

## **A Multi-Disciplinary Community Based Service-Learning Project: The Girl Scout Wall Project**

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### Abstract:

During the fall semester of 2002, students from the Introduction to Materials Class (Department of Mechanical and Aerospace Engineering) and the Facility Management Class (Department of Health and Sport Science) at the University of Dayton (UD) participated in a joint service-learning project with the Buckeye Trails Girl Scout Council. This service-learning project was initiated by the service-learning coordinator at UD. The overall technical goal of this project was to design and repair a climbing wall on a challenge course at a Buckeye Trails Girl Scout camp. The health and sport science students participated in this project as the “prime contractor” to the Girl Scout organization. The mechanical and aerospace engineering students served as the engineering design firms competing to be the subcontractor for this project. Students from the two disciplines were required to communicate with one another throughout the semester. Additionally, students from both disciplines were required to interact with representatives of the Girl Scout organization, retailers, student organizations, faculty members and other professionals to obtain the needed information, seek donations and facilitate construction and/or repair of the wall. This paper will focus on the involvement of the engineering students in this project. A detailed description of the project will be provided. The educational goals of this multi-disciplinary service-learning project will be presented. The techniques used to assess the outcome of this project will be discussed and the results of the assessment will be summarized. Finally, conclusions regarding the overall effectiveness of this project at meeting the academic and technical goals will be presented.

### Introduction:

Recent pedagogical trends in engineering education encourage both experiential learning and interaction with peers and faculty members from other majors and other engineering disciplines. One reason for this trend is that engineering educators as well as professionals from industry have recognized the fact that practicing engineers are required to work with coworkers and clients that have a variety of educational backgrounds. Experiential learning is being encouraged in engineering education because it has been recognized that students engaged in this type of learning have better retention of technical knowledge and are better able to apply what they have learned in college courses to real life situations after graduation<sup>1-3</sup>. Furthermore, industry and academia have identified the need for the development of soft skills in engineering students. Among these soft skills includes oral and written communication, project management, team skills including collaboration and leadership, an appreciation of different cultures and business practices, engineering ethics and understanding the societal, economic and environmental impacts of engineering decisions<sup>2-5</sup>. Experiential learning as well as the

opportunity to work on multi-disciplinary and multi “major” teams can provide an opportunity for students to develop these soft skills.

There are many forms of experiential learning including co-operative education and internships, lab experiences, project based coursework, field trips and service-learning. The concept of service learning has been interpreted in many different ways ranging from a single college course where the students are required to spend one afternoon doing community service (i.e., picking up trash in the neighborhood, giving blood, etc.) to multi-year, service projects that are fully integrated into the curriculum and include opportunities for reflection and interaction with the organization and/or people being served. The former extreme provides limited educational benefits, but is very easy to implement. The latter extreme has significant educational benefits, but implementation of this can be very time consuming and generally requires full support and cooperation of the university, department, faculty members and the community<sup>1,6</sup>. A compromise between these two extremes provides the more practical and most widely recognized definition of service-learning. This definition of service-learning includes three basic components: course structure, community service and structured reflection. A service-learning course should be structured so that it does not compromise the educational objectives. The project done in the course must provide a definite and needed service to the community or to an organization. A critical component to service learning is reflection. Reflection provides the students with the opportunity to think about the larger social issues associated with the service project. The objectives of structured reflection are to develop a sensitivity in the students to the impact of professional decisions on society and the environment and to provide the students with an opportunity to think about concepts of ethics and sound professional practice<sup>3</sup>.

Since the 1980’s, service-learning has been formally and successfully implemented in the social sciences and in disciplines in which clinical experiences are required<sup>2,5,7</sup>. In 1985, Campus Compact was established to provide support for both service-learning and volunteerism at universities and colleges. Since then, Campus Compact has been able to gain support for service-learning from over 500 universities and colleges and from both public and political organizations and representatives<sup>7</sup>. Although engineering courses often provide opportunities for project-based experiential learning, service-learning is not implemented as frequently in engineering courses as it is in other disciplines. This is unfortunate since most descriptions of engineering careers include service to society or meeting societal needs as a goal or requirement of the profession<sup>2,8</sup>. Furthermore, service-learning in engineering courses provides the opportunity for experiential learning that can not only help develop technical and soft skills, but can also help establish the skills for practicing engineering in an ethical and civically minded manner<sup>2</sup>.

