a particular engineering school could reflect poorly on that institution if projects are not executed in a timely and responsible manner.

## 5. Summary

This manuscript describes a novel structure for a PBL course in which engineering students can earn credits for multi-semester projects which have historically been reserved for extracurricular activities. A unique difference between the course structure piloted in this report and typical engineering design courses is the use of undergraduate TAs and project managers in the creation of weekly assignments. While there are challenges that come with this approach, the authors believe based on observation and student feedback that the positive impacts on student learning outcomes and professional preparation outweigh the difficulties. The authors plan to continue refining the course structure based on student feedback, feedback from stakeholders, and project outcomes. Further work would be necessary for the authors to conduct a rigorous research study

in order to determine whether learning outcomes are better met by the structure of *Humanitarian Design Projects* or more traditional pedagogies.

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**Supplemental Information**

*Syllabus*

***Humanitarian Design Projects is a two-credit course***. It was designed this way as Harvard students may only take up to eight credits of any given course number. As such, a student may take four semesters of *Humanitarian Design Projects* during their Harvard career. *Humanitarian Design Projects* will still fulfill a general engineering elective for those students who are engineering majors, but four credits of the course must be taken in order to earn credit toward your major.

## 1. Purpose

This course intended to supplement Harvard SEAS's Engineers Without Borders USA projects. Separate overviews of the projects are given below.

### 1.1 Kibuon Water Project

Kibuon is a community of about 1600 residents located in the southwestern region of Kenya. The current sources of water in the Kibuon community are springs and shallow hand dug wells which are unclean and insufficient, leading high cost for acquiring water and occurrences of symptoms such as diarrhea, fever, convolutions and coughing which could be attributed to water borne illnesses; furthermore, community members spend a lot of time traveling to collect this water, and the water supply is severely limited. The Kibuon Water Project aims to provide cleaner, stable, and more accessible water for members of the community which would reduce the occurrences of such illnesses and reduce the amount of time spent collecting water, hence allowing time for other activities, particularly education for children who spend time collecting water. The Harvard SEAS Chapter completed an assessment trip in the summer of 2019 where the team collected demographic, geographic and hydrogeological data. This data will be used in this course to explore, generate, analyze and design potential solutions to the water challenges faced by Kibuon residents.

### 1.2 Los Sanchez Water Distribution System

The Los Sanchez project is a water supply project based in the Dominican Republic. Its purpose is to provide safe and reliable water distribution to the Los Sanchez community of 400 residents spread across 450 acres. The community faces intermittent electricity, incomplete piping and inadequate water storage. As a result, the community has partnered with Harvard SEAS's chapter of EWB-USA to alleviate these problems. The design scope of the project will include a water storage and distribution system for the community that improves and expands the existing infrastructure and is sustainable.

## 2. Course Overview

Using topographic data, infrastructure surveys, material availability, and community input collected on previous assessment trips, the students in the course will design elements of a water

system for the communities of Kibuon and Los Sanchez. They will do this in two separate groups with the help of local Boston area professionals. This design will incorporate elements from civil, mechanical, electrical, and environmental engineering in addition to global public health, social anthropology, and community development. A full documented alternatives analysis (if applicable) will be performed before finalizing a design appropriate to the community. Likely elements of the water distribution system include: well design, pumping systems, distribution piping, tap stands/spigots, valve box, water storage etc. All project elements will all be designed and analyzed using appropriate design and simulation software. The final project designs will be reviewed for approval by a panel of professional experts appointed by Engineers Without Borders USA.

To facilitate the design process, engineering and other professionals will lead some class meetings and may assign assignments. These assignments are part of the course grade as determined below.

## 2.1 Meeting Time and Location

There will be 2 x 75 min required class meetings per week with required attendance. Additional time will be required outside of the three hours of in class time for research, analysis, design, etc. *Humanitarian Design Projects* will meet during Reading Period.

## 2.2 Grading

All work done for the course ***must be submitted on CANVAS*** in order for it to be considered for grading unless otherwise specified by the instructional staff. This includes work done in as a part of a group and any additional work done outside of the classroom such as attending a conference, a training event, a webinar etc.

