

## **2007: USING ADVISORY BOARDS IN THE CAPSTONE DESIGN PROCESS**

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# Using Advisory Boards in the Capstone Design Process

## Abstract

The Capstone Design Course has been developed in recent years through the active participation of the Department's Professional Advisory Board. This paper presents how the course evolved, the assessment tools for continued improvement, the relationship of the course to ABET's "a – k" and program criteria, and plans for future work. Included are the results of surveys as well as a description of the senior design projects.

At one time, the Department's capstone design course assigned civil and environmental engineering students to projects involving students from other engineering departments. The assessment data showed that this was not helping students prepare very well for careers in their profession. The course was modified to involve small groups of only civil and environmental engineering students working together on different small projects. The assessment of this method showed improvement but room for much more improvement. The Advisory Board suggested that larger groups of students work together in teams on larger projects and that all teams work on the same project to create a situation similar to several firms responding to a proposal.

In addition to providing understanding of the basic concepts of planning and design of engineering projects to the students, the main objective of a capstone design project is to encourage students to develop their coordination and collaboration skills working in teams and in various engineering disciplines.

## Introduction

At Southern Illinois University Carbondale, the Department of Civil and Environmental Engineering has approximately two hundred undergraduate students. The four areas of concentration in our undergraduate program are environmental engineering, water resources engineering, structural engineering and geotechnical engineering. In addition, we offer the twenty four hours of surveying courses required for state licensure as a land surveyor. We define proficiency in our areas by offering a junior level course (generally with a laboratory component) followed by a senior level design course, as well as two Faculty in the area. Our senior design capstone course is a two semester course which focuses on both the synthesis of technical knowledge and developing the soft skills needed for a professional career in civil and environmental engineering. The objective of this paper is to provide an overview of our senior design course. We will focus on the evolution of the course, the involvement of our professional advisory board, and the assessment tools used to evaluate our senior design projects.

## History of Curriculum

At one time, the Department's capstone design course assigned civil and environmental engineering students to projects involving students from other engineering departments. The

assessment data showed that this was not helping students prepare very well for careers in their profession. The course was modified to involve small groups of only civil and environmental engineering students working together on different small projects.

The common first semester experience involved forming teams and assigning the projects as well as lectures on ethics, the importance of professional licensure, project development skills, feasibility and cost estimation, and project management. In the second semester, the teams were required to present the preliminary and final design of a civil engineering project, including documentation of all stages of the design project. The final design required both a written and an oral presentation.

Our assessment of this capstone experience provided the motivation to revamp this approach. First, we acknowledged that the projects were too small and too limited in scope. Students were not encouraged to explore alternate solutions. Most importantly though, we acknowledged that the potential for multi-disciplinary projects within our broadly defined discipline was not being fully tapped. As with many programs, the faculty involvement in the project was limited to a few champions on a good day, but more generally, it was limited to the faculty member assigned to the course. In general, student presentations in the second semester were only attended by the faculty member assigned to the course and students in the first semester course.

Therefore, the approach was scrapped. In its place we developed a capstone experience based on larger projects developed through the involvement of members of our Professional Advisory Board. These projects are developed to include all four areas of our program as well as surveying. Because of the scope of the project, more students are needed for a team. The average team size is eight to ten students. In the Fall semester, we generally have three to four teams starting in the first of the two semester sequence of courses. In the spring, we have two to three teams. All teams are assigned the same project. In the spring, students completing the second semester of senior design present their designs to the Professional Advisory Board as part of the Boards spring meeting. This includes a one hour period where the team captains review the reports and CAD drawings of the project. In the fall, students completing the second semester of senior design present their design to local professionals.

This revamped approach provides several advantages. Since the student teams are all developing the same project, the students explore alternate solutions. The larger scope of the project provides the students with a true capstone experience that integrates more of the curriculum and the diversity of the civil engineering profession. It should be noted that the capstone experience still maintains the fundamental experience of project development skills, feasibility and cost estimation, and project management, as well as lectures on ethics and professional licensure. By involving the Professional Advisory Board, the project presentations are now actively attended by graduate students and Faculty. The professional interaction is beneficial at many different levels.

### **Professional Advisory Board**

One of the major components to our success with the capstone experience is our Professional Advisory Board. Our board meets in the fall and spring semester. Our fall meeting is primarily focused on assessment, strategic planning and partnership. Our spring meeting is focused on

developing and evaluating senior design projects. The Board is governed by an operating paper that promotes new membership through nomination by faculty, students, alumni and board members. Board members can serve for two four year terms. At the time of writing this paper, the Board consisted of members from the following professional affiliations: nine members from consulting, two members from state government, two members from the federal government, and one member from a professional society. Thirteen of the members are licensed professional engineers, structural engineers or land surveyors.

## **Projects**

The following two projects are examples from recent semesters.

### **Example 1**

SIUC has had a Business Incubator and Research Park to aid in the development of Southern Illinois for many years. In light of the success of these facilities and to further industry in this region, it has been decided to develop a light-to-medium industrial park within the are of the SIUC Farms.

The 63.6 acre tract is located along McClafferty Road (only access to site) just north of Pleasant Hill Road. This selection has good access from Route 51 through the use of the above mentioned roads. Also existing sanitary sewer, potable water, electricity and gas are available along McClafferty Road. A 20' wide buffer area is to be created around the perimeter to allow plantings as a screen.

The SIUC Industrial park is to consist of six five acre tracts with the remainder of the land to be divided in to tract no larger than 7.5 acres. Each of the sites are to be provided access and all utilities located within easements (25' wide). Roads are to be placed within a 60' right of way and be of a suitable design to withstand heavy truck traffic. Roads are to have a barrier cub system with storm sewer capable of handling all runoff, including proper detention/retention systems. The entrance will cross a wetlands area and the 100 year flood elevation is 441 MSL, this area is to be crossed by a bridge allowing a minimum of two feet of vertical clearance.

The sanitary sewer system for the site will connect to the existing City of Carbondale system along McClafferty Road. it has been determined that the systems from the industrial park must undergo pre-treatment and this facility is to be enclosed. This building should be of sufficient size to allow for the pretreatment facility, a small storage area for chemicals and a small testing lab all within the steel frame structure.

Potable water is to be provided to each of the lots within a looped system with fire hydrants placed at a maximum of 250' intervals. This system will connect to the City of Carbondale existing water mains along McClafferty Road.

The goal of this project is to create an esthetically pleasing, environmentally safe industrial area to work in conjunction with the existing Incubator and Research Park.

### **Example 2**

