Designing Service Learning Projects for Freshman Engineering Students

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***Abstract*—Within the Department of Freshman Engineering at the University of Pittsburgh, a study was conducted to assess the value of a service learning course for freshman honor's engineering students. This venture was based on the success of using service learning as an educational tool for undergraduate engineering students at many universities world wide. At the University of Pittsburgh, all students entering the school of engineering are required to enroll in a two-semester course in introductory engineering analysis and programming. The student population chosen for the service learning course experience included the honors' students. A different freshman experience was created that included a fall course which covered the material contained in the traditional two-semester introductory course at an accelerated rate, and then a spring semester service learning course. This paper will focus on the challenges in developing a service learning specifically for freshman engineering students.**

***Index Terms*—Freshman Engineering Students, Honors students, Service Learning.**

I. INTRODUCTION

The primary goals in offering a service learning project within the framework of a traditional curriculum is to ensure that students understand the impact of engineering projects on society as well as the social contexts within which they operate, develop confidence in the students' ability to solve problems, help the students function successfully and comfortably in a professional engineering environment, and to understand and appreciate what it means to be a professional engineer

Service learning has been shown to do this while also providing an experience that is both fulfilling and enlightening [1-2]. Many engineering students are overwhelmed by the workload of the engineering curriculum, and are not stimulated by the course material. Some students lack the maturity or experience to understand how the engineering curriculum will be of value to them in the future. They have not yet been exposed to the variety of opportunities that will be available to them upon completion of an engineering degree, nor do they understand the skills they will need to ultimately be effective and of value in a professional work environment. With such an imposing challenge facing them as engineering students and little understanding of how and where their education will take them, many students lack the confidence in themselves to succeed. This can lead to constant anxiety and struggle in their chosen major. Research suggests that service learning can address these issues more efficiently than traditional courses because service projects have an inherent purpose, to solve a problem for a community in need [2-3]. Additionally, projects that deal with poverty provide obvious answers to students struggling with the question, "Why am I studying engineering?"

The most immediate challenge is the establishment of community partners through which appropriate projects must be identified that fit the needs for freshman engineers. The second fundamental challenge is that of setting forth the desired outcomes of the course, and developing the means by which these outcomes will be achieved. While the challenge of developing community partnerships and appropriate projects are a necessity to conduct such a course, and can be very difficult, it was found that the most critical challenge in successfully implementing and sustaining the course was the latter. Identifying the desired outcomes of the course involves evaluating the needs of not only the students, but also the community partners as well as the instructor. This challenge can be summarized by the following three steps:

1. Determining what the students should expect to learn from the course, as well as the processes through which they will achieve these expectations.
2. Determining the expectations of the instructor in terms of not only the standards by which the instructor will grade the students, but also of student behavior in class and with the community partners.
3. Identifying what the community partners should expect to contribute and expect to gain by agreeing to become involved with the course.

Though these elements seem somewhat vague upon first review, the expectations and course outcomes must be carefully laid out and communicated from the first day of class in order to maximize the level of satisfaction experienced by not only the students, but also by the community partners and the instructor(s). Furthermore, it is also vital to reinforce these expectations and evaluate whether they are being met at various points during the course via survey and reflection. Although the community project is the fundamental tool with which a service learning course is conducted, the specifics of each project are incidental; it is through determining, clarifying and reinforcing the expectations that all parties involved will have a positive and valuable experience.

II. AMBIGUITIES OF SERVICE LEARNING

The literal meaning of "service" and "learning" and the relationship between the two can vary among the disciplines for which it is used. The meaning of "service" is straightforward, though the degrees of service can vary from volunteering in a soup kitchen, participating in a Habitat-for-Humanity build, participating in K-12 education, or even participating in a third-world community

development project. Nevertheless, service implies a transfer of time, skills, or resources to an underserved segment of society. Therefore, collaboration with a partner organization is often necessary. "Learning" is more ambiguous – it can refer to learning about community service, learning about the organization for which the service is being performed, learning about the population served by a non-profit organization, learning about how to perform a specific service, learning about various aspects involved in performing a service, or some combination of the above.

