AC 2007-109: PROJECT MANAGEMENT APPLICATIONS FOR SERVICE-LEARNING IN ENGINEERING

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Abstract
In 2003 Lafayette College established its own chapter of Engineers without Borders (EWB-LC) with the goal of establishing sustainable infrastructures in the Yoro region of Honduras using multidisciplinary student teams. EWB has seen much success over the past three years. Work was completed in the Lagunitas village, work is being completed in La Fortuna, and work is beginning in a third village, El Convento. EWB-LC has won several grants including a P3 grant from the EPA for sustainability research. Despite these successes, EWB faces several challenges that are common amongst student-led service groups particularly rotating members, uncertain budgets, and a lack of communication. While there are certainly other issues with running a student group, these are by far the most prominent issues. Using EWB-LC as a case study, we applied project management concepts to develop a system to improve the performance of student-led, multidisciplinary, service-learning organization. We used surveys to measure how students and leaders perceive the efficiency of the club, and we used project management efficiency ratios to determine how effective the club is pre and post use of the project management system. The results should be useful to other EWB-USA student chapters and similar organizations at other colleges.

Project Objective
In this project, we apply Oberlender's[1] concepts of project management to develop a framework that addresses the organizational challenges faced by undergraduate student-led service-learning groups. We evaluate the framework using the Engineers without Borders, Lafayette College (EWB-LC) student chapter as a case study. The results may be applied to similar service-learning organizations across a variety of undergraduate college settings.

Background
"Service-learning means a method under which students learn and develop a thoughtfully organized service that is conducted in and meets the needs of a community and is coordinated with an institution of higher learning and with the community; helps foster civic responsibility; is integrated into and embraces the academic curriculum of the students enrolled; and includes structured time for the students to reflect on the service experience."[2]

According to studies done at the Higher Education Research Institute of the University of California, Los Angeles[3], certain things must be done to ensure that a service-learning experience is effective. The first is that students must receive sufficient training through course material before engaging in the service. The second is that instructors must engage students in conversation about their service. The last is that students must reflect on their service through a medium such as a paper or journal. The study shows that when this was done, students who participated in service-learning classes had a better sense of civic responsibility then their peers in non service-learning classes. Students also tended to improve their writing skills and their critical thinking skills.

In addition to the non quantitative benefits of service learning, the study showed that there were tangible benefits to service learning as well. Students in service-learning classes tended to have higher GPAs and were more likely to go on to earn masters and doctoral degrees.

Service-learning clubs provide students with an opportunity to apply their knowledge to real-world situations. In addition to education, service-learning provides students with the opportunity to help the local or global community. However, it is difficult to manage student-led groups because of rotating members, uncertain budgets, and the corresponding lack of communication.[4] Students can only participate in organizations for a maximum of four years; however, many students do not really become involved in organizations until they settle into their sophomore, or junior year. The group is interdisciplinary and so communication is often an issue. In addition, the amount of money a club receives often depends on the generosity of the College's student government. Because student government changes every year as well as the number of clubs on campus, a club's budget can vary significantly over time. External donations also change yearly depending on the givers willingness to donate and the aggressiveness of the student group. And, grants are not guaranteed.

Various authors have also commented on the factors that lead to successful service-learning student groups. Green et. al. concludes that service-learning student groups must be interdisciplinary due to the nature of the real-world projects.[5] The same authors suggest that partnering with a non governmental organization (NGO) improves project success even though such partnerships may be an obstacle for students who now have an additional organization to coordinate with[5]. Similarly, close faculty mentoring is needed as well as access to sub-area experts due to the interdisciplinary nature of these projects. Green, et. al. mentions that faculty needs to be involved in selecting projects to make sure they are meaningful[5]. This means that faculty must be traveling with students to ensure that projects are feasible, however it is often difficult for faculty travel because of family and work commitments. Green, et. al. suggest that travel planning is a critical element, however this may not be appreciated by student members who instead want to be involved with the design of the solution[5]. A variety of authors discuss how difficult it often is for students to come up with creative technologies with only a limited understanding of the underlying theories[6].

The Case Study

Founded in 2000, "Engineers without Borders-USA (EWB-USA) is a non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. This partnership involves the implementation of sustainable engineering projects, while involving and training internationally responsible engineers and engineering students."[7] EWB-USA helps communities to develop sustainable systems that can be owned and operated by the individual communities with minimal external help. Communities must buy into the proposed solution and must feel that this is their project, or else it will not last after the member organization has left. EWB-USA stresses the importance of a partnership between the member organization and the community. These projects not only provide technology for the community, but help community members develop technical, managerial, and entrepreneurial skills[6]. EWB- USA has two types of member organizations; professional chapters and student-based collegiate chapters.

Lafayette College is a small, liberal arts college located in Easton, PA. In 2003, Lafayette College established its own student-based chapter of Engineers without Borders (EWB-LC) with the goal of establishing sustainable water and sanitation infrastructures in the rural, Yoro region of Honduras using multidisciplinary student teams. In addition to EWB-LC, Lafayette College has the Landis Community Outreach Center that provides students an opportunity to do community service during their time at Lafayette College. The Landis Center runs a program known as Alternative School Break (ASB). ASB provides opportunities for students to travel to different parts of the country and abroad to do community service during the winter and spring breaks. In the winters of 2005, 2006, and 2007 EWB-LC and the Landis Center worked together to send students to the Yoro region to help implement solutions developed by EWB-LC. In addition, EWB-LC sent members to Yoro in 2004, 2005, and 2006. Future trips are planned for the spring of 2007.

