An Innovative Student Engagement Project: Lessons Learned from a Log Cabin

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Abstract - As an element of its fundamental mission of teaching and learning, Western Carolina University aids businesses, industries, and individuals in western North Carolina through the expertise of its faculty, staff, and students. “Engagement” is a valuable commodity among professors who seek to provide appropriate experiences for their students, as well as assisting emerging business and industry in the region. Innovative professors supplement classroom instruction and lectures with student engagement projects that provide real life, hands-on experience for their students. This paper will describe how one particular project was integrated into Engineering Technology classes at WCU.

During the fall semester 2005, students in the Engineering Materials and Processes class performed an air conditioning load survey for the owners of a local, historic restaurant. This project challenged the students with a real world design problem involving several different areas of study including ethics, design methodology, architectural design and financial analysis. Students were also exposed to concepts of heat conduction and insulation properties of various building materials, report writing, presentation, and public relations.

This project captured the interest of students and provided a means for professors to present material in a unique format. The project was used in conjunction with lectures and labs to address ABET learning outcomes in an innovative learning environment. Additionally, emphasis was placed on collaboration strategies and teaming approaches as applied to project management. In this paper, student experiences are evaluated, feedback from the business is provided, lessons learned are described, and results of the study are presented.

Keywords: Engineering Technology, student engagement, student project

INTRODUCTION

Maggie’s Galley is a local restaurant in Waynesville, NC. The menu consists primarily of fresh seafood and Angus steaks. The building is constructed from parts of five log cabins dating back to the Eighteenth century from Tennessee and North Carolina. The building has been a restaurant since 1991.

The owner feels business is lost during the summer due to the lack of air conditioning in the main dining areas. During the summer months, the busiest time of the year, there are forty-two seats on the second floor of the main building that must be closed due to the hot weather and lack of air conditioning. There are about 60 seats on the screened-in back deck, which can be opened during the summer months, but often customers must still wait a considerable amount of time to be seated.

The Engineering Materials and Processes class was asked to calculate the required amount of air conditioning for the building and to provide a technical report. The instructor felt this project provided a unique means to explore the properties of materials as they apply to a real-world situation. The report would be used to provide a contractor

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with sufficient information to purchase and install the recommended equipment. Design considerations for the structure were:

- Inside design temperature of 76 degrees F.
- 20 CFM of ventilation air needed per person per ASHRAE 62-2001 [1].
- Outside design temperature of 85 degrees F.
- No humidity control would be considered for afternoon and evening operations.

These conditions were chosen to ensure compliance with local building codes and to provide air conditioning sufficient to increase customer flow into the restaurant. The outside design temperature was determined by considering the evening dinner time average outside dry bulb temperature obtained from local weather data. The lack of humidity control was considered to minimize equipment requirements and costs. The owner was consulted and agreed to these design conditions.

**STUDENT EXPERIENCES**

**Teams**

One of the fundamental skills demanded of the graduating engineer is proficiency in working as a team. In addition to content competencies, business and industry desire basic workplace skills, excellent listening and oral communication skills, creativity and problem solving skills, solid personal management, interpersonal skills/conflict management, and leadership and organizational effectiveness [2]. Although extremely important, these skills are not explicitly taught in engineering curriculums where the focus is normally on the content and analytical skills of the engineering disciplines. Industry and the Accreditation Board for Engineering and Technology (ABET) however expect engineering graduates to have well developed teaming skills [3]. With that in mind, the class was split into five teams for this project:

- The Seating team concentrated on the load due to ventilation requirements and was to ensure compliance of the final design with ASHRAE code 62-2001 [1].
- The Envelope team developed a floor plan on AutoCAD for the building to use as a reference during the design process.
- The Propane team analyzed the propane bills to determine the amount of cooling needed in the kitchen.
- The Electrical team analyzed the electric bills to determine the amount of cooling needed for lighting, coolers, refrigerators, freezers and kitchen equipment such as coffee makers and water heaters.
- The Report team generated a report for the owner to use to obtain bids for the recommended equipment.