The relationship between "service" and "learning" can therefore be both direct and indirect, i.e. learning about service versus learning through service. The characteristics of the course, the project, and the community partner often lend themselves to one or the other. The challenge is to prevent students from feeling as if they've merely volunteered their time and learned nothing about engineering, or from becoming absorbed only in the course material related to their project and not gaining from their involvement with a community organization. A balance must be struck between the technical and non-technical objectives of the project.

We have found that service learning with freshman can be a valuable educational tool when designed to develop the student's sense of value and direction. These experiences have taught skills such as team dynamics and professional communication, and help engage the students in the community surrounding their university [4]. A fundamental challenge in developing a successful and rewarding experience for each student is the identification of appropriate community partners and projects.

III. SERVICE LEARNING FOR FRESHMAN ENGINEERS

Very rarely have service learning courses been conducted entirely by a team of freshman level engineering students. There is a preconceived expectation on the part of students, instructors and community partners that the primary value of a service learning project should involve some form of engineering analysis or design which results in a deliverable of value to the community partner. Although this can be a valuable facet of such a course, it is an inherently difficult expectation to meet for a team comprised entirely of freshman engineering students. It establishes an expected outcome which can very easily result in dissatisfaction from the perspective of both students and community partners, as was our experience with one of the projects performed in our first year pilot course in 2006.

After our pilot, we concluded that the specific problem a team attempts to solve, the possible engineering skills required to address the problem, and the expected deliverables should not be the focus of the course, but rather a motivator. The expectations of the community partner should be clearly spelled out to communicate that they will be working with and contributing to the development of a team of first level engineering students, and in return should expect professional courtesy and communication, specific and limited time requirements, and the potential for the solution of a problem of value to their organization. The elements of the students grade will be based primarily on how they interacted with their client, how they functioned and developed as a part of their team, how well they worked to solve their problem, and the level of satisfaction felt by the client; it should not be based significantly on whether the intended deliverable was achieved as proposed. This conclusion leads to the question - what value does a service learning course for freshman engineers provide?

IV. THE VALUE FOR STUDENTS

Students benefit in different ways from different aspects of the coursework. We have found it helps to improve retention, to develop students' accountability and self-reliance earlier than is typical, to improve student confidence and performance in co-op positions and summer internships, to help students understand how course materials will be used in their future, and to encourage community involvement. The project aspect provides real-world experience and a concrete starting and ending point, simulating the real-world project implementation experience. The service-learning aspects introduce the concept of engineering as a tool for helping society, the importance of understanding customer needs, and introduce an invaluable depth to the experience of engineering. An experience like this early in the professional career is exciting and stimulating, as the most basic assumptions in our daily lives are challenged. Those moments, when students' senses are peaking, are opportunities for transformational educational impacts that can have ripple effects on their future lives and careers.

A. Project-Based Coursework

The benefits of project-based coursework have been well-documented [5 - 12]. Project based learning can help to develop the higher order critical thinking, life, and self-management skills that are so important for any young adult. The project format also allows students to more actively engage in learning, delve deeper into an issue, makes the content more meaningful, and is an effective way to engage multiple different learning styles into one project. Students are empowered to take initiative and responsibility for their own learning, and ultimately make critical choices as to which part of the project process they wish to explore [13]. One of the key elements of project-based coursework and employment in the engineering field is interaction with and accountability to a client. Designing to satisfy the needs of a client, reporting information clearly to keep your client updated on progress, and dealing with changes requested by the client are all integral parts of the project cycle. Our students have shown, again and again, to rise to these newly introduced challenges and gain a sense of accomplishment that a traditional lecture-based course cannot match. Additionally, project-based learning promotes the development of project-management skills, teamwork, and the ability to effectively schedule around other commitments. These life-skills are important to any working professional, but specifically the engineer of today. As globalization and technical competitiveness are changing the landscape of the job market, a new approach is needed to train these engineers [14, 15]. Project-based learning has consistently been shown to be one of the most effective strategies for this purpose.