From 2003-2006, the EWB-LC structure was similar to a typical student club with a president, vice president, secretary, and treasurer. Member participation and work loads varied depending on an individual's willingness to work. Every spring semester, Lafayette College offers a course, EP480: EP Design Project, during which enrolled students who are not necessarily EWB-LC members, provide the student group with feasibility studies, conceptual solutions, and grant proposals. EWB-LC develops final designs from these deliverables during the fall semesters relying completely on student member participation. Over the past three years, EWB-LC completed 90% of the work needed in the village of Lagunitas (EWB-LC's first project). EWB-LC is currently completing work in a second village (La Fortuna), and is preparing to begin work in a third village (El Convento). In recognition of their success in bringing sustainable clean water and sanitation solutions to villages in the Yoro region, the Environmental Protection Agency (EPA) awarded EWB-LC a $75,000 P3 grant for these efforts to be used between 2006 and 2008.

Project Management Concepts

According to Oberlender, project management can be defined as the "art and science of coordinating people, equipment, materials, money, and schedules to complete a specified project on time and within approved cost."[8] Oberlender consolidates 20 key concepts of effective project management into five basic functions: planning, organizing, staffing, directing, and controlling[7]. However, Oberlender's theory is intended for a professional organization and the roles he describes are not suited for college students such as "ample human resources," or "long-term planning," or even the ideas of "controlling" and "directing" volunteer members. Instead, we revised the five basic functions from Oberlender into five functions that are more relevant for student-led clubs. These revised five basic functions still address Oberlender's 20 key concepts and include communication, document management, decision making, effective staffing, and quality control.

Communication refers to keeping everyone aware of the actions taking place throughout the organization. Document management allows the club to keep track of drawings, research, and other information so that the entire group has access. Decisions must be made in a clear, consistent, and equitable manner so that members have a stake in the project. Effective staffing ensures that members are not over, or under used because both situations can minimize interest in the organization. Finally, quality control measures ensure that effective solutions are

developed for the community served. In addition to these organizational challenges, the over-riding framework for student-led service-learning groups must also help members understand what service means in general and for them as individuals. Below is a summary of Oberlender's 20 key project management concepts that we mapped to the five revised basic functions (added in bold) that student-led service-learning groups should follow. We included the challenges that remain.

1. Ensure that one person, and one person only, is responsible for the project scope, budget, and schedule. **Decision Making**
   Challenge: Organizational and planning skills vary among members and are not "taught." Rotating members and changing budgets make this difficult.

2. Don't begin work without a signed contract, regardless of the pressure to start. **Communication**
   Challenge: Preliminary site assessments must be done without an agreement to start the process prior to a community agreement with the club.

3. Confirm that there is an approved scope, budget, and schedule for the project. **Quality Control**
   Challenge: Rotating members and changing budgets make this difficult.

4. Look in the project scope at the beginning and ensure there is no scope growth without approval. **Quality Control**
   Challenge: Rotating membership and changing budgets makes this difficult.

5. Make certain that scope is understood by all the parties, including the owner. **Communication**
   Challenge: Language, cultural, and educational barriers, along with the issue of rotating members make this difficult.

6. Determine who developed the budget and schedule, and when they were prepared. **Communication**
   Challenge: Rotating membership and changing budgets makes this difficult.

7. Verify that the budget and schedule are linked to the scope. **Quality Control**
   Challenge: Rotating membership and changing budgets makes this difficult.

8. Organize the project around the work to be performed, rather than trying to keep people busy. **Effective Staffing**
   Challenge: Cannot control the number of people who sign up, their level of effort, or skills.

9. Ensure there is an explicit operational work plan to guide the entire project. **Decision Making**
   Challenge: With the many obligations that students have, it is tough to meet deadlines. Rotating membership and changing budgets also makes this difficult.

10. Establish a work breakdown structure that divides the project into definable measurable units of work. **Effective Staffing**
    Remaining Challenge: With the many obligations that students have, it is tough to meet deadlines. Rotating membership and changing budgets also makes this difficult.

11. Establish a project organizational chart that shows authority and responsibilities for all team members. **Effective Staffing**
    Remaining Challenge: Students often work with several teams so it can be difficult to define team membership.

12. Build the project staff into an effective team that works well as a unit. **Effective Staffing**
    Remaining Challenge: Busy schedules make it hard to set time aside for team-building.

13. Emphasize that quality is a must because if it doesn't work it is worthless, regardless of cost or how fast it was accomplished. **Quality Control**
    Remaining Challenge: Quality review deadlines do not always correspond to semester deadlines.

14. Budget all tasks; any work worth doing should have compensation. **Decision Making**
    Remaining Challenge: Students cannot be compensated [other than via grades for the work done in formal courses].

15. Develop a project schedule that provides logical sequencing of the work required to complete the job. **Decision Making**
    Remaining Challenge: Students have difficulty planning ahead because of all the variables associated with the project and their own schedules. Rotating membership and changing budgets also makes this difficult.

16. Establish a control system that will anticipate and report deviations on a timely basis so corrective actions can be taken. **Quality Control**
    Remaining Challenge: Students don't take the time to fill out thorough reports because of time constraints as well as a lack of understanding of the necessity.

17. Get problems out in the open with all persons involved so they can be resolved. **Communication**
    Remaining Challenge: Students don't take the time to fill out thorough reports about problems because of time constraints as well as a lack of understanding of the necessity.