Another pedagogical deficiency that exists in engineering education is the lack of opportunities for engineering students to work on academically or professionally diverse teams. Generally, the idea of multi-disciplinary projects in engineering courses means that students from the various engineering disciplines such as civil, chemical, electrical and mechanical work together on a project. Unfortunately however, most projects do not provide the opportunity for engineering students to work with students from other majors such as art, business or education. The value of being able to work with students from other majors cannot be underemphasized. In

the “real world,” engineering professionals are often required to work with professionals, workers, vendors and clients from many different fields and areas of interest and expertise. The way in which professionals, workers, vendors and clients from other fields were trained to manage projects, communicate and solve problems can be very different from the way that engineers were trained. Having the opportunity to experience these differences while in college can help to better prepare the students for the real world and give them an appreciation of the different approaches to working on the same project.

For the climbing wall service-learning project, a highly unlikely combination of students was teamed together to design and repair a climbing wall on a challenge course at a local Girl Scout camp. This mismatched team included second and third year students from the Department of Mechanical and Aerospace Engineering (MAE) and the Department of Health and Sport Science (HSS) at the University of Dayton (UD). This project was done for the Buckeye Trails Girls Scout Council (BTGSC). This project had the three components required to qualify it as a service-learning project including educational objectives, community identified need and the opportunity for reflection. Furthermore, students were given the opportunity to develop their teamwork, business and communication skills by having to work with students from their own major as well as students from another major.

#### Project Description:

The service-learning coordinator at UD in conjunction with representatives from the BTGSC identified the need for the repair or replacement of a climbing wall at a local Girl Scout Camp, Camp Whip-Poor-Will. The existing climbing wall was in a state of disrepair and had been shut down for the past several years for safety reasons. This climbing wall was a major component of an adventure program at Camp Whip-Poor-Will. The challenge course at Camp Whip-Poor-Will was used predominantly by the Girl Scouts from the BTGSC, but was also used by various school groups and outside groups as a fundraiser for the BTGSC. Like all adventure programs, the activities on the challenge course at the Girl Scout Camp were designed to enhance the participants’ self esteem and confidence, encourage team building and cooperation, improve physical fitness and skill and provide fun and excitement. Because the climbing wall could not be used, the challenge course was not as attractive or as affective at meeting these goals.

The instructors of the Introduction to Materials Class (MAE) and the Facility Management Class (HSS) as well as the service-learning coordinator at UD and representatives from the BTGSC chose this project as a suitable service-learning project because it appeared to be able to meet specific educational goals and it provided a needed service to the community. Both instructors as well as the service-learning coordinator were committed to providing structured opportunities for reflection so that the students could gain the added benefit of recognizing the societal impact of their work. In an effort to provide the students with an opportunity to gain experience that would reflect what they might be subjected to when working as a professional, the project was set-up so that the Girl Scout organization was the “client”, the HSS class was the contractor and the four student teams from the MAE Class were the subcontractors. Responsibilities of the HSS class included overseeing the construction of the wall, interacting with the BTGSC representatives, coordinating material donations and repair teams and providing specifications and guidance to the MAE students. The HSS class was

responsible for doing the necessary background research and submitting request for proposals (RFP) for new designs of the wall to the MAE student teams. The MAE student teams were to respond to this proposal with design plans and a cost estimate for repairing or rebuilding the wall based upon their research on the current wall design and the materials used for the climbing wall.

A Quickplace website was established, <http://udayton.edu/quickplace/gswall> , to facilitate communication within and among the classes and student teams. Within the Quickplace site, individual rooms were created for each class as well as for each student team. E-mail addresses and links to Girl Scout representatives and the BTGSC website were included on this Quickplace site. Additionally, links to websites that had information regarding climbing walls, sport industry standards and materials were included on this site. This site was routinely updated by faculty and students to include current information, student work and pictures.