B. Service-Learning

Benefits of service-learning to students involved are less documented, as the phenomenon of service-learning has grown out of the project-based learning paradigm, but practitioners of service-learning have become convinced it is an effective tool in many aspects of engineering educa-

tion. Over the years researchers have been garnering evidence of the short and long-term benefits of service learning [16, 17] and urging its addition in standard teaching curriculum. Service learning has a distinct advantage over traditional teaching techniques in that it adds two additional elements to the obvious goal of learning course content: the local community is served by students, and those students are then forced to reflect on the connection between the course educational objectives and the experiences they had in the field. Education ultimately is meant to produce positive results for society, and this point is inherently reinforced through the service-learning experience. Combining learning and service objectives ensures that both the community partner and the students providing the service receive benefits from the interaction. In a lucrative field such as engineering, service learning is one opportunity for students to give back to their local community, learn a about the personal and moral merits of engineering, and gain a understanding of the struggles that underserved populations encounter. Engineering as a field was developed to respond to the needs of the community, and service learning provides an experiential framework for this [18 - 21].

V. THE VALUE FOR AN ENGINEERING PROGRAM

These "soft skills", which are very effectively taught using a service learning course, specifically address the objectives and program outcome criterion set forth within the ABET Engineering Criteria [22]. The objectives of ABET accreditation are to

1. Assure that graduates of an accredited program are prepared adequately to enter and continue the practice of engineering;
2. Stimulate the improvement of engineering education;
3. Encourage new and innovative approaches to engineering education;
4. Identify these programs to the public.

A service learning course for engineers provides a unique methodology for improving engineering education by providing students both a classroom and real world learning environment, thus effectively learning skills beyond the traditional course material. This increases their effectiveness as engineers in the future work force and their value to the world community as problem solvers. Furthermore, by teaching these skills through service to a community organization, not only is the public becoming involved with and benefiting from the student's education, they are also learning more about the role of engineers in society. Thus, technically oriented students are exposed to non-technical issues, and the general public is exposed to some of the technical aspects of design and problem-solving.

The ABET accreditation criterion for program outcomes and assessment include among others: an ability to apply knowledge of mathematics, science, and engineering, an ability to function on multi-disciplinary teams, an ability to identify, formulate, and solve engineering problems, an understanding of professional and ethical responsibility, an ability to communicate effectively, the broad education necessary to understand the impact of engineering solutions in a global and societal context, a knowledge of contemporary issues, and an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

All of these criterions are outcomes of a service learning course for engineers. The outcomes listed above cannot all effectively be reached through a single traditional course. Introducing the concepts and true importance of professionalism, communication, team work and problem solving in a service oriented program forces students to focus on how their engineering education can and will be used following graduation. It prepares students for what to expect when put in a work environment. Furthermore, it results in an improved reputation of an engineering program, as the quality and work-preparedness of its students increases. While experiencing the thrill of solving a problem which is of value to a community partner, students become drawn in to their course material and fine tune the development of their problem solving skills.

In short, a service learning course for engineers results in more engaged students who more deeply appreciate their skills as engineers and the value of their education to themselves and to their community.

VI. LEASONS LEARNED

In the spring semester of 2006, a pilot course was offered. For the pilot program, ten projects were undertaken with four community organizations. The experiences of the students were wide-ranging as determined through the reflection components of the course as well as through a series of surveys. In particular, some of the teams felt much more rewarded by the experience than the others, and some were left feeling let down and unfulfilled by their projects and results. What the majority of students reported as being the greatest challenge and most important lessoned learned through their project experience was how to function effectively as a team. In fact, many students reported being surprised by how difficult yet significant a role the team dynamic aspect of the course played in conducting their projects, regardless of whether or not they felt fulfilled by their results. Following completion of the pilot course, we concluded that the three fundamental challenges in maximizing successful outcomes of a service learning course for freshman engineers are 1) project selection, 2) establishment, communication and reinforcement of expectations for the students, community partners and instructors, and 3) since skill set of freshmen engineers is limited, the focus of the experience should not be on the specifics of the project but rather the process and skills required to solve a problem which meets the needs of and satisfies the community partner. Furthermore, the expectations set forth should not only prepare the students for what they are intended to learn from the course but also for what constitutes a "successful" outcome.