18. Document all work, because what may seem irrelevant at one point in time may later be very significant. **Document Management**
    Remaining Challenge: Students don't take the time to fill out thorough reports because of time constraints as well as a lack of understanding of the necessity.

19. Prepare a formal agreement with appropriate parties whenever there is a change in the project. **Decision Making**

Remaining Challenge: Language, cultural, educational and barriers, as well as rotating members affect communication about changes for all parties.

20. Keep the client informed; they pay for everything and will use the project upon completion.
    Communication
    Remaining Challenge: Language, cultural, educational and barriers, as well as rotating members affect communication about changes for all parties. In addition, service projects don't consider "pay" in the same way.

Oberlender also states that a project team's work structure must rely on overlapping subteams to work together for a common goal[7]. Oberlender mentions that the key for these different sub teams is to identify with the shared interest of the overall group and to highlight the shared ownership of the project[7]. He emphasizes that by doing so people will be more willing to work on the project with enthusiasm rather then doing the minimum to just get the job done[7]. Oberlender states that in order for this to occur, each subteam must have a single head to lead the group, however any project management framework must create an environment in which the individual teams feel a common identity and trust within the group[7]. Subteam members must feel inspired to work by being able to not only identify within the subgroup, but to identify with the larger group[7]. Each subteam must have individual goals which fulfill their own needs as well as the needs of the larger team and it is the team leader's responsibility to ensure open lines of communication are present[7]. Since it is common for workers to do as they are told, it is the responsibility of the team leaders to provide their team with specific instructions on what work needs to be accomplished[7].

Objective and Methods

We developed a project management framework for EWB-LC based on Oberlender's theories on project management adapted for a student club. During summer 2006, the faculty advisors as well as with the student leaders provided feedback to refine the project management framework. The team leaders adopted the project management system at their first meeting at the start of classes in Fall 2006. EWB-LC followed this framework for the 2006/2007 academic year. We then evaluated how the members feel about the new framework by questioning both student leaders and the general body throughout the academic year using surveys and semi-structured interviews, including observations during a site visit. We also compared the previous output of EWB-LC using an efficiency ratio defined as the cost per person served for a completed project. We compared the efficiency ratio for the completed EWB-LC project in Lagunitas versus projects completed by a leading non governmental organization (NGO) working in Honduras. Although we could not evaluate how such an efficiency ratio may change with the new management framework, the comparison provides a baseline that can be monitored over time. In addition, we compared the project length for Lagunitas as compared to the projected project length for EWB-LC's current project in La Fortuna. We used the overall results to make general recommendations for effective management of student-led service-learning clubs.

Project Management Framework

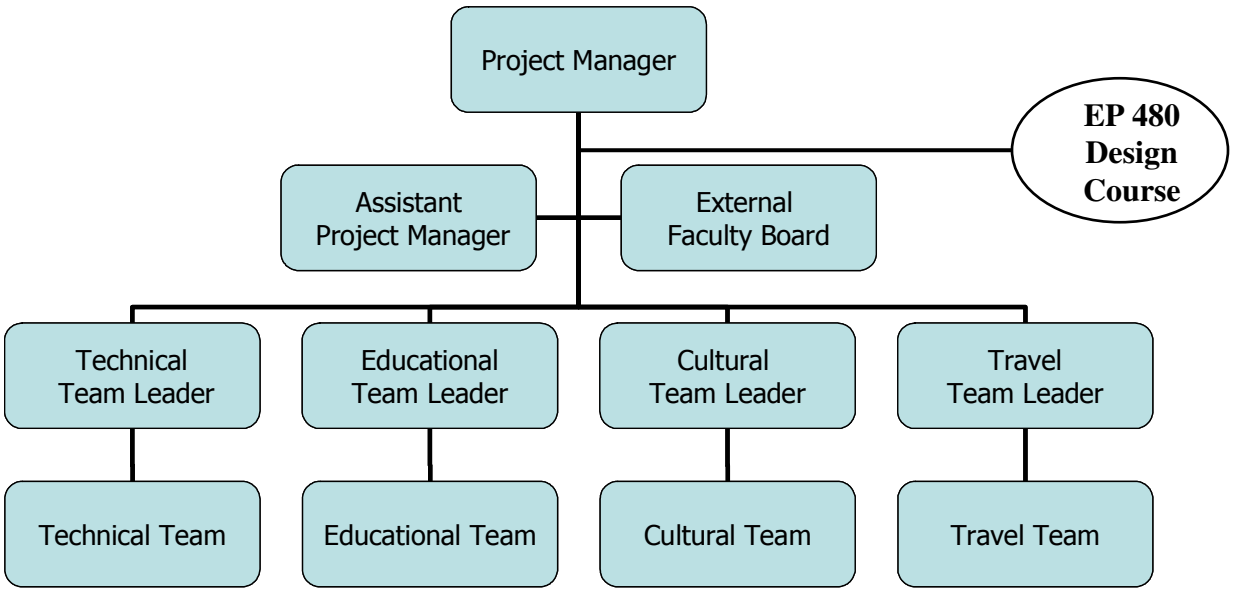
The project management system used in this study can be summarized as follows:

- We assigned roles for a Project Manager (PM), Assistant Project Manager (APM), Technical Team Leader, Educational Team Leader, Cultural Team Leader, and Travel Team Leader.

These positions are in charge of individual teams responsible for the different, but overlapping aspects of the organization. The spring design course (EP 480) serves as a "sub contractor" to EWB-LC during the spring semester; however the intent is for all teams to function throughout the school year.