### 2.2.1 Attendance

There is one unexcused absence allowed without penalty. Subsequent absences will result in a loss of 10% of the final semester grade for each absence unless they are ***pre-approved by the course instructor at least 48 hours in advance***. In addition, late arrivals are also unexcused and will be tracked. Two unexcused late arrivals/early departures are considered equivalent to 1 unexcused absence. Students will be considered late if they arrive greater than 5 minutes after the start of the class. The attendance policy supersedes all other grading elements, meaning it heavily influences student grades in the course. If you have any questions, please contact a member of the teaching staff.

### 2.2.2 Participation – 30%

Peer & Self-Evaluations

One important aspect of team design work is the ability to objectively evaluate your individual progress as well as the progress of other individuals on your team. Peer and self-evaluations will be an integral part of the course and will be completed periodically throughout the semester. This feedback should be honest and objective in order to preemptively address potential conflicts as well as to facilitate effective communication among the group. If

feedback is not constructive, critical, and thorough, points will be lost. *Everyone can't be doing a great job with everything, all the time. It's just not possible.*

### 2.2.3 Summative Design Documents – 30%

#### 2.2.3.1 Alternatives Analysis

The purpose of the alternatives analysis is to document the thought process that the project team has gone through to determine which alternative solution is best for a given situation. There is sufficient information presented in this analysis to justify the choices made by the project team. For example, if there are a number of different water sources that may be used for a water supply, the alternatives analysis would describe how the preferred source was chosen. There is no prescribed methodology for carrying out this analysis as long as it is logically documented and makes sense in context of the project.

Per the EWB-USA website, the Alternatives Analysis Report must be externally approved prior to moving into the Implementation Phase. This document may take at least four weeks for a review.

#### 2.2.3.2 Preliminary Design Report

The preliminary design report should present a complete design for the proposed implementation. It is only preliminary in the sense that it is not yet being presented to the Technical Advisory Committee of EWB-USA. But the design, calculations, drawings and all other aspects of the design should be completed to the best ability of the chapter. The intent of this document is to allow the chapter the chance to receive feedback from the EWB-USA Project Managers and modify the design as appropriate and incorporate those changes into the pre-implementation report submittal to the Technical Advisory Committee.

Per the EWB-USA website, Implementation Pre-Trip Plans are due 16 weeks prior to trip departure date (please note that an Alternatives Analysis must be approved prior to submittal of an Implementation Pre-Trip Plan).

#### 2.2.3.3 Other Summative Documents

As each project will be in different phases of the project cycle, other design documentation or reporting may be necessary and assigned. If a project does not submit an Alternatives Analysis, Preliminary Design Report, or Final Design Report during the course of the semester, another summative document will be developed and assigned by the instructional staff. Additionally, any design documentation or analysis that is a substantial deliverable may be added to this category.

#### 2.2.3.4 Additional Information

The report(s) will be compiled from individual work into completed documents. Each section will list the students who performed the design, analysis, or writing to appropriately attribute credit as well as for grading purposes.

### 2.2.4 Other Assignments – 40%

#### 2.2.4.1 Design Notebook

Each person will be required to ***purchase and keep*** a design notebook which will be checked periodically throughout the semester. While CAD files and simulations do not need to be reproduced in the design notebook, to do lists, important details, back of the envelope calculations, etc. should all be done this notebook. You should use a waterproof pen or a Sharpie so if the notebook gets wet, the content does not bleed. Additionally, this notebook should be bound so that pages cannot be torn out of it. *This is really important when you are in the field!!!* Don't worry about errors, just draw a line through it and keep going.

Examples of items that should be included in your notebooks:

- Information central to the project
- Conclusions/takeaways from your milestones
- Things you need to know in order to complete your milestones
- Questions you need to have answered
- Things that confused you while you were working
- Team members' contact information
- Sketches and hand drawings

#### 2.2.4.2 Weekly/Biweekly Assignments

There will also be weekly/biweekly assignments to be ***submitted through CANVAS***. The content of these assignments may vary based on individual student's responsibilities within their own project.

Weekly assignments will be graded on a 0-3 point scale but out of 2 points. A score of 0 represents that no assignment was turned in, turned in late, or the milestone was not properly addressed. A score of 1 represents that the milestone was addressed but the quality of work did meet the expectations of the project leads and teaching staff. A score of 2 represents that the milestone was addressed and the quality of work met the expectations of the project leads and teaching staff. A score of 3 represents that the milestone was addressed and the quality of work exceeded the expectations of the project leads and teaching staff; very high-quality work.