The MAE students were organized into four teams of approximately six students each. Students interested in being a company owner submitted a one paragraph, written request to the MAE class instructor summarizing their leadership skills and experience. Company owners received ten bonus points. Their responsibilities included maintaining the team room on the Quickplace site, overseeing all team activities, coordinating the presentation, delegating duties to the principal investigator (PI), scheduling team meetings and communicating with HSS students. After the company owners were selected, each student in the MAE class was required to prepare a resume and to submit their resume to at least two of the company owners. Company owners were required to select PI's and engineers from the resumes submitted to them. The PI's received five bonus points and were responsible for keeping minutes at meetings, delegating duties to the engineers and coordinating the research. The company owners were permitted to dismiss the PI and choose a new PI if the PI failed to perform their duties. The resulting teams or companies were photographed and a company roster was submitted to the MAE instructor. This information was placed on the Quickplace site. Student teams for the HSS class were selected in a similar manner.

Early in the semester, the MAE and HSS students and instructors took a field trip to Camp Whip-Poor-Will to examine the wall and to assess the current condition, materials, construction and needs of the wall. The students had an opportunity to measure the current wall, photograph the site, see the rest of the challenge course and interact with the service-learning coordinator and Girl Scout assistant director of facilities and camp services. Shortly after this visit, the HSS student teams prepared RFP's. The HSS instructor selected the best RFP and this RFP was placed on the Quickplace site. MAE student teams were required to respond to this RFP in the form of a fifteen-minute team presentation where they presented their design and cost estimate. Students and instructors from both the HSS and MAE classes as well as the service-learning coordinator, BTGSC representatives and invited faculty attended the design presentations. The MAE instructor evaluated the presentations for both technical content and delivery. The HSS students evaluated the MAE design presentations using a format created by the HSS students during class. After the design presentations, the HSS students were required to submit their final design choice for rebuilding the climbing wall.

The HSS students found it difficult to select a single best proposal as each design proposal had components that the HSS students found desirable. Therefore, company owners

(team leaders) from both classes met to discuss the designs and to come up with a composite wall design. During this meeting, the MAE company owners agreed to work together to come up with the final composite design that included some of the ideas and addressed some of the concerns that the students discussed at this meeting. Additionally, the student leaders organized wall destruction teams, discussed plans and safety issues and made a checklist of materials needed to complete the wall destruction. The service-learning coordinator volunteered to make all of the necessary arrangements with the Girl Scout organization.

Once a final wall design was decided upon, the HSS students proceeded with trying to raise funds to purchase the materials required to reconstruct the climbing wall. The HSS students designed sponsorship and fundraising proposals to present to potential sponsors and donors. They also contacted members of the Dayton business community and invited them to a presentation of their proposal. This presentation included cost information as well as the details of the composite design of the wall developed by the MAE students. Representative MAE students attended the presentation to help field any technical questions and to provide support to the HSS students. Presentation of the fund raising proposal resulted in a donation to partially fund the rebuilding of the climbing wall from a Dayton area construction firm.

The service-learning project culminated with the HSS and MAE students going to Camp Whip-Poor-Will to tear down the existing wall and dispose of the unusable materials. Students were treated to a cook out where the service-learning coordinator facilitated a short reflection session. Additional opportunities for structured reflection were facilitated by the individual instructors during class time. Before leaving the camp, the students gathered in front of the wall skeleton for a group picture. The students participated in a traditional Girl Scout song led by a group of Cadet (older) Girl Scouts. Construction of the wall had to be postponed until the spring semester of 2003 for reasons beyond the control of UD or its students, Figure 1.



*Figure 1. MAE and HSS students gather in front of the wall skeleton after spending the day tearing down the old wall.*

#### Educational Objectives:

Instructors of the HSS and MAE classes had both course specific educational objectives as well as non-course specific educational objectives associated with this service-learning project. Many of the non-course specific educational objectives were the same for both the MAE and HSS courses. One educational objective of both classes was to further develop the students'

previously described soft skills. Another educational objective common to both classes was to give the students an appreciation of working with students and faculty members from other majors as well as with people in the business community and representatives from non-profit organizations. Both classes were required to do Internet and library research and to seek information from other professionals through personal interviews, tours, phone calls and e-mail. This was done in an effort to help the students develop their research skills and to help them understand how to apply information gained from their research to solve a problem. Another educational objective was to enhance the students' ability to use technology to aid in their research, communication, project management and design preparation. Some of the technology used by both the MAE and HSS students throughout the semester included the Quickplace site, the Internet and e-mail, Microsoft Office (Word, Excel, PowerPoint, etc.) and digital photography. The MAE students also used computer aided design programs to generate detailed schematics of their designs. The objective of the service component was to provide the students with a greater understanding of how their chosen vocation might be used to provide community or public service. As part of this, the instructors hoped that this project would be helpful in increasing the students' sense of ethics and understanding of the societal impact of their work. Another very important educational objective of this service-learning project was to provide a fun and challenging learning experience that might help to increase the students' motivation to learn and make the students excited about their chosen field.