- We stated that a leadership clinic should be conducted for all team leaders at the beginning of each academic year to provide those skills that students probably never learned in traditional coursework and to accommodate the rotating membership across the years. Unfortunately this was not held for unknown reasons.
- We suggested meeting types, purposes, times, and the members that need to attend each meeting type. These meetings are intended to improve communication among the group as well as provide a forum to make necessary decisions, discuss problems, develop quality solutions, and efficiently assign tasks. The first type of meeting is a general body meeting once a month to allow all members to learn about the work being done across teams, and to reflect on the service-learning experience. The second type of meeting is a team leaders meeting held weekly for the leaders to make decisions and share necessary information. The third type of meeting is the weekly team meetings for each team to get together and schedule tasks etc. And, the final type of meeting is biweekly between the team leaders and the faculty advisory board for consultation and quality control.
- We gave guidelines for communicating information to the entire club using emails and meetings.
- We developed a written system for communicating lessons learned to future members to help prevent repeated mistakes. And, we developed an equipment checklist for field visits.
- We developed guidelines for decision making for solutions and for selecting the travel teams.
- We established requirements for electing new team leaders to ensure that the most qualified candidates are in charge of the appropriate teams.
- We developed organizational charts to help members see how they fit into the club structure. A simplified chart is shown in Figure 1.
- We established an education team to educate the general public, the student body, and the chapter members, as well as to conduct community outreach.

Figure 1. 2006-2007 Organizational Tree for EWB-LC



Evaluating Baseline Perceptions of the Membership

One way to determine the effectiveness of the project management system is to find out how members perceive the organization. We administered two surveys (one for new members and one for returning members) at the first EWB-LC general body meeting on September 8, 2006. We focused on returning EWB-LC members since we wanted a baseline of student's perception of EWB-LC. Members were identified as anyone who had been to any EWB-LC event before regardless of subsequent participation. Since we also surveyed new members (first attendees of a meeting), we obtained some information about member expectations. We used concepts from Dipak K. Gupta's text, *Analyzing Public Policy* to develop the survey and defined unfamiliar terms.[9] For example, many of the new and old members did not know that EP480 is a course focused on EWB and so we included a definition. We also tried to use a mix of open-ended and Likert scale questions depending on the type of answers. For example, on certain questions we asked people to check all of the reasons they decided to attend the meeting rather then restricting their answers to one reason. On the other hand, we left open ended those questions such as *what are your goals* because there are so many unique reasons that could have been reported. To help get a general sense for member objectives, we asked how much leadership members want using a Likert Scale that "allows people to express their feelings on a continuum[8]." Below is a summary of data collected from the first surveys.

There were approximately 27 returning members at this first Fall 2006 meeting and twice as many potentially "new" members. The Fall 2006 returning membership shows slight increase from previous years with former and current EP480 students comprising the majority of the club and few non engineers.

	EWB-LC Chapter				EP 480	
Year	**Total**	**Non-Engineers (NE)**	**Returning**	**NE Returning**	**Total**	**Non-Engineers (NE)**
Spring 2004	17	3	0	0	17	3
Spring 2005	18	3	8	1	6	1
Spring 2006	23	2	3	0	14	0
Spring 2007	27*	3	7	0	12	1

*- As measured in the Fall of 2006

Gender: As expected, more men than women attended the general body meeting since women make up 28% of the engineering student population at Lafayette College. However, women made up approximately 40% of the regular meeting attendees.

Major: Among returning members, most were civil engineering majors as expected since the EWB-LC projects to date involve construction, surveying, drinking water and waste water. In the new member category, other majors were present in larger numbers however their reasons for attending may have had more to do with the opportunity to attend a brownbag. Mechanical engineering majors comprise 35% of the sophomore, junior, and senior engineering classes which is consistent with the proportion of mechanical engineering majors among the new members. A much smaller percentage of students were from non engineering majors.

Time: Both new members and returning members said that, on average they plan to work 0-50 hours per semester. This perception contrasts sharply with the amount of work students complete

for the EWB-LC projects when enrolled in the spring EP480 design course. For example, in the spring 2006, each student worked on average 125 hours.

***Participation Levels*:** Returning members indicated that their average participation level in the past was low (2 out of 5). This suggests that very few of the members who attended past EWB-LC meetings were involved in project tasks.

Purpose/Identification: Despite the low expectations for participation, two of the 27 respondents stated that they attended the meeting because they belong to a EWB-LC team. This shows some identification with the group before the year had even started.

Evaluating Changing Perceptions of the Membership

In the second survey we wanted to learn how people's perception of EWB changed over the first quarter of the school year since the implementation of the new project management system. We used primarily the same questions during the next (October) general body meeting with minor adjustments. One question we added asked about international students and specifically Latin American status to see whether international students are more interested in such service projects then American students. Unfortunately, although the meeting was very well attended, significantly less EWB-LC members attended. Part of the reason for the low EWB-LC attendance may be that the meeting was a brownbag presentation with a speaker that was co-sponsored by other groups and open to the campus community. Therefore, members may not have perceived this meeting as a general body meeting. This may be an example of the difficulties that arise when members do not identify with the larger team as discussed by Oberlender[1]. Since the meeting was not well attended, the results are not meaningful.