A. Setting Expectations

Based on the pilot results, we modified the future year projects and the expectations presented to the students at the beginning and throughout the course. To improve the experience for the students, the following expectations were communicated on the first day and reinforced as the course progressed. For their service learning projects, each student should expect: 1) To have a unique learning experience; 2) To solve a "real world" problem of value to a community organization; 3) To learn about and be challenged by truly working as a team; 4) To learn how to listen to and understand what your client really wants

from you, and not what you think they should want from you; 5) To develop professional communication skills and to begin to see yourself as a professional that is uniquely you; 6) To feel pressure by nature of the fact that your work is meaningful and of value to an organization who wouldn't otherwise be able to have this work done; 7) To develop an awareness of what it takes to "do a good job" and to be of value to an engineering team; 8) To develop an awareness of your own personal strengths and weaknesses with respect to working as part of a team or with your client; 9) To develop an awareness of what real world engineering and problem solving is like in comparison to classroom problems; 10) To know how to work towards a solution which is not ultimately available "at the back of the book", and how to evaluate if the solution you've achieved is valid and appropriate; 11) To feel uncomfortable at times with your team or with your client; 12) To have things go very wrong, and to have the experience of working through whatever has gone wrong; 13) To feel under-challenged; 14) To feel over-challenged; 15) That each person and each team in your class is going to have different experiences and reactions to their experiences than you will; 16) To feel more connected to the communities surrounding the University of Pittsburgh, and to feel satisfaction when you see the positive impact you can have on your community; 17) To develop a sense of your potential value as a person and an engineer; 18) That their clients treat them with respect and professional courtesy.

At first glance the list of expectations might appear to be long. But we have found that over a long time frame you will be involved with a very diverse population of students, clients and projects and as such you need to develop a list of expectations that is just as diverse.

VII. DESCRIPTION OF COMMUNITY PROJECT

Including the pilot year to the present we have had 380 students involved in 95 projects with the following breakdown: in 2007 we had 66 students in 17 different projects, in 2008 we had 64 students in 17 projects, in 2009 we had 65 students in 16 projects, in 2010 we had 56 students in 14 projects, in the spring of 2011 we had 52 students in 12 projects, and in 2012 we had 37 students in 9 projects. The following is a brief description of each 2012 group's community projects (These are typical for all 95 projects). The value of the list is to gain an understanding of the type and depth of the project.

Team 1: Create an organizational system that will store all relevant information relating to Team Pittsburgh's trip to the U.S. Transplant Games. This system was to be functional and manageable, while easily accessible and aesthetically pleasing. This project serves to satisfy the organizational requests of the leaders of Team Pittsburgh. After the National Kidney Foundation withdrew form hosting the Transplant Games in 2011, the task of organizing the participant/player information had fallen onto the University of Pittsburgh Medical Center (UPMC) nurses. With the result, players and participants who were at the Transplant Games last year were not adequately informed about the schedule of their events. This led to confusion, withdrawal from events and in some cases under performance.

Team 2: Create a UPMC patient interaction system which facilitates underprivileged patients with interpreting the alarms on their heart-monitoring devices. Engineers have designed two life saving devices that have greatly increased the quality of life of heart failure patients: the HeartMate II and the HeartWare ventricular assist system. These devices successfully replicate the function of the human heart, and the project goal was to enhance the effect of these devices in illiterate, disabled, and non-English speaking patients. Hospitals are unable to discharge some patients due to their inability to properly operate their left ventricular assist device (LVAD). The aim was to create a more simplified, compact manual, which will allow the patients to easily reference information concerning their device, and produce, a website for patients and their families which would enable them to develop a greater understanding of these ventricular assistive devices.

