

2006-1484: SERVICE LEARNING PROJECTS AS PLATFORMS FOR AN UNDERGRADUATE PROJECT MANAGEMENT COURSE

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Service Learning Projects as Platforms for an Undergraduate Project Management Course

Abstract

One of the challenges facing today's engineering faculty is how to make the textbook knowledge real to the student. This is especially true in the area of project management where the essence of the subject is a combination of people skills and planning skills. Both of these skills have been identified by ABET as essential skills for the next generation of engineers¹. At Western Carolina University, project management is a senior level course and a requirement for graduation. Prior approaches to the course required the creation of individual project as part of the course. It was preferred that the project be an actual and useful project but often times it was only an imaginary project. In the fall 2005 semester, the instructor chose to plan *and execute* an actual project during the course. This pedagogical approach has been successfully demonstrated to work at the graduate level² but had not been tried at the undergraduate level. After careful evaluation, the project was selected to plan and execute the move of an organization that serves persons with disability from their existing facility to a new location. This paper presents the criteria for the project selection, the approach to the project plan, the reality of this approach, the lessons learned and the reflections of the students and faculty on the total learning experience.

Introduction

Of the many skills demanded of new engineers, one is the ability to organize, manage and be effective in project teams. Proficiency in teaming skills and in project management tools is an important element of the ABET requirements¹. Many of the tools of project management have been well defined over the past fifty years and our students are expected to be proficient in their use. These tools include creating a succinct and clear project proposal, constructing well organized work breakdown structures, generating task estimates and budgets, putting together schedules and task relationships using tools like Gantt charts, developing risk mitigation strategies, and resolving and managing personnel conflicts. An experienced project manager knows very well that the most challenging aspect of project management is dealing with people. It's all about people! As in many pedagogical approaches, hands-on experience through real life projects is invaluable to the learning process and this is most particularly true for conflict management and negotiation. At Western Carolina University, a three hour course in project management covering all these topics is a requirement of graduation in the Engineering Technology program of the Kimmel School of Construction Management, Engineering and Technology. In the past the curriculum has included the development of an individual project as the culmination of the course. While this project could be real, it was more commonly conceptual and imaginary. In the fall 2005 semester, the approach was to plan *and execute* an actual project during the course. The principle philosophy embodied in the course is crystallized in the often quoted Chinese proverb:

Tell me and I'll forget

Show me and I might remember

Involve me and I will understand!

This class was focused on learning the skills of project management and immediately applying the learning to a real project. This pedagogical approach has been successfully demonstrated to

work at the graduate level by Roya Javadpour at California Polytechnic State University². The approach for this class was to implement this idea at the undergraduate level recognizing that the decreased professional maturity of undergraduate students might make this approach more challenging.

Project Selection and Definition

Prior to the beginning of the semester, the process of identifying candidate projects was initiated. Selection criteria included that the project 1) must provide service to the community, 2) must occur in a narrow window of time toward the end of the semester and be accomplishable in two weekends, 3) must be large enough to require the efforts of all the class, 4) must be complex enough to require planning to be successful, 5) should not contain major technology uncertainties and finally 6) should only require skills that already exist in the class or could be easily learned by members of the class. When the semester began on August 30th, only one serious candidate had surfaced that meet all the criteria. In Western North Carolina, centers have been created to prepare and train persons with disabilities to enter the workforce. All operate as independent not-for-profit corporations and they depend on the efforts of volunteers and contributions from the community to operate. The revenue generated by the products they make allows these centers to provide a broad range of skill training to persons with disabilities. In addition to hands-on skills, clients are taught interpersonal, stress coping, and communication skills in a confidence building environment. Foothills Industries Inc (referred to as Foothills in the remainder of this paper) is one of these centers serving McDowell County and located in Marion, NC. Marion is approximately 90 miles from Cullowhee where the university is situated. Foothills had been in existence for over 15 years and, during that time, had expanded its facilities several times to meet the requirements of the organization. In 2004, Foothills decided that further expansion of the 24,000 sq. ft. of manufacturing and office space in three separate buildings was not desirable and a new site and



Figure 1. The Foothills Industries Inc. had outgrown its original 24,000 sq. ft. three building site. Clockwise from top, the car liner room, the surgical drape cutting machine, the main office warehouse and a therapist office.