Evaluating PM, APM, and Team Leader Experiences

Near the end of the fall semester, we conducted individual semi-structured interviews of each team leader to understand the effectiveness of the project management system from their perspective. We asked each leader to comment on how he/she felt the five organizational issues were being addressed: communication, quality control, decision making, document management, and staffing. We taped all interviews and then summarized the results as shown below. Unfortunately, we did not include questions about service-learning education for members and for the larger campus community. However, based on observation and some feedback from faculty and team leaders, the substantive aspects of service-learning were not being conveyed to the membership formally. In other words, members were not asked to reflect on their experience, keep journals, etc. Some travel-related education occurred in terms of first-aid training and a crash course in Spanish for those attending the January 2007 field visit to Honduras. However, no formal education activities occurred for the membership to gain more of an understanding of sustainability for the communities in Yoro, Honduras.

Communication: In general, EWB leaders reported that the majority of communication that takes place within the group is done through e-mails and weekly team meetings. All leaders reported that the addition of weekly team meetings has been helpful in keeping better control of their teams. The meetings increased communication and helped the teams have a better grasp on the project progress. In several cases, team leaders who are engineering majors also reported that casual conversations with fellow team members in class are an effective form of communication.

They also noted that direct emails got a better response then general emails which got poor responses. They believe that this is the case because individuals get so many emails that general emails are often ignored whereas personal emails are read more carefully. For teams with members who were primarily non-engineers, email and team meetings were the only form of communication. All team leaders reported that it was very easy to communicate with their teams with the exception of the technical team. Because of the many sub-teams within the technical team, groups working on different technical aspects did not communicate with each other as well. With regards to leader communication, all team leaders reported that they have a very good understanding of what is happening in all of the other teams because of the weekly team leader meetings. They reported that it is a good way to establish schedules and to ask one another for work that will assist them with their own tasks.

Despite the fact that communication within the teams and among the leaders increased using the new project management system, team leaders reported that communication across the teams has dropped significantly since last academic year. Leaders reported that the segmented groups help to keep members focused on their own work, but sheltered them from the rest of the EWB-LC organization. Leaders offered two reasons for this separation. The first is that the organization has just grown too large to keep everyone as informed as they have been in the past. The second is that teams are able to complete their tasks without knowing what is going on in the other teams. Some leaders even went as far to say that it was not necessary for the people in their team to know what was going on in the other teams. This result contrasts with Oberlender's basic teamwork model, which explains the need for teams to be aware of what is going on in other groups to function well[1]. Based on our observation, EWB-LC did not conduct general body meetings during the fall semester for the purpose of disseminating knowledge about the project.

Quality Control: Most leaders expressed that in general, quality control was going fairly well within their teams as well as within the group as a whole. From within their teams, leaders said that they try to use older, more experienced EWB members to work with younger, inexperienced members to help ensure that the quality of the work was up to par. Leaders all expressed concern with the lack of experience within the organization and the large amount of new members. While all leaders were pleased with the increase in the organization's size, some leaders felt that because there was a lot of new information to teach the new members, quality overall had decreased a little bit this semester. Leaders agreed that this was a result of the large number of new members and not a systematic problem with the Project Management System. As far as quality control goes outside of their teams, leaders said that they utilize the weekly team leader meetings to check on each other and ensure that all necessary work is being accomplished. One leader said that the weekly meetings were a great opportunity for leaders to discuss how their individual projects are going as well as to ask for help if necessary. Almost every leader said they use the club's advisors as a check on the work that they do to ensure that their project's quality is up to par. Team leaders also plan to use the Professional Advisory Board as needed to help ensure quality. It did not appear that the lessons-learned forms were being used.

Decision Making: Within each team, the decision-making process is governed by one variable: the size of the group. Team leaders who have small groups reported that they were able to make decisions based on group consensus after discussing any issues that arise. For those groups that are larger, team leaders state that they try to make decisions based on the group's

recommendations. Because large groups cannot always come to a unanimous decision, team leaders reported that their procedure for decision making included listening to as many suggestions as possible from the team and then making a decision based on all the given information. Most decisions for the organization are made by the team leaders in weekly meetings where the PM and APM typically present their idea for a solution. The team leaders then have the opportunity to make suggestions and discuss the proposed solutions. Then, a solution which every leader can agree to is implemented. This again is able to occur because there are only four team leaders. The decision-making guidelines we developed were not being used for technical issues, in part because most major design decisions were already made and agreed to by the community being served. The travel guidelines we developed were loosely followed.

Document Management: In all cases, leaders reported that the document management system is very poor. All claimed that the documents on the publicly available (and backed up), internal, central server were organized a little bit better in the past, but there was still a lot of confusion within teams about where to find certain documents. In addition, leaders said that their teams were even having trouble understanding which documents contained what information. Leaders expressed that the reason that this may occur is because there is no standard way to name a file. In many cases, it is tough to decipher which copy of a drawing, or other documents is the most recent because there are no dates in the title. To help remedy this, one team leader has started to require that his/her team include the last revised date on all documents when saving drafts. Another leader suggested that only final documents should be posted on the central server and that working copies of documents would be saved to an individual's network account until it was finished. Yet another leader recommended that the document management system should not be changed too much because all of the experienced people are familiar with it. As stated, it did not appear that the lessons learned forms were being used.

Staffing: In all cases, leaders reported that they had the perfect number of people in each team. The two major issues which arose from staffing were that teams either don't have enough experienced members, or the members that they have aren't very involved. In either case it isn't the number, but the type of members that were the issue. The first will be corrected as the new members learn their roles. The second problem still needs to be addressed. As far as leaders were concerned, all agreed that there was the right amount of leadership. Leaders felt that there should be no more leaders to avoid communication and decision-making problems. They also said that they should not reduce the number of leaders because they felt that it was nice to have a small team to work with to support each other with their roles and work. A remaining concern with regards to staffing has to do with sustainability of the leaders since the current PM puts in about 15-20 hours per week on EWB-LC.