In general, weekly milestones will be distributed on section days for each team. These deliverables will be due approximately 5 days later. The Project Leads and/or teaching staff will provide comments by the next section meeting. All corrections and edits will need to be completed and uploaded within approximately 3 days. Any and all late assignments will be penalized. Additionally, if milestones are not completed by the initial submission (~5 days after assignment) full credit will not be earned upon revision.

Example timeline:

| | **Kibuon** | **Los Sanchez** |
|---|---|---|
| **Milestone distributed on section day** | Monday – Week 1 | Wednesday – Week 1 |
| **Milestone due 2 days before section** | Saturday 23:59 – Week 1 | Monday – Week 1 |

| | | |
|---|---|---|
| **Staff provides feedback by section meeting** | Monday – Week 2 | Wednesday – Week 2 |
| **Revised milestone due** | Wednesday – Week 2 | Friday 23:59 – Week 2 |

2.2.4.3 Humanitarian Library

The Humanitarian Library assignment will be completed in inter-team partnerships (one student from the Kibuon Project, one student from the Los Sanchez Project) and is an opportunity for students to explore unique ways to enrich and discuss aspects of project that may not be 100% related to project work. The project will have separate assignment information, but will consist of a short abstract, a ~15 minute class presentation, and a final deliverable appropriate to the topic which must be approved by the teaching staff.

## 3. Syllabus Policies

### 3.1 Knowledge of Syllabus

All enrolled students in this course are expected to have read and understood each item of the syllabus. Failure to read, understand, and seek clarification of any point within this syllabus is solely the responsibility of the enrolled student.

### 3.2 Edits and Revisions

Revisions can be made to this syllabus at any time during the semester in order to clarify points, address errors and omissions, etc.

### 3.3 Discrepancies

If any discrepancies arise between the HTML version of the syllabus and the Word/PDF version, the Word/PDF version located on CANVAS will take precedence.

*Peer and Self Evaluations*

Listed below are questions asked of enrolled students during the Peer and Self Evaluation Assignment. This assignment is repeated three times throughout the semester.

Self-Evaluation

1. Please discuss your level of satisfaction with progress of the project and why you feel that way.
2. Which project team are you a part of?
3. What have you accomplished this semester and what impact have you made on the team? (Please include your top three accomplishments in your response)
4. In the future, how can you improve? What are your goals and how will you accomplish them?
5. What have the Project Leads done well this semester? (Have your assignments been clear? Do you understand how your personal tasks benefit the project? Do the Project Leads foster a good team culture? Do they make you enthusiastic about this project?)
6. What can the Project Leads do better? (Have your assignments been clear? Do you understand how your personal tasks benefit the project? Do the Project Leads foster a good team culture? Do they make you enthusiastic about this project?)

Peer Evaluation(s) (repeat for 3 peers)

7. What has [reviewed student] done well? (Has their work been of good quality? When they are part of group assignments, do they do their fair share? Have they used class time efficiently? Are they encouraging to classmates? Is this person someone you would want to work with?)
8. How can they improve? (Could this person be more timely? Does their work need extensive revisions? Have they not sought help when they needed it and instead done poor work? Is this person not enjoyable to work with?)

Course Feedback

9. Do you go to Office Hours? If not, what can the TAs do better in order to improve attendance. What have the TAs done well in meetings and Office Hours. How can they do better?
10. If you have taken this class in previous semesters, when did you previously take this class? How does your experience this semester compare to previous semesters?
11. Please include additional comments not included elsewhere. This section can also be used to provide confidential comments to the course instructor about any topic relating to the course, specific team members, etc.

*Humanitarian Library*

***Assignment Introduction:*** *The goal of this assignment is to allow you to explore some part of humanitarian design work or project work that interests you, find some unique way to enrich the work that your project is doing, discuss ethics or failures in the context of humanitarian engineering projects. Additionally, you will be creating a publicly available resource for other individuals who are interested in international development and humanitarian engineering projects. The assignment is outlined below, but the guidelines are intended to offer a helpful structure as opposed to restrictions. If you have an idea that does not fit within the suggested project scope, please talk to one of the teaching staff. We love creative projects!* ***In addition, if the topic has been covered in recent semester, we will ask you to choose a new topic.***

**Suggested Prompts:**

(1) **HUMANITARIAN ENGINEERING FAILURE CASE STUDY*:*** Use the community toolkit and/or search on your own for a humanitarian engineering failure. How did it fail? Who did it impact in failing? Did anyone benefit from its failure? Could/should the failure have been prevented? Apply the answers to our projects: what does it mean for us? *Engage with at least 7 high quality sources.*