Team 3: The objective of this project was to research and help design three one-credit bioengineering labs in the areas of cell biology, biomechanics, and biotransport. The design process entailed gathering information on existing labs and making recommendations concerning scheduling, equipment, and spacing that will facilitate the current system's transformation into a three one-credit lab series. Since the laboratory system is undergoing a period of transition, the client wished to know the specifications and current practices of the functioning labs as well as any improvements that could be made in the new one-credit format. This type of re-evaluation of the current bioengineering lab system was essential in order to accommodate an expanding demand for bioengineering courses as the department anticipates a significant influx of students in the near future.

Team 4: This project was to construct educational material for the Almono Bike trail which runs along the Monongahela River, just southeast of downtown Pittsburgh. The primary goal was to build a kiosk that described the route and other connecting trails. In addition, research was conducted to find historical pictures and information that could be placed strategically along the trail in order to give pedestrians an idea of the history associated with the local area, including many of the steel mills which once operated along the trail. The trail runs through a local suburb of Pittsburgh called Hazelwood, which has experienced a severe economic decline since the collapse of the steel industry. This project seeks to stimulate the local economy in Hazelwood by bringing in tourists to experience the new amenities to the trail.

Team 5: The objective of the project was to help improve the recreational and intramural facilities at the University of Pittsburgh. In order to accomplish this task, input was gathered from current Pitt students about what facilities they would like to see improved upon or even added. In addition, the project focused specifically on Trees Hall which houses many of the university's athletic facilities including basketball and racquet ball courts. A survey was conducted to gather input from current Pitt students about what changes they would like to see in Trees Hall. Finally, taking into consideration those student responses, a new floor design was proposed for the large gym in Trees Hall, targeting specifically the issues of storing belongings and seating.

Team 6: This group had two goals. The initial project objective was to successfully represent the University of Pittsburgh with a well-designed and interesting display composed of Lego Mindstorm Robots at the Carnegie Science Center, to increase interest in the University and

also engage K-12 students into engineering. The Lego Mindstorms were programmed to perform exciting tasks and operations for children to view and enjoy. The second stage of this project was to compose a day-by-day in depth curriculum for the University's Investing Now summer K-12 course on Lego Mindstorm Robots. The purpose of this part of the project was to create a detailed and effective course to have others learn how to operate the robots. In addition, the goal was to create a stimulating and exciting program for Investing Now, so that the Lego Mindstorm summer course was a success and the University of Pittsburgh was held in high regard as a result, to future students, their families, and all who hear of the program.

Team 7: The objective of this project was to provide an alternative plan for the city's Kennard Park, based on ideas from the current city master plan provided by the Pittsburgh Park Conservancy. Kennard Park, is in a state of complete disrepair in one of Pittsburgh's most poverty stricken areas in downtown Pittsburgh. In redesigning the park, the goal was to attract more people to the park who may see the nearby restaurants and shops which could potentially strengthen the local economy. The design took into consideration the objectives laid out by the Conservancy's Greenprint plan, as well as those specified by the client. The new park would draw in the surrounding Hill district communities and encourage development in the area. Completing this project would potentially satisfy the Pittsburgh Park Conservancy's vision which is to "establish visual and physical relationships between the Hill District and the neighborhoods and rivers that surround it".

Team 8: The Oakland Planning and Development Corporation (OPDC) requested a plan to enhance the visual appeal of the street block at the intersection of Atwood and Louisa Street. Louisa Street, at the heart of the University of Pittsburgh's Oakland campus was in a state of disrepair thereby potentially damaging the reputation of the Pitt campus and potentially discouraging prospective students from attending. By redesigning the street and its accompanying staircases, the goal was to stimulate the local Oakland economy.

Team 9: The objective of this project was to design a floor plan for the Community Human Services Corporation (CHSC) that serves underprivileged members of the South Oakland community with complimentary food. The food pantry building was not optimally designed to facilitate the transfer of food to the incoming patrons. This has resulted in long waiting lines for patrons and in some cases not enough food due to lack of storage space. The primary goal of the project was to submit preliminary floor plans that would make the food pantry operation a more efficient process, while also reorganizing the offices and meeting spaces.