January 2007 Site Trip Summary

Pre-travel: Pre-travel is an important part of any trip. You must adequately plan for any issues which may arise during the trip as well as educate those who will be attending among other things. Therefore, the project management system outlines specific guidelines to help minimize travel issues.

For the January 2007 trip to Honduras there were several workshops planned for the group traveling. In October of 2006, ASB members met with EWB-LC members to be educated on the technical components of the trip. ASB members were given an opportunity to practice what they were doing in Honduras.
In November 2006, there was a cultural workshop presented by the Spanish Department as well as students who have traveled in the past. Both ASB and EWB-LC were in attendance. Cultural food was served and there were discussions regarding the cultural of Honduras. There was also an elementary Spanish lesson.

In December 2006, there were three more meetings/workshops held. The first one was an opportunity for EWB-LC members to get to know one another as well as discuss individual roles and responsibilities on the trip. The second meeting was a workshop developed by the Cultural Team for EWB-LC and ASB members traveling to pass along advice for what to expect while in Honduras. Presenters were both students and faculty who have traveled before. The third meeting was for EWB-LC members to finalize all plans for the two weeks.

These workshops were in accordance with the project management system. The only thing which differed was that there was no consequence for missing sessions as outlined in the PMS.

Equipment: There were two significant equipment management issues. One was pre-trip and one occurred during the trip.

There are specific procedures set up by the College when making significant purchases such as engineering equipment. For the January 2007 trip, these procedures were not followed, and therefore equipment was not purchased in time for the trip. It also caused administrative problems as well. Ultimately, it was the responsibility of the Travel Team to ensure that all equipment needed for the trip is discussed at the beginning of the semester and the procured throughout the semester.

According to the project management system, there is also a form which assigns individual responsibility for equipment being used on the trip. On the January 2007 trip, this form was not used, and individuals were not assigned responsibility for equipment. As a result, there was one bag of equipment which was lost. There were circumstances which were unavoidable due to a professor being out of town; therefore equipment could not be accessed to be distributed before students left for winter break. In the future, equipment will be individually assigned before leaving school.

Fieldwork Decisions: As previously discussed, communication is one of the key components of management. Accordingly, guidelines were set in the project management system to ensure that there was open communication to allow for better decision making and staffing in the field.
Every night EWB-LC members met with each other as well as with the town mayor to discuss plans for the next day. This allowed all leaders to create a plan that was acceptable for all persons as well as make adjustments for any changes which need to be made. In the beginning, ASB was not briefed on a nightly basis for the next days plans; they were told the next day what they were doing. Towards the end of the week, EWB-LC started explaining what was happening

the next day. ASB responded very positively to this and there was more of a sense of inclusion; one of Oberlender's components to building a strong team.

Reflection: As cited by the Higher Education Research Institute at UCLA[3], reflection is a significant component for service learning. In the project management system it states that reflection should be held nightly during travel and students should keep a journal for reflection.

Both of these things occurred on the January 2007 trip. Nightly reflections, led by ASB, took place and time was set aside for journal writing. Overall the group seemed to grow closer because they were able to share their experiences and feelings. In addition to group dynamics, the learning experiences for most individuals were enhanced by hearing about others experiences.

Because reflection was an integral part of travel, it is recommended that students continue to reflect as a chapter in the United States. Monthly general body meetings provide an excellent venue for the group to reflect on the work that is being done. Smaller group reflection can take place monthly at the weekly team meetings.

Definition of Roles: It is important to define the roles of all of the equal partners in the Community Agreement. This includes, but is not limited to, ASB. It was clear when we arrived in Honduras that the community was not initially receptive to the ASB members and their role in the project. This was a result of not establishing a community agreement in writing when the project began. This must be corrected for future projects to include roles for all of Lafayette groups as well as the community.

Post-travel: There are two components of the post-travel assessments; the post-trip report to EWB-USA, and the post-trip report to the EWB-LC.

The first component, the post-trip report to EWB-USA, was done in a collaborative effort by all who attended. The PM informed all of us of our specific responsibilities for the report and set a deadline for returning our portions. She then compiled all of the pieces and created a single report which took about 3 weeks to complete. The report to EWB-LC was delivered as a presentation at the first general body meeting of the semester. Along with the trip-update, elections were held, and other club updates were given by various team leaders.

Efficiency Ratios and Project Duration Comparison

We were able to calculate an efficiency ratio, dollars spent per villager served, for EWB-LC's completed project in Lagunitas. Our goal was to compare past EWB-LC project efficiency as compared to other similar organizations. Another goal was to establish a baseline of information that future EWB-LC projects could be compared to in order to determine quantitatively whether or not this is an effective project management system.

EWB-LC: Table 1 shows a breakdown of project costs for the completed project in Lagunitas that included a spring collection box and watershed fencing, distribution piping, yard faucets, and greywater removal pits. This holistic cost includes a combination of cash outlays as well as

in-kind labor and donations. Based on the 400 people served, the efficiency ratio is approximately $32 per person as shown in Table 2.

In terms of duration, the Lagunitas project started in January 2004 with assessment and design and all infrastructure systems were installed with associated training by January 2007. The associated travel cost that is not included in the project costs was $14,682 to cover two site assessment trips (May 2004 and January 2005) and three implementation trips (August 2005, January 2006, and January 2007. In comparison, the current project in La Fortuna began in January 2006 and system installation and training is expected to be complete in August 2007. The projected travel cost is expected to be $12,300 for two site assessment trips (January 2006 and August 2006) and one implementation trip in August 2007.