**Seating and Ventilation**

During the first site visit, the team observed four primary dining areas. There are 26 seats on the first floor of the main building where the cashier’s station is located. There are 42 seats on the second floor of the main building and 42 seats in the smoking area where the bar is located. Finally, there are about 60 seats on the screened-in back deck that are used during the summer months. The total number of seats available during the summer months is about 128 and during the winter months about 110. More summer seating is needed, but there are an adequate number of winter seats. There are about 10 employees in the restaurant at the busiest times.

For ventilation air, the maximum number of occupants in the main building during the summer months was considered to be 120 people, including the 10 employees, and the second floor dining area if air conditioned. According to ASHRAE standards [1], 20 cubic feet per minute (CFM) of outside ventilation air would be needed per occupant, and 60 CFM needed for the smoking areas.
Total ventilation (outside air required) was calculated to be:

- 78 non-smoking occupants X 20 CFM/occupant = 1560 CFM
- 42 smoking occupants X 60 CFM/occupant = 2520 CFM
- 550 CFM for customers entering and leaving = 550 CFM

Total CFM = 4630 CFM

Heat gained due to ventilation was calculated, using the equation $H = Q \times \Delta T \times F$ from the Stamper & Koral [4] manual, page 2-104, to be 44,170 BTU/hour or about 4 tons of cooling.

In addition to the ventilation load, occupants will produce about 500 BTU per hour [4]. By multiplying the number of people inside the dining areas during the summer by 500 BTU per hour, another 60,000 BTU/hour or 5 tons of cooling is required. The total “people load” was calculated to be 9 tons.

**Building Load**

The main building measures roughly 79 feet by 89 feet. It is constructed primarily of seven-inch thick logs with concrete chinking. All windows were single pane, with a high expectation of air leakage. The roof is tin. The front of the building faces northwest. A floor plan is included in Figure 1. A standard load estimate was performed on the building using an accepted standards manual [4]. The calculated envelope load for the building is 15 tons. This estimate was checked using an on-line load calculator [5] and was found to be 15 tons. The calculation includes the square footage of the open back deck areas which will not be air-conditioned, so the result is probably a liberal cooling load estimate. It is based upon the 95% ASHRAE weather data given in the ASHRAE Fundamentals handbook [6]. This means that during the June to September months, the temperature will exceed 85 degrees F about 5% of the time.
Propane

Propane is used in Maggie’s Galley for cooking and space heating. As indicated in Figure 2, the highest consumption determined from records provided by the owner was December (1026 gallons), and the lowest consumption was in November (451 gallons). Average consumption for the year was 657 gallons per month. The only cooling load required is to address the heat produced by combustion of propane in the summer months found in the kitchen.
The calculated cooling load to account for propane usage was based upon July usage of 601 gallons. Cooling due to outside weather conditions only will be required from June until October, but the heaviest months will be July, August & September. It was assumed that the average energy content of propane was 91,690 BTU’s per gallon.

The following formula was used from McQuiston & Spitler[7], page 5.3:

\[ Q = \frac{(G_p \times H_{cp} \times DF)}{Hop} \]

Calculation:

\[ Q = \frac{601 \times 91,690 \times .60}{356} = 104,963 \text{ BTU/hr} = 8 \text{ tons} \]

This load should be deleted from the total if it is decided that the kitchen will not be air-conditioned.