VIII. COURSE STRUCTURE

The learning objectives of the course are to develop an awareness and begin development of A) Fundamentals of the engineering design process, B) Essential skills for working in a team environment, C) Professionalism /communication skills, D) Fundamentals of project management, D) Engineering for community service, and E) Personal potential to be successful as an engineer. The course challenge is achieving course goals with first year engineering students that are not accustomed to independent research, do not yet have engineering training, that struggle with open-ended poorly defined projects, where course expectations apply differently to each project, and there are no answers at the back of the book. In addition, there are the challenges of finding community partners that are willing to work with Freshman, identifying appropriate projects within the student skill sets, transportation issues such as freshman do not have cars, managing 10 – 20 different projects, managing the quality of the results, and allowing students to work through project challenges on their own (taking ownership). Thus, the course is structured to combine the highlights of engineering in industry as well as research in academia. As such, a grade is allocated to the students based on their professional relationship with their client, as well as their ability to produce effective solutions to their engineering problem through research.

A. Course Components

Students are required to have client-review meetings with their client and/or instructor on a bi-monthly basis. The highlights of the meeting are then summarized in a mandatory progress report, which the students submit to their client as an update and their course instructors for a grade. The progress report outlines what was discussed at any meeting, what accomplishments have been achieved to date, and what task items remain to complete the project. The instructors of the course are in constant communication with the clients, so that a fair grade is allocated to the student groups for their progress report.

The rest of the course is designed to encapsulate the endeavors of graduate students by requiring the service learning students to present research "proposals" and research "final reports". Midway through the semester, the freshmen students of the service learning course are required to submit a 10 page proposal to the instructors and the clients for a grade. In this document, the students seek to acquire the approval from the client and instructors for their proposed solution to the engineering problem. The document is also accompanied by a 20 minute oral presentation of the proposal. The proposal requirements are structured similarly to the guidelines designated by National Science Foundation for research grant proposals. The first section of the proposal required for the service learning class is the "significance" section. This section is divided into three "sub-sections", the first being the project objective, stating clearly and concisely what the purpose of the project is. The second sub-section of the significance section is the project "background". This subsection describes the limitations and difficulties with the current status. That is, the background section answers the questions, "Why is this project important and what is wrong with current status that makes this project so useful?" For instance, if the interested reader looks to the project description of Team 9, it is seen that this group worked on a project to redesign a local food pantry building where the employees distribute food for the less fortunate. Prior to the redesigning, the food pantry building was small which led to significant foot-traffic and insufficient storage space. As a result, there were long waiting times for the incoming patrons and in some cases not enough food for everyone due to the paucity of storage space. These are the issues discussed in the background section of the proposal and they adequately describe why the project is needed. The third sub-section of the significance section is the project "motivation and impact." This

sub-section provides a high-level overview stating what advantages the proposed system would have over the current state. Again, using Team 9 as an example, "the successful redesigning of the food pantry building would potentially lead to less wait time for patrons and enough food for everyone" as written in their motivation and impact section. The next section after significance is the "technical approach". This is the bulk of the proposal and is thus allocated the most percentage weight for grading the proposal. In this section, the students layout a clear strategy or work-statement describing how they will complete their project. The technical approach is to be filled with technical detail on the procedure required for finishing the project and yet this section must be written as clearly and concisely as possible. The third section of the proposal is the "preliminary data" section. Here the students report the results to date of their project and supplement these results with figures and tables and more technical discussion. One section of the discussion is a list of possible solutions. The students were expected to present at least two alternatives at this phase. The goal of this first presentation is to discuss the alternative designs and have the client pick one for the final design. The proposal closes with a summary of the deliverables and listed references.

At the end of the semester, the students submit their "final report". The structure of the final report is similar to the proposal, except that the "preliminary data" section is replaced with "final results". The final results section becomes the bulk of the final report grade. Additionally, the "technical approach" is often different in the final report as the students have encountered several barriers and challenges throughout the semester thus requiring them to alter their approach. The final report concludes with a "recommendations" section where the students suggest any necessary future work on the project to their clients. Both the proposal and final report documents are supplemented by oral presentations, which are also graded by the clients and course instructors. Presentation skills are developed throughout the term, by having each group make bi-weekly progress report presentations to the entire class. During these presentations feedback is provided stressing the importance of eye contact, voice projection and effective power-point slide development.