An MAE course specific educational objective of the Girl Scout wall service-learning project was to provide the students with technical knowledge related to material characteristics, materials selection and design. Specifically, the goal of the project was to provide the students with an opportunity to go through the steps involved in the material selection process. In going through these steps, it was hoped that the students would be able to identify the factors that are important in material selection including material properties, environmental considerations, use environment, corrosion considerations and material safety, availability and cost. Another goal of this project was to give the students the opportunity to be exposed to material concepts that are generally not covered in the Introduction to Materials course due to time constraints. Examples of some of these concepts include natural materials, corrosion and failure analysis. The final objective of this project was to give the MAE students the opportunity to apply some of the technical knowledge they gained in other classes such as Computer Aided Design, Statics and Strengths to solve a problem.

The MAE students were given a team grade for their presentation from the MAE instructor. Additionally, each MAE student was required to submit an individual technical report that summarized their research and their team's design. These papers were evaluated for both technical content and technical writing and were worth one test grade. In the report, students were required to demonstrate the material selection process and address any ethical concerns or issues associated with the project. The MAE students were required to evaluate their team members' performance in the following areas: technical contribution, participation at team meetings, attendance at team meetings, performing and completing assigned tasks on time and overall team involvement. Scores from the peer evaluations were averaged for each student and each student was assigned a peer grade based on these results. The peer grade counted as one test grade. In the MAE class, this project was worth approximately 33% of the students' total grade.

### Project Assessment and Discussion:

Each instructor made an effort to assess the overall effectiveness of the service-learning project at meeting the specified objectives and to determine the students' overall perception of this project. The MAE students were asked to fill out an evaluation form at the end of the semester that consisted of twenty statements that summarized both the course specific and non-course specific educational objectives of this project. The students were asked to respond to each statement by providing a score from one to five indicating how affective the service-learning project was at meeting a specific objective. A score of five indicated that the project did an excellent job at meeting the specified goal, whereas a score of one indicated that the project did not meet the specified goal. The students were also asked to provide written responses to three questions: (1) What did you like most about this project; (2) What did you like least about this project; (3) What are your suggestions for improving this type of project?

The results of the evaluation conducted in the MAE class are provided in Table 1. These results were separated by type of educational objective. Scores for the course related objectives had an average value of 3.95 with a standard deviation of 0.24. This score indicates that the project did a good job at meeting the course related objectives such as providing the student with technical knowledge related to materials selection and design. Scores provided for the non-course specific objectives had an average value of 3.75 with a standard deviation of 0.26 indicating that the course did a good job at helping the students further develop their soft skills. Goals that received the highest scores included developing teamwork skills, giving the student a greater understanding of other people (clients, classmates, engineers, professors, HSS students), helping the student gain an understanding of community service and providing the student with an understanding of how to break down a design into smaller components. An average score of 3.04 was tabulated in response to the statement, "This project was an asset to the lecture portion of this course." Although this score is in the "good" ranking, it was the lowest averaged score generated from the evaluation forms. This indicates that the instructor may be required to make a more concerted effort at explaining the connection between the technical information provided in the lecture with that imparted by requiring the students to be involved in a service-learning project.