(2) **CONTEXT IS EVERYTHING*:*** Dive deep into the context of some aspect of one of EWB's projects. This could means going into U.S. - Tanzanian relations, the differences in Dominican/American culture, what factors influence the sustainability of projects, how language barriers impact relationship building, how body language varies by region, things to consider while preparing for an assessment in a new community, etc. Find some way to engage with the project in a way that our teams don't usually. *Engage with at least 7 high quality sources.*

(3) **TECHNICAL NOTE**: Dive deep into a technical subject and extract the meaningful points for your audience. Presentations should be on a similar level or technical depth as McKenna's GPS presentation, Chris' Solar PV talk or Electrical Assessment presentations, or similar. Think about this as a primer so that someone who is unfamiliar with this topic can quickly get the essentials. You should share with the audience what they know and what they don't so that they can further their learning after the presentation. *Engage with at least 7 high quality sources.*

(4) **JUST GO FOR IT*:*** Nothing above sounds interesting? Feel free to get creative, just be sure to get your idea approved before you write your abstract. *Engage with at least 7 high quality sources.*

**[ASSIGNMENT NAME] Components:**

(1) **ABSTRACT**: The abstract for your presentation will be due 2 weeks before the date of your presentation and should outline what engineering challenge you are engaging. The abstract should about a page long, followed by a bullet point for each of the 7 sources and

a statement on how the source will be utilized in your presentation. You will receive feedback from a member of the teaching staff on the submitted abstract.

a) The abstract will be uploaded to CANVAS by the beginning of class 2 weeks prior to your presentation date.
b) If you are interested producing a Team Resource other than a Webinar (see section 4), you it would be highly beneficial to propose it during the abstract.
c) ***In addition to uploading the document CANVAS, please email the instructors*** to notify that this has been completed. Failure to email may result in a delay receiving feedback on your abstract.

(2) **SUBMITTED SLIDES**: The slides for your presentation are due 1 week to canvas before your presentation date. Any revisions suggested by the teaching team should be made before the date of the presentation. You should have enough slides for a 15 min presentation. Time will be strictly enforced. Your slides must include the following things:

a) *Details*: The title of your study (be descriptive and creative), your name, major
***b) POWERPOINT! They must be generated in PowerPoint, no exceptions.***
- ***Note: This does not mean create slides in Google Slides or Keynote and export to a PPT or PPTX file. You will need to use certain features that only PowerPoint has***.

c) *Citations*: All sources referenced properly in the references section of the PowerPoint using a format that contains all proper referencing information. Why? So that parties can reference your work and dig deeper in the future!
- If you have any questions about how to properly cite sources, please consult the teaching staff prior to the presentation. URLs are not a proper citation format and you will lose points in a citation is only a URL.

d) Any additional content (like a reference guide/map/graphic/etc.) that was specific to your prompt
e) ***In addition to uploading the document to CANVAS, please email instructors to*** notify that this has been completed. Failure to email may result in a delay receiving feedback on your slides.

(3) **CLASS-WIDE PRESENTATION**: You'll have 15 minutes and time will be strictly enforced. Give your audience enough context without overwhelming them with details. Your goal is to be engaging, generate interest in your topic, and convey the important points. Your audience should walk away equipped to further investigate these issues and be aware of the "unknowns" present in this area.

(4) **TEAM RESOURCE GENERATION**: CHOOSE ONE OPTION

After the class-wide presentation, the teaching staff will share with you their comments. Incorporate that feedback in the generation of your team resource:

*a)* ***Webinar***
i. You will use PowerPoint's audio recording feature to create a webinar. To use this feature please consult the following walkthroughs:
1. Windows: https://goo.gl/71qUXH
2. Mac: https://goo.gl/teYgnC
3. Linux – Too bad, you are going to have to use Windows or Mac

ii. Be sure to save your file and upload to CANVAS in the same assignment where uploaded your initial set of slides. Please be sure to save as a PPTX file.
iii. In addition to uploading the document CANVAS, please email the instructors to notify that this has been completed.

*b)* ***Something Else***

i. *Webinars are not the only way and rarely the best way to present useful information*. If you believe that the topic you are presenting on can be made useful to the group in a manner different from a webinar, then you are welcome to propose a different team resource. This must be done no later than the slide submission. If you have ideas, please add those ideas to your abstract to receive feedback from the teaching staff.