EWB-LC versus other EWB Chapters: We researched other EWB student chapters who were involved with water distribution systems in Honduras to establish a baseline to compare EWB-LC's efficiency ratio to. By keeping with projects done in Honduras, we can assure that the differences in project costs are not associated with different costs of living. After doing research on the EWB-USA website as well as individual chapter's website, we found that financial information about other schools projects is not readily available. EWB-USA has not responded to our request for financial or project duration information. We are currently awaiting information from the EWB chapter at the University of Pennsylvania's (EWB-PENN).

EWB-LC versus Water for People: According to the Water for People (WFP) website, "Water for People helps people help themselves. We facilitate the development of simple, affordable solutions appropriate to the particular geographic, social and economic needs of a community[10]." They do this by incorporating four basic principles into every project that they are involved with[11].

1. **Develop a sense of community ownership.** The community must be a part of every step of the process. They are the ones who will use the system, fix the system, and manage the system long after international help leaves. This is why the community needs to be involved right from the start. They need to be involved with the design and the implementation. The community needs to know how the system works so that they can fix it when the engineers are gone. In addition to being involved with these components, additional workshops may need to occur to discuss further O&M topics and finance topics.

2. **Develop a relationship with the local governments.** After international help is gone, the community may require additional help. By building a relationship with the government will provide a venue to keep important documents filed properly and organized. Because local engineering bodies will request to review the drawings, there will be another group of people who can solve problems and help the community.
3. **The private sector needs to be involved.** Local contractors need to be involved with the construction of the projects. If additional skills are required, it is best to get local people who know how to work in the local conditions to help with the work. In addition, when designing a system, local materials must be used. If something breaks and needs to be replaced, it must be easy to obtain, otherwise the system may not be used for a long time.
4. **Local NGOs must be involved.** When international help leaves, there needs to be an independent organization which the community trusts and has worked with in the past to help them with any problems which arise.

Based on these principles, WFP's philosophy assumes that no community, no matter how isolated it seems, is truly isolated. Instead, such communities are part of a larger context that includes the government, the private sector, and NGOs. As such, WFP maintains that evaluating project efficiency cannot be done with just an efficiency ratio, and WFP does not necessarily keep statistics such as the "duration of the project". Because these are sustainability projects, and WFP does not actually do the work themselves, there is no defined "duration".

Given the above considerations, WFP did provide a contribution breakdown so that we could calculate efficiency ratios for four of their recently completed projects. The La Union- El Dorado (LUED) and Corralito (COR) projects were both latrine projects. The Casitas (CAS) and San Luis (SL) projects were both water distribution projects however we are not certain of all of the system components or the type of water supply and treatment selected. WFP provided the population served for the latrine projects, however we did not have access to the population for the water projects which are more relevant for our comparison. As such we used the overall estimates from the WFP website that state "*Water For People began working in Honduran communities in 1994 and has focused on villages in the western part of the country around San Pedro Sula. It supports 10 to 15 communities each year, helping approximately 5,000-15,000 people obtain safe drinking water, sanitation services and hygiene education.*" In other words, we assumed each project in Honduras serves approximately 1,000 people.

Table 2 shows the project costs and Table 3 shows the efficiency ratio for the WFP projects as between $31 to $40 per person for latrine projects and $30 to $42 per person for water projects. This compares very well with the efficiency ratios for EWB-LC on their first project despite the youth of the organization as compared to the more established WFP. We need to evaluate the projects costs in more detail to consider the various contribution sources as an indicator of the needed partnerships for sustainable projects. Also, note that this is a very initial comparison that should be tracked over time.

Table 1. Lafayette College Lagunitas Project Costs*[12]

Lafayette College LaGunitas Project Costs		
Contributor	**Lempiras**	**US Dollars**
EWB-LC	L. 124,290	$6,611
Community Contribution**	L. 71,288.00	$3,792
NGO	L. 30,000.00	$1,596
Tribe of Lagunitas	L. 9,000.00	$479
Local Government	L. 5,075.00	$270
Total	L. 239,653	$12,748

*- project costs include – equipment, materials, local construction management and specialized services, materials transport, water rights, land purchase, regulatory costs, and all other costs associated with the project.
**- Includes work done "in kind". Work done "in kind" is defined as the value of the work done by the villagers.

Table 2. Water For People Project Costs*[13],[14],[15] and [16]

Water For People	La Union-El Dorado		Corralido		Casitas		San Luis	
Contributor	**Lempiras**	**US Dollars**	**Lempiras**	**US Dollars**	**Lempiras**	**US Dollars**	**Lempiras**	**US Dollars**
WFP	L. 247,369	$13,157.90	L. 65,000	$3,457	L. 121,248	$6,449	L. 194,916	$10,368
Community Contribution**	L. 64,200	$3,414.89	L. 104,000	$5,532	L. 157,042	$8,353	L. 220,533	$11,730
NGO	L. 11,700	$622.34	L. 30,000	$1,596	L. 250,363	$13,317	L. 366,920	$19,517
Tribal Contribution	L. 0	$0	L. 0	$0	L. 0	$0	L. 0	$0
Local Government	L. 56,032	$2,980.43	L. 5,900	$314	L. 35,650	$1,896	L. 0	$0
Total	L. 379,301	$20,176	L. 204,900	$10,899	L. 564,303	$30,016	L. 782,369	$41,615

*- project costs include – equipment, materials, local construction management and specialized services, materials transport, water rights, land purchase, regulatory costs, and all other costs associated with the project.
**- Includes work done "in kind". Work done "in kind" is defined as the value of the work done by the villagers.