The MAE students provided many comments on the evaluation sheet that summarized their thoughts on the Girl Scout Wall Service-Learning Project. Some aspects of the project that they found favorable include getting hands-on experience, having the opportunity to apply their engineering knowledge to a real life situation and having the freedom to be creative in generating a practical and safe design. The students seemed to enjoy the responsibility of managing the project. One student wrote, "(What I liked most about this project was) the fact that it was our responsibility to achieve the goal assigned to us. We started from scratch and were able to produce a design for the new wall. The goal seemed unachievable at first, but the project ended up going well." The students liked the fact that this project was being done for a good cause. They also enjoyed having the opportunity to work on a team. Specific aspects of this that the students enjoyed included getting to know their teammates, developing leadership skills and developing teamwork skills. A few students indicated that the part of the project they enjoyed most was tearing down the wall. Several of the students indicated that they liked having the opportunity to work with people from other majors. One student wrote, "(What I liked most

about this project was) the whole design and presentation part. I thought it was a good experience and gave us a feel for what it is like to work with people that are not engineers.” Not surprisingly, only one student wrote that their favorite part of the project was writing the technical report.

*Table 1. Summary of MAE Assessment Survey Responses*

		<b>Average</b>
1	This project was an asset to the lecture portion of the course.	<b>3.04</b>
2	This project provided me with technical knowledge related to materials selection and design.	<b>4.08</b>
3	This project helped me to understand how to break down a design into smaller components.	<b>4.19</b>
4	This project helped me to identify which properties are important for the various components of a design.	<b>3.88</b>
5	This project helped to develop my ability to conduct library and internet research.	<b>3.31</b>
6	This project helped me to understand how to apply information gained from research to solve a technical problem.	<b>3.77</b>
7	This project gave me an appreciation for basic material properties and the property, processing, structure interrelationship.	<b>3.64</b>
8	This project helped to develop my ability to manage a project and helped develop business awareness and skills.	<b>3.88</b>
9	This project helped me to develop my written communication skills.	<b>3.50</b>
10	This project helped to develop my oral communication skills.	<b>3.65</b>
11	This project helped me to develop my teamwork skills	<b>4.19</b>
12	This project helped me to understand others (classmates, engineers, professors, "client")	<b>4.12</b>
13	This project helped to develop my interpersonal skills.	<b>3.73</b>
14	This project helped to develop my leadership skills.	<b>3.85</b>
15	This project aided in preparing me for the workplace.	<b>3.88</b>
16	This project gave me an appreciation for working with people from other disciplines	<b>3.69</b>
17	This project helped me to understand or reinforced my understanding of community and/or public service.	<b>4.00</b>
18	This project made me aware or reinforced my awareness of environmental responsibility.	<b>3.42</b>
19	This project helped to increase my sense of ethics and moral knowledge.	<b>3.50</b>
20	This project was enjoyable and made me excited about being an engineer.	<b>3.96</b>

Although the MAE students had a lot of positive comments regarding the project, many of the students felt that the project was disorganized and that there was a general lack of communication among the parties involved. One student wrote, “It didn’t seem as though we were on the same page as the sports management team. They knew things that we didn’t know and we knew things they didn’t know and it was hard to get the full picture because

communication was often poor.” Some students expressed frustration in working with the HSS students. The MAE students felt that the HSS students were often times unprepared for meetings and presentations, had unreasonable design constraints, had a general lack of knowledge, were not responsive to the MAE students’ questions and did not appear to be interested in the project. Several students felt that the project was too time consuming and they did not like the fact that a majority of their research and design had to be completed within the first half of the semester. Some students felt that the design constraints did not allow for enough creativity. Many students expressed disappointment in having to postpone construction of the wall until the spring semester. One student wrote, “(What I liked least about the project) was the fact that we didn’t get to finish and see the final product of our hard work. It kind of felt like we did it for nothing, since it won’t be finished for a while.” As expected, a few students indicated that the part of the project that they liked the least was writing the technical paper.

The MAE students offered many good suggestions for improving this type of project in the future. One suggestion was to provide more opportunities for interaction between the MAE and HSS students. MAE students also suggested that HSS students be required to do more research at the very beginning of the semester so that the RFP the HSS students generate has more realistic requirements and includes some budget constraints. A few students suggested that the instructors and service-learning coordinator provide a more detailed timeline of project due dates. The MAE students also felt that it would be helpful if a party assigned with a certain task be required to stick to steady fast deadlines to prevent delays in the project. Students suggested that an effort be made to enhance communication between UD and BTGSC to ensure that deadlines, requirements and commitments are met by both parties. Some students suggested that the teams be smaller so that each team member has more work to do. The MAE students also felt that it would be helpful to have the HSS students more actively involved in the design process. Miscellaneous suggestions including better direction on the technical paper, switching to an industry related project and getting the civil engineering students involved were also offered.