Finally, the course also follows proper laboratory course procedures, requiring the students to keep and regularly update a lab-notebook. A fundamental component of any service learning course is that of reflection. It is a critical mechanism to help the students grow from their experiences and to evaluate what they are in fact learning in the course. The students are required to use the notebook during class lecture, when the instructor provides guidelines for completing their proposal/final report or other specific tasks related to each project. The students also use the notebook to document their observations and results throughout the term, as well as any challenges and barriers that have been encountered. The notebook also needs to include weekly journal entries that includes a summary of the community organization and the project, a review of an aspect of technology involved with the project, and reflection on their experience with the specific project as well as the concept of service learning. The notebook is also used extensively during client-review meetings when the client may suggest any necessary changes to the student's proposed research plan. The students are required to sign and date the notebook after each entry, and the notebook is handed in at the end of the semester for a grade.

B. Syllabus

The Grade is based on the following

Project Proposal:20%

When? Week before Spring Break

Journal:15%

What? A chronological and legal account of every thought, action, communication, calculation and pertinent detail encountered in relation to project. Why? To maintain an accurate account of what transpires; Proof of work; To provide means of organizing, analyzing, and processing the many components needed to complete project.

Progress Reports: 15%

What? Bi-Monthly accounts of progress made, and future planned actions (2 pages). Why? Helps to break down overall project into well defined tasks, and to motivate and summarize progress.

Individual Web Page: 15%

What? Personal ENGR 0715 web page stored in Unix accounts to supplement the team web page, and document individual efforts. Why? To develop an understanding of web page design and organization, and to provide a means of posting individual assignments. When? By Spring Break

Team Web Page: 15%

When? First draft at Project Proposal and Final version during final weeks. Why? To develop an understanding of web page design and organization, and to provide a means of posting individual assignments

Final Client Report: 20%

What? Summary report and all specified deliverables to be presented to client and instructor in both written and oral format. Criteria? Grade will be on quality of report, how well it addresses client expectations, and if it adequately and honestly describes deviations from planned deliverables.

IX. RESULTS

It is common to perceive freshmen as not sufficiently trained enough in their education in order to implement practical solutions to pragmatic problems. For instance, it would be difficult for freshmen students to address the technical projects encountered by senior design students, which often require various amounts of skills and knowledge that are instilled in the upper level engineering classrooms. However, through this course and the proper structuring of projects, we have learned that freshmen students are still capable of developing and acquiring the various skill sets necessary to solve existent real-life problems. In light of the fact that the projects were amenable to fit within the skill sets of honors freshmen students, we found that the students were able to develop research skills while also producing satisfactory and functional results. For instance, if the interested reader looks to the project objective of Team 1, it is seen that this group developed an organizational system for Team Pittsburgh's recent trip to the U.S. Transplant games. It was reported that this year, Team Pittsburgh's participation and success rates were higher than in recent years, with less participant withdrawal from events. Relative to

previous years, this observation demonstrates the ability of Team 1 to effectively develop an organizational system that would lead to an enjoyable and successful trip to the U.S. Transplant games for Team Pittsburgh. Furthermore, the interested reader can see that Team 4 was to develop educational and informational material for the Almono Bike trail which runs along the Monongahela River through some of greater Pittsburgh's most poverty stricken areas. We can report that the client, who is the director of a local program designed to stimulate the economy of Pittsburgh, has accepted Team 4's project plans in full. An informational kiosk is under development at the beginning of the trail which will enable local tourists to learn more about the trail's new amenities as well as the historical background of the greater Pittsburgh area. Both Team 7 and Team 9 submitted professional computer-aided designs to their clients for the redevelopment of Kennard Park and the local food pantry, respectively. In addition to developing designs for new park amenities, Team 7 proposed the development of an underground parking garage in the area of the park, and this idea was met with positive feedback. For the food pantry, Team 9 submitted floor plans for each story of the food pantry. These plans were accepted in full and will serve to optimize the space available for storage of food, as well as to accommodate incoming patrons. While neither Team 7 nor Team 9 will be constructing their respective projects, the above observations still point to the ability of freshmen students to produce satisfactory and functional solutions to practical problems within the scope of their educational background.