Using these project costs, I was able to find the following efficiency ratios for each project.

Table 3. The Efficiency Ratio

	EWB-LC	La Union-El Durado	Corralido	Casitas	San Luis
Total Cost ($)	$12,748	$20,176	$10,899	$30,016	$41,615
Total Cost (L.)	L. 239,653	L. 379,301	L. 204,900	L. 564,303	L. 782,369
People Served	400	650	271	1000	1000
$/Person	$31.87	$31.04	$40.22	$30.02	$41.62
L./Person	L. 599.13	L. 583.54	L. 756.09	L. 564	L. 782

People served for CAS, SL are estimates based on generic information on the Water for People website. No information was provided.

Future Work Plans

The results reported in this paper are part of an ongoing study over the 2006/2007 academic year. As such, there are several more steps that will be completed between March and April 2007. These include the following:

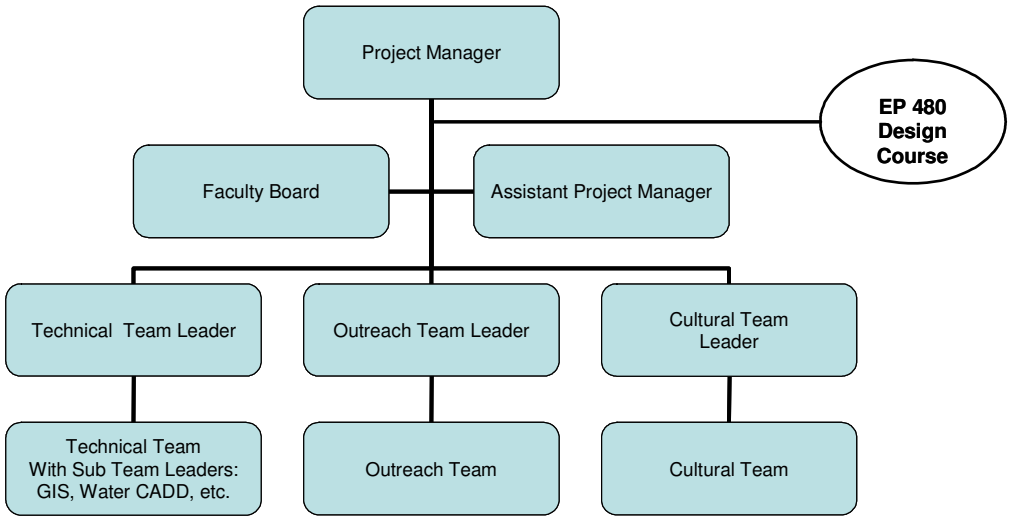
- ***The Efficiency Ratio and Project Duration.*** As more schools report information to us, we will continue to establish a baseline for comparison with the efficiency ratios.
- ***Evaluating Member Experiences with Survey.*** We will conduct a final survey of the membership that focuses on their perceptions of the organizational issues facing EWB-LC such as communication, decision making, staffing, document management, and quality control; as well as the effectiveness of the new project management system. This survey will also include the same statistical information as the previous two such as major, class year, gender, etc. to track membership over the academic year. To avoid the problems of the second survey, we will conduct these surveys at the individual team meetings (as opposed to a general body meeting).
- ***Evaluating PM, APM, and Team Leader Experiences using Semi-structured Interview 2.*** The purpose of this second team leader interview is to see how the leaders perceive the effectiveness of the project management system during the spring semester when the EP 480 design class is taught. In the past, this design course adds both benefits and challenges to the sustainability of EWB-LC since students do not need to be actively involved in the chapter to take the course, however most of the tedious work is done in this course.

Conclusion

Based on the results, it is clear that although the project management framework had improved several aspects of communication, decision-making, and quality control, there was still room for improvement. In particular, several aspects of the project management framework were not followed and could not therefore be evaluates. These include a) a leadership clinic was not conducted at the start of the academic year, b) general body meetings did not occur as often, or as specified, c) several documents were not being used, and d) the education team was not conducting the necessary membership and campus education about sustainability, service-learning, etc. In addition several components need to be added to the project management system including a) scheduling for each team and across the teams, and b) service-learning formally incorporated into EWB-LC activities. In addition, the travel team did not have enough tasks to continue functioning as its own group, therefore the travel team tasks were transferred to the PM and APM for Spring 2007 with an appointed travel leader for each group going to Honduras. In contrast, the technical team was too big for only one leader because of the much larger scope of work in that team. And, the education team (now known as the Outreach Team) needs structured mentoring and/or guidelines so that it operates as needed.

The organizational changes can be summarized in the following organizational tree. The team leaders also agreed to host general body meetings specifically focused on bringing EWB-LC together to discuss/reflect on accomplishments and challenges. The remaining problem is the need for an improved document management system and improved scheduling. Besides project management issues, we also found that there is little publicly available information about the effectiveness of such service-learning efforts for the communities they serve. Such information is needed so that organizations can both continuously improve and so that other organizations can benefit from benchmarking data.

Figure 2. Revised Organizational Tree for EWB-LC



As stated earlier, this model is meant to be used by service learning groups of all kinds, not just engineering groups. The organizational structure can be generalized to fit any group by adjusting the titles and roles to fit the needs of the organization. We hope that other organizations adopt similar models and share the information and lessons learned with other service-learning groups so that these groups themselves are sustainable.

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