Session: FD2-1

FRESHMAN CAPSTONE EXPERIENCE: LAND DEVELOPMENT PROJECT

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Abstract

The first author teaches a course called Engineering Graphics, which is a hand drawing course for engineering students. There is not a need for a full semester on this topic and so the second half of the semester is a Freshman Capstone Experience. This is designed to introduce the students to parts of the engineering process, as listed below, even though they are not fully prepared to address all the problems. It also is designed to help increase retention in their selected engineering field. The class is broken into five groups: soil, drainage, economics, housing, and roadway and tell them to develop a 28 acre piece of land for single dwelling homes. This is done by having each group develop an engineering and economic design. The big question to ask – will we make money on this project?

1. Introduction

The first author teaches a course called Engineering Graphics, which is a hand drawing course for engineering students. There is not a need for a full semester on this topic and so the second half of the semester is a Freshman Capstone Experience. This is designed to introduce the students to parts of the engineering process, as listed below, even though they are not fully prepared to address all the problems. It also is designed to help increase retention in their selected engineering field. The class is broken into five groups: soil, drainage, economics, housing, and roadway and tell them to develop a 28 acre piece of land for single dwelling homes. This is done by having each group develop an engineering economic design. The big question to ask – will we make money on this project?

The structure of this project is to have the students turn in a series of reports – 25% Design, 50% Design, 75% Design and 100% Design. Their 100% Design Report is given as a presentation in lieu of a Final Exam and is graded by two practicing engineers and a senior engineering technology student. The grading is done through an assessment sheet.

Many of the skills for each group to be successful with their design are skills the students haven't learned yet – they're freshman! Each group has a mentor that fills in the blanks.

There are designs from previous semesters available as examples and a 25% Design Report is shown, which isn't much more than an outline. When the students are getting ready for submission of their 75% Design, we again show them a 75% Design Report. Both are attached.

The learning objectives for this project are:

- Show a complete engineering experience
- Develop Engineering Judgment
- Incorporate economics into engineering designs
- Establish good team work and inter-team skills
- Provide concrete incentive for good technical writing and oral communication skills
- Introduce Problem Solving Skills
- Showcase several areas within Civil Engineering

These learning objectives are assessed through the following means:

- Team grades on each design report
- Meeting with team to go over their grade and how to improve
- Pre- and Post-survey of the experience (randomly select students to be interviewed by education professionals before and after the experience)
- Written assessment of final presentations by outside reviewers

What may be the biggest challenge to the student is where to begin. The student probably thinks "I'm in a team that needs to design two styles of home, determine all the quantities of materials, make sure the design meets local, state, and federal applicable requirements, determine a cost to build the home, and a price that we can sell it at." No one tells him or her where to find this information and so they struggle. Some groups thrive on the open-endedness and some flounder or sink without the help of their mentor.

1.1 Site Description

The site is a plot of land 1200' wide by 1000' deep and is adjacent to a highway that runs between Thibodaux and Houma, Louisiana. They are required to have two main roads with certain specifications, as given by Terrebonne Parish, and the land drains toward the back where a drainage canal will be located. Typically, the students develop a sub-division with around 100 homes.

The students are told the project will take 60 months and through a marketing survey assume sale of 20% of our homes each year. They also own the land, equipment needed and have the following resources in-house:

- One Surveying Crew
- Four Housing Crews
- One Roadway Crew
- One Drainage Crew
- One Soil Crew

There are fixed costs associated with each crew in terms of labor and equipment. Depreciation and tax considerations are ignored. Each group has to justify their costs.

1.2 Requirements for Each Group

This section outlines the requirements asked of each group at the beginning of the project.

1.2.1 Roadway Group

The roadway group has the most important job – to lay-out the roads and without this, no one else can do their part. Once Roadway has laid out the streets and lots only then can the other groups begin their work. The requirements for roadway are:

- Give sub-division layout with all roads, lots, and completed elevations.
- Design cross-section for larger and smaller roads based on all local, state and federal applicable requirements.
- Design cul-de-sacs for all dead-ends
- Prepare necessary drawings
- Determine material and labor costs
- Present your findings as a written report and oral presentation

1.2.2 Soil Group

The soil group is tasked with the following efforts:

- Compute soil volume required to fill-up a depression that exists with the property
- Compute soil volumes to bring elevation up to as-built

- Design housing foundations, drive-ways, and sidewalks
- Prepare necessary drawings
- Determine material and labor costs
- Present your findings as a written report and oral presentation

1.2.3 Drainage Group

The drainage group is tasked with the following efforts:

- Determine the volume of rainfall from a prescribed storm event utilizing time of concentration models for sheet flow and open channel flow
- Determine the inlet spacing for the drainage system
- Determine the size pipes and quantity of pipe through the entire subdivision
- Determine the size open channel that needs to be built at the back of the sub-division
- Prepare necessary drawings
- Determine material and labor costs
- Present your findings as a written report and oral presentation

1.2.4 Housing Group

The housing group is tasked with the following efforts:

- Provide Floor Plans with two style homes (2000 sq. ft. and 3000 sf. Foot)
- Provide Landscaping views
- Provide Elevation Views
- Provide Material and labor costs for home broken into the following categories:
    a. Frame
    b. Plumbing
    c. Electrical
    d. Walls
    e. Cabinetry

f. Roofing

g. Floors

h. HVAC

- Determine reasonable asking price for each size house based on local market survey
- Present your findings as a written report and oral presentation

1.2.5 Economics Group

The economics group takes all the economical data from the other groups and determines whether the project, based on a present worth analysis, can be done at a marginal annual rate of return of 10%. The economics group is tasked with the following efforts:

- Prod other groups for economics data
- Provide Schedule of work for all activities that need to occur over the 60 month life of the project
- Provide cash flow diagrams based on economics data and determined timeline
- Conduct PW Analysis
- Present your findings as a written report and oral presentation

2. Literature Review

There has been a significant amount of research addressing the retention of engineering students in the first two years in an engineering program [1, 2]. The explanation appears related to a complex of several reasons including student attitude toward engineering, their self-confidence level, their interaction with faculty members, and their engineering aptitude. Our observation has also been that in the first two years student are mostly involved with the preparatory course of general education – mathematics, chemistry, and physics. They get little exposure to an engineering team process [3, 4, 5]. Consequently, it was decided to use part of the engineering graphics course to group students in teams assigned to address a more real world engineering problem like the one that has been explained. This gives students a chance to work in groups to solve a realistic problem, which is a more realistic engineering experience.

3. Methodology

This methodology section will discuss the following:

- What approach to mentoring seems to work best (it's important to formalize the mentoring process)

- How best to give constructive criticism during the group design report review (goes back to first point)

- How to asses more intangible skills such as “engineering judgment”

The approach for mentoring was to have mentors provide feedback to the various designs, 25%, 50%, 75%, during a meeting between mentor and group. Criticism during these meetings was given as the mentor went through their review of the design report and provided more information on design and economics as they saw fit.

Engineering judgment was assessed through providing open-ended problems that were solved during pre and post-surveys.

4. Assessment/Results

The assessment for this experience included the following: 1) Feedback on 25%, 50%, 75% and 100% Design Reports, 2) Pre and Post-Surveys, 3) Progress Reports to co-Mentor, 4) Assessment of Final Presentation, 5) Assessment of Final Report, and 6) Team Grading.

4.1 Design Reports

During the seven weeks, a 25%, 50%, and 75% design report was due. Each group was given an outline of how far they should be. Each groups mentor reviewed their document and sat down with them and discussed the review, and where the group should go from that point forward.

4.2 Pre- and Post-Surveys

Before, and after, the freshman capstone experience, surveys were conducted on 5 randomly selected students. These surveys assessed how well they understood the project they were working on and an opened ended problem to assess their problem solving skills; it should be noted that these surveys were more qualitative than quantitative. The results of this survey are as follows:

1. Students gained a better idea of what engineers do and how they do it

2. Problem solving skills increased

3. Students gained a better appreciation of all the skill sets needed to complete an engineering project

4.3 Progress reports to co-Mentors

Each Wednesday, each group filled out a 1-page form for their co-mentor who was a senior in another class. The idea was that the freshman capstone groups could freely communicated with an upper division student, who had been through the experience, and deal with various issues. The team mentor was expressly not part of this process.

4.4 Assessment of Final Presentation

Two engineering professionals and one upper level student assessed each group's final presentation. This along with the final report represented their grade for this section of the course.

4.5 Assessment of Final Report

The course instructor provides the assessment of group final reports.

4.6 Team Grading

A team grade will be implemented the next time this experience is conducted.

5. Discussion/Conclusions

How well did the project go and what could be done better in the future? The grades on the project were two A's, two B's and one C. This was assessed through the final report and three reviewers of their presentations. How well did it go?
The students gave their design presentation and turned-in their final reports, and what do we think about it all? The faculty realize they are freshmen, but still feel the quality of their presentations and writing are poor, and the faculty are to blame for some of this. The seven weeks we spend on this project are structured, but there could be more structure in the sense of having weekly activities involving lectures and problem based learning (see **Table 1**).

Week	Activity	Assessment	Timeline
8	Memo Writing	Write Instructions for building a wooden toolbox	
9	Learn Excel	Computer Based Learning	25% Design Due
10	Learn Economics, I	Solve Problems in Excel	
11	Learn Economics, II	Solve Problems in Excel	
12	Problem Solving, I	Solve Problems in Excel	50% Design Due
13	Problem Solving, II	Solve Problems in Excel	
14	Presentation Skills	Each Student gives a 15 minute presentation	75% Design Due

Table 1 - Experience

And how do we assess engineering judgment? The best that could be determined is to provide an open ended problem on both the pre and post-survey and provide lectures and assignments on problem solving. Currently, a more rigorous approach to assessing the development of the student's problem solving skills and using this as a surrogate assessment of engineering judgment is being created.

A more rigorous survey will be developed to more closely, and quantifiably, assess the proposed learning objectives.

6. References

[1] Astin, A.W. “Engineering Outcomes”, ASEE Prism, September, 1993, pp. 27-30.
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[3] Wankat, P. and Oreovicz, F.S., (1993) Teaching Engineering, Purdue University.
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