**Electricity**

The cooling load to account for electrical usage was based upon the July consumption of 13,400 KW-hrs, and as above, cooling will be required from June until October. As indicated in Figure 3, the heaviest months are July, August & September. According to McQuiston & Spitler [7], the maximum hourly heat gain may be estimated from the consumption assuming a 50% diversity factor (p 5.3). There are 3413 BTU’s in one KW-hr.
RESULTS OF THE STUDY

Total Cooling Load
The total cooling load was calculated by adding the component loads as calculated by each team:

- Seating team: 9 tons
- Envelope team: 15 tons
- Propane team: 8 tons
- Electrical team: 6 tons
- Total load: 38 tons

Recommendations
A financial analysis was discussed by the class but was not formally done to determine the feasibility of this project. A local HVAC contractor was contacted to provide a budget estimate to install the required equipment. The following measures should be considered if the project proves feasible:

- Neglect the load due to natural gas in the kitchen.
- Provide exhaust air through the smoking area such that no other area is affected.
- Provide make-up air through the proposed packaged unit.
- Further consider Waynesville Building and Fire Code issues.
- Ensure the electrical capacity is adequate for the new AC unit.
If the project does not prove to be feasible, an optimum fan cooling system should be considered which will exhaust the heat produced within the restaurant. While this alternative will not provide the desired outcome, this option may minimize the discomfort of the summer patrons at a much lower comparative cost. Since about $10,000 per year is spent on electricity, other energy saving ideas should be investigated which will reduce the restaurant’s power bill to include:

- Fluorescent lighting in all fixtures within the restaurant.
- New windows with thermal glazing.
- A larger outside eating area.
- Swinging doors to isolate the kitchen from the dining areas.

Propane costs totaling just over $11,000 per year were found to be competitive with that of natural gas, but the owner might consider negotiating with local propane companies to obtain the lowest cost, most reliable propane supply available in the area. The lowest monthly propane consumption of the year was November, 451 gallons. Propane vendors might provide a price break to customers with higher, year round usage.

**LESSONS LEARNED**

**Computer Skills**

Most of the students in this course were freshman engineering technology students. They gained knowledge and experience with Microsoft Office programs such as EXCEL and WORD. The Internet was used extensively for research and information applicable to the project. In addition, the Envelope Team used AutoCAD to draw the floor plan and layout of the restaurant. These students will received coursework that included AutoCAD and ProEngineer design programs, but most had not taken these courses at this point in their study. They learned the programs on their own time, out of class.

**Critical Thinking**

This project was unstructured, and therefore the learning experiences of each student were unique. Students determined the scope of the project and team goals. The main focus for the professors involved in this project was to provide real world experiences for students new to the engineering technology profession. Discussions were held to determine the best course of action for each team. There were several right (and wrong) answers for each issue to be addressed, but students were given responsibility to choose courses of action based upon the time available. They also had to apply design calculations with which they were unfamiliar. This real world problem stimulated students to perform work outside of the normal course materials provided during in-class lectures and labs.

**Feedback from the Business**

The owners of the restaurant were very pleased with the work provided by students. They cooperated in providing electric and propane bills; they provided unlimited access to the restaurant before and after hours; and they were enthusiastic when discussing the project with the professors and students. However, the owners of the restaurant do not own the building. The initial cost estimates to implement the installation of air conditioning equipment appear difficult to justify based upon the amount of additional business that might be gained and the time remaining on the building lease.

**Conclusion**

This project captured the interest of students and provided a means for professors to present material in a unique format. The project was used in conjunction with lectures and labs to address ABET learning outcomes in an innovative learning environment. The Chancellor of WCU has directed the faculty to seek ways in which students can engage with the community in a learning environment. This project certainly achieved that. Also, proficiency in teaming skills must be one of the desired learning outcomes from any engineering technology program and those
skills are particularly highly valued with regional enterprises in Western North Carolina, as evidenced by feedback received from those industries.

Implementation of the project required the professors to ensure sufficient planning was done to schedule meetings and site visits with students and to complete the required tasks in one semester. They also had to guide their students technically, taking small steps into the design process to keep students interested and engaged. Some supplementary materials such as ventilation codes and design texts had to be provided by the professors and their contents explained in detail to students with little technical experience. All in all, this project was an innovative engagement project for freshman students in an engineering technology program. Learning experiences were diverse and unique for both the students and the professors.

REFERENCES


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