Each year a survey is given to measure the students perceptions of the course. First a set of 12 questions designed to access the students understanding of some of the main course learning objectives are given as a pre and post test. The answers are given as a score from 1 -5. The following are a few sample questions. What was your level of understanding of the concepts of team work? Do you feel you have a grasp of what it will be like to work as a professional engineer? How do you feel about your ability to attack a large ill-defined problem? How do you feel about your capacity to have a positive effect on your community as an engineer? What is your level of interest in community involvement? The average pre test score was 3.2 and the average post test score was a 4.1, or an increase of 20%. Thus, the students did see a gain in their perception of a number of key course goals. The most interesting outcome is their ability to work on a team. All of the students reported a gain on these questions, but in the open ended survey questions the vast majority of the students also reported they over rated their abilities at the start of the semester. That is they thought they were better at this skill then they actually were. Thus, the 20% gain would of been actually higher if the students had not over rated their skills.

We also asked the students to access the courses ability to impact the ABET a-k outcomes. On a scale of 1 -5 the students rated each of these three questions a score above 3.5: "Do you feel this course helped to make you aware of the importance of these ABET outcomes?", "Do you feel this course helped you to improve yourself with respect to these ABET outcomes?" and "Do you feel that taking this course as freshman will help you to develop these ABET outcomes more effectively in the future?"

X. SUMMARY

Based on our experience in conducting the freshman service learning course, and based on survey and reflection of the students participating in the course, we found that students most benefited from learning to function in a team environment, learning to communicate effectively with a client and feeling as if they had a positive impact on their community. The fact that their project was part of a service learning course served more to motivate the students and to make them aware of their ability to solve a problem of value to their community. The service learning aspect had less impact on any specific aspect of engineering analysis or design. Of course, the principles of the design process were introduced to the students as part of the curriculum, which provided them with a framework for attacking each of the specific projects. The more beneficial elements of the curriculum, however, were the aspects of team development and performance, communication both written and verbal, the procedures for documentation using a journal notebook, and reflection on the experiences of each student with their project. In other words, the value of the course is that the students learned, both in the classroom and through experience that the "soft skills" are necessary to function effectively as engineers upon completion of their degree. They were also motivated to focus on engineering design problems as their struggle to solve problems for their client created a motivation for technical study.

A service learning course for freshmen engineers provides students with a unique, challenging and rewarding educational experience during their first year through which their interest in the field of engineering is sustained. Students strongly value projects that are of importance to others in need while also being challenging on their own. Offering projects of this sort have been shown to increase the likelihood of student satisfaction and their continued involvement in community service [23]. In addition, the service learning experience can expand the students' perspectives regarding their potential value as engineers and the skills that are required to successfully complete a "real world" engineering project in a team environment. Such skills as how to work in and function as a team, how to communicate professionally, and how to manage a project are not as emphasized in traditional engineering courses. Furthermore the value of such skills is difficult to impress upon students unless they are able to experience the need to learn and develop them first hand, as is the case with service-learning projects.

Problem based learning courses have been employed at the freshman level and have been shown to improve retention. An engineering service learning course has a multidimensional set of additional benefits above and beyond those observed using problem based learning. The challenges the students encounter in their service learning projects are more consistent with those that engineers are faced with in the professional workplace (the "real world"), and furthermore, the students are motivated to overcome the difficulties they encounter by nature of the project being a real problem whose solution is of value to a community organization. In addition to the students, there are other beneficiaries of a well-organized service learning course. Non-profit organizations in the community are able to have problems solved that would not otherwise be attended to. The university itself also benefits in the strengthening of the relationship with its sur-

rounding community, and the engineering program benefits by offering an innovative educational program which addresses specifically the objectives and program outcome criterion set forth within the ABET Engineering Criteria 2000 [22]. Additionally, these projects help demonstrate what the engineering process is all about and teach students that the primary role of engineers is to serve the community.

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