Student evaluations conducted in the HSS class at the end of the semester demonstrated that there were several benefits to the Girl Scout Wall project. The HSS students felt that participating in this project gave them a better understanding of the course concepts, namely the various phases of facility planning. In addition to the course related educational benefits of this collaborative project, HSS students felt strongly that the experience they received in working with the MAE students gave them a better understanding of the complexity of working with facility designers and engineers. The HSS students gained some insight into how each group approaches a project from a slightly different perspective and that communication can sometimes be challenging when working on a collaborative project. The HSS students oftentimes felt intimidated by the technical knowledge the MAE students brought to the material selection and design process. Several times throughout the project, HSS students became frustrated by their inability to communicate safety and programming concerns regarding materials and wall design to the engineering students. The HSS students also felt that they benefited from involvement in this project because they had gained valuable experience that could be included on their resumes and that would help them in their future career aspirations whether from a facility management or marketing/sponsorship perspective. The practical knowledge gained from the Girl Scout climbing wall project will be invaluable to them as they begin their careers.

From both the HSS and MAE instructors' perspectives there were many side benefits to the project. One benefit was the inclusion of technology in the research and planning process. Students were required to conduct background research using the Internet. This gave the instructors the opportunity to expose students to a wide variety of current sources of information and to discuss the ways of discerning the reliability of information posted on the Web. In addition, students from both classes had the opportunity to enhance their information technology skills through the use of a Quickplace site. Although it was not a goal of either instructor to have the students become frustrated with the project, the frustration the student experienced provided a very important educational benefit. This educational benefit was providing the students with the opportunity to experience some of the pitfalls that can occur when working as a professional. Many of the complications and delays that occurred in this project were ones that occur in the "real world." Problems arising from a lack of communication among client, professional and employee are common in the work place. Project delays and stringent deadlines are also often experienced in a business environment. Another source of frustration for the students was having to wait for input from other groups or team members before finishing a certain aspect of the project. In some cases, the students received important information late. When this happened, the students found themselves having to scramble in order to finish their assigned task on time. Although very frustrating and inconvenient for the students, it provided a good experience for the students as this type of situation can occur in the business world.

#### Conclusions and Recommendations:

Overall, this collaborative service-learning project was a positive learning experience for both the MAE and HSS students. Based on the results of the evaluations and through conversations with the students, the Girl Scout Wall project did a good job at meeting both the course specific and non-course specific educational goals. Although the students were disappointed that they could not build the wall, many of the students have committed themselves to following through with the project to its completion by volunteering their time to go down to the Girl Scout Camp during the spring 2003 semester to rebuild the wall and spend the day with some Brownie Girl Scouts. Although improvements can be made to the process of completing a project of this nature the positive benefits appear to greatly outweigh the negatives for students and instructors alike.

Some improvements that could be made to any future collaborative service-learning projects include allotted more time for the students from the two classes to formally meet and discuss the project. The students often felt frustrated at the lack of communication between the two classes both in terms of the quantity and quality of the interactions. Additionally, communication among the students could be enhanced through improved use of the Quickplace site. The site was used primarily for posting project guidelines and assignments and for communicating within a team. The students did not use the Quickplace site for threaded discussions or to communicate between the two classes. It is also recommended that the instructors, service-learning coordinator and Girl Scout representatives do more organizational work early on in the semester to avoid any possible delays so that the students can have the satisfaction of seeing their project through completion within the context of the course. It is important that the responsibilities and expectations of the instructors, service-learning coordinator and Girl Scout organization be clearly communicated.

Incorporating a collaborative service-learning project into a course can be extremely difficult and time consuming. Part of the reason for this is that a service-learning project is rarely repeated from semester to semester. Therefore, the instructor essentially has to start from scratch when organizing a service-learning project, researching the topic and determining how the students will be assessed for their work on the project. Additionally, service-learning projects require the instructor to establish new contacts and to spend a lot of out of class time with the students to organize, discuss and implement the service component of the course. However, the educational benefits of a collaborative service-learning project are well worth the effort.

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