facility was needed. Through grants and community support, the construction of a new 48,000 sq. ft. facility was undertaken approximately 6.5 miles away in a new industrial park. The task of gathering the financial resources to fund this construction was extremely challenging. Actually effecting the move of the organization to its new home with the small staff of service providers was even more daunting. The Kimmel School had previously provided assistance to several of these centers. Upon learning of this situation during a routine visit, the planning and execution of the move for Foothills became an excellent



Figure 2. The new Foothills site approximately 6.5 miles down the road opened up 48,000 sq. ft. of space.

candidate for the Project Management class. This project met all the selection criteria. Foothills serves persons with disabilities. The move was scheduled to occur on October 30-31 and November 6-7. This project could be completed by the 25 students in no more than four days. The complexity would warrant planning and no real technological hurdles were obvious. In the initial discussions with the Foothills management, only two pieces of equipment were identified as needing technical support for their moving and reassembly and Foothills was willing to arrange for this support themselves.

At the first class session, this candidate project was presented and discussed. In order to define and understand the extent of this project it was decided to immediately visit the site and appraise the situation first hand. Because time was critical and the trip was planned quickly, not all the class was able to make the trip which took place on the following Saturday. On reflection the distance from the university and the fact that not all the class was able to go on the first visit were negatively viewed by the class. The strongest observation from the visit was that this project was serious and that people were going to be counting on the class for results. Failure was not going to be an option and the class would have to deliver on what it committed to do. It was reassuring to observe the sense of responsibility and accountability that the class exhibited. The class had 100% attendance on all the planned project workdays which speaks volumes to its commitment to the project. Additionally, some of the class members were skeptical that the move could be accomplished in the time frame allotted. From a learning point of view, this skepticism offered an opportunity to clearly demonstrate how much can be accomplished if adequately planned. The challenges of the Foothills move were presented to the entire class by those members who made the visit. All members of the class then wrote a one page executive summary containing the *who, what, where, how and why* of the project. In the next class session, the decision was taken to commit to the project and a presentation was made to the Foothills management which they accepted.

One of the first issues to clarify was the issue of liability, not only between Foothills and the University but also between the students and the University. To address the former, an agreement was formalized with Foothills that released the University from responsibility for damage to equipment and facilities during the move. This project also used the “Conduct and Liability Waiver” form developed by the service learning office of the University. Furthermore the organization of the project also included a safety officer and a safety plan.

Organizational Structure and Planning Phase

Based on the scope defined in the proposal to Foothills, a project organization was developed. Six teams were created based on the similarity of skills and capabilities:

- Team HEAVY..... responsible for the movement of any piece of equipment that **could not be** moved as is by the available lift trucks.
- Team LIGHT..... responsible for the movement of any piece of equipment that **could be** moved as is by the available lift trucks.
- Team OFFICE..... responsible for the movement of office furniture and their contents.
- Team SHELVING..... responsible for the disassembly, movement and reassembly of all shelving.
- Team LOGISTICS..... responsible for the trucks and site to site movements as well as other resources needed for the operation including food and housing.
- Team COORDINATION..... responsible for project integration and maintaining the master schedule.

All class members were asked to identify their first and second preferences for team membership. In most cases the first choice could be accommodated while, in a few cases, the second preference had to be assigned. In no case was an assignment made that was not the student’s first or second choice. Due to the fact that the coordination team would entail significantly more effort and would require giving direction to their class members, membership to this team was both voluntary and by election only. Class members willing to take on the responsibility of this team were asked to volunteer and to present to the class why they were willing to serve in this capacity. Four members were elected to this team. Additionally one member of the coordination team volunteered and was appointed the safety officer. Each team picked a leader and developed and signed their team charter including their commitment, mission and responsibilities.

An important dimension of the teaming process was to determine the criteria to be used to evaluate individual and team performance. The class identified the following seven individual performance metrics for the project:

- Being punctual
- Have the ability to develop consensus
- Being accountable
- Being organized
- Demonstrating motivated attitude
- Having and sharing skill and knowledge
- Communicating effectively

	TEAM	Heavy Equipment	Light Equipment	Office and Classroom	Shelving	Logistics and Transport	Project Coordination
Task							
1	Relocate Main Office Area		2	1	2		3
2	Relocate Classroom and Small Assembly area		1	2	2		3
3	Relocate Woodworking and Car Liner Room	1	2		2		3
4	Relocate Manufacturing Area		1	2	2		3
5	Relocate Clean Product Area	1	2	2	2		3
6	Relocate Warehouse						
6.1	Relocate Main Building Warehouse			1	2	2	3
6.2	Relocate Warehouse #2 Upper Floor	2		2	1		3
6.3	Relocate Warehouse #2 Lower Floor	2	1				3
7	Relocate Trailer			2		1	3
8	Provide Logistics Support					1	3
9	Coordinate the Project	3	3	3	3	2	1

Figure 3. The responsibility matrix established lines of responsibility based on the work breakdown structure created for the project: 1 has lead responsibility, 2 must be consulted and 3 must be informed.

These metrics were used by each student to rate the performance of their team members including themselves. This rating approach has been described in detail³ in previous work. In addition, the students was asked to rate the performance of each team with regards to a) performance on task assigned to the team and b) willingness to assist other teams. The approach to assessment relieved the stress of some students around interdependence on fellow team members. They had comfort in the fact that they would have a voice in assessing the performance of other team members and thereby mitigating against slackers.

With functional teams in place, organizing the work began with the creation of a work breakdown structure (known as the WBS) and establishing a responsibility matrix. The WBS was formed around the various work areas of the plant while the teams were created according to the equipment types to be moved. Prime responsibility for a work area was given to the team whose skills best matched the type of equipment in the area. The responsibility matrix that resulted is shown in figure 3. The team with final responsibility for the task is identified as 1, teams that must be consulted on the task are identified as 2, and teams that must be informed of progress on the task are identified as 3. The team with primary responsibility then broke the work down into smaller work packages, created the resource budget, duration, predecessor linkage and Gantt schedule. In this project, no actual financial budget was made. The resource that had to be managed was manpower. All tasks were integrated by the coordination team. Early in the planning process, it was recognized that project success depended on a critical resource instead of the more common critical path. The critical resource and the project bottleneck was the number of trucks available for the project. For this reason, decreasing the time for a round trip became a focus. The team quickly realized that palletizing as much of the items to be moved dramatically decreased the loading and unloading time and optimized the trip cycle time. The sequence of tasks was also optimized. First a staging area was created followed by planning the sequence of material movements out of a given area to optimize the task duration. In the latter phases of the move, the disassembly, movement and reassembly of the

largest piece of equipment, the surgical drape cutting machine, rose as the critical path and was appropriately addressed by the teams.

Putting the Plan into Action

Significant changes to the project timeline occurred almost immediately. The Foothills organization was informed that their certification was going to be reviewed and assessed by their external regulatory body. The facility had to be fully operational for the assessment and the Foothills management felt that it would be best to complete this review before the move rather than afterwards. This decision meant that the move could not start as planned pushing back the move for one week.

Later, prior to implementing the plan, the move was hit with construction delays. The final certificate of occupancy would not be issued until two weeks later than the planned move. This possibility had been identified by the teams as a risk and contingency planning had occurred. The team felt that it could compress the move into one extended weekend. One of the assumptions in this assessment was that at least one additional truck would be needed. For reasons that will be discussed later in the lessons learned, the Foothills management chose to reduce the class' scope of work instead. The class was asked them to rearrange the sequence to allow Foothills to operate in the original plant over the two week move period and to deposit the moved equipment into a holding area at the new site. The only exception was the surgical drape cutting machine which would be moved and reassembled in its desired final location.

The teams performed exceptionally well. During the first weekend, all scheduled and possible tasks were completed by 4:00pm in the afternoon of the first scheduled day, November 5, 2005. During the intervening week, the remaining tasks were re-evaluated. The original plan called for an overnight stay to eliminate the four hour roundtrip from Marion to Cullowhee on the Saturday evening. After careful review, the teams felt that the entire move could be accomplished in one day if an additional truck could be provided. With Foothills' agreement, that plan was put into action for the second weekend. The entire move was completed by 4:30 pm on Saturday November 12, 2005.

Reflection and Lessons Learned

After the completion of the project, each student was required to write a reflection paper on the project. Almost unanimously the class stated that the dual goals of the course, namely that of learning project management skills and applying them to a real world project, had been accomplished. The initial concerns that an undergraduate class might not have the maturity and the expertise to actually complete the project did not materialize. The class took the commitment seriously and showed steadfast resolve to successfully complete the project. It was easy to be proud of the class. A relative of one of the Foothills staff made the comment to the instructor that the enthusiasm and commitment shown by the class had convinced him that his son should seriously consider enrolling at WCU. Many of the students expressed surprise at the closeness of the time estimate to the actual duration of the tasks and the impact that planning had on the outcome. Others expressed the disappointment that the class did not follow the WBS on the initial day religiously but adjusted the sequence and content in response to changing conditions.



Figure 4. Cohesive teamwork made for a successful ahead of plan completion.

This development occurred primarily because there was no clear critical path but only a critical resource, that of the trucks. In the second weekend, with an additional truck, the critical path was clearly identified and the WBS was followed closely.

In the reflection papers written by the students, numerous comments were made that indicated a generational clash. The class has several non-traditional students in their late 50's and 60's. These older students were more inclined to give as well as accept orders and direction. Their style was more autocratic. The younger generation of students did not espouse this approach and resisted it. Their view was much more democratic and demanding an input on every decision. This generation gap was fascinating and accentuated the fact that project management is all about people. The younger generation did not recognize this conflict for the generational clash that it was, while the non-traditional students picked up on it immediately and were amazed by its clarity.

From a pedagogical point of view, the selection of this project presented several limitations, not all of which were immediately recognized. The 90 miles between Cullowhee and Marion limited the interaction of the class with the tasks and a closer site would be easier. The client in this project, Foothills Industries Inc., did not have previous experience with the university. As a result there was a credibility gap and lack of confidence in the class that it would carry through with its mission and commitments. When delays in the construction forced a re-evaluation of the project timeline, the Foothills management did not feel sufficiently secure with the class to capitalize on a compressed schedule despite the fact that the beneficial effects were clear. It was too risky. It was only after the first moving day that the Foothills management realized that the class was truly committed to the project and would make it a reality. The confidence barrier was overcome. Future classes will benefit by having the Foothills testimony to support the class' commitment to follow through and succeed.

Another limitation resulted from missing the opportunity of enrolling the Foothills staff in the learning scope of the project. This project had two aspects: the first was to provide community service to the persons with disabilities served by Foothills. The second was to enhance the learning experience for the students. The Foothills staff fully accepted the first but the class instructor failed to fully educate the staff in their instructional role and explain their participation. As the two days unfolded, several interactions between the staff and the students were not supportive causing irritation and bad feelings. In future projects the complete engagement and preparation of the client for active participation in the learning experience will be a high priority.

A third limitation, the anticipated construction delays, could be viewed as being positive by adding realism to the project and as being negative by adding risk. In hindsight, this class was lucky that the construction delays were only minor. Major delays that would have pushed the move outside the semester timeline could have made the project difficult. In the future, the selection of a project for which the class has definite control on the schedule would be more desirable.



Figure 5. The 2005 Project Management class moved Foothills Industries Inc. into its new 48,000 sq. ft. facility where it will continue to serve the persons with disabilities of McDowell county North Carolina.

Conclusion

The 2005 Project Management class of Western Carolina University successfully planned and executed the move of Foothills Industries Inc. into their newly constructed facility. This project allowed the class to provide Foothills with much needed assistance as well as to give the students the opportunity to apply the tools of project management in a real world setting. The demands on the students and faculty were substantial. The learning process was real and rapid as deadlines and milestones approached. Nevertheless the experience was priceless and will stay with these engineers for a lifetime. An added bonus to the graduating seniors is the sincere letter of gratitude from the president of Foothills Industries Inc that will spruce up their resume and portfolio. The lessons learned in this hands-on enhancement of the Project Management course have led the instructor to keep the planning and execution of a real team project as a permanent component of the course. Future refinements will include educating the client such that they realize that they are accepting to be part of the learning experience and are being asked to support the inquiry process. Projects will be selected that have more certain timelines and the students will play an active part in the project selection.

Acknowledgements

This project could not have been carried out without the hard work of many other people. First and foremost the author congratulates the 25 students of the 2005 *Project Management for Engineers* course for a job very well done. Their commitment to this project made a lasting difference for so many persons with disabilities and they appreciate it. Thanks also to the staff and management of the Foothills Industries Inc. who had faith in the students and faculty and entrusted the class with their long heralded event. Without the support of Dr. Duane Dunlap, the

logistics of this project would have been daunting and he made it easy. Finally the author thanks Dr. Roya Javadpour for sharing her successful program with the engineering community and giving the author the many words of wisdom and encouragement that made the project seem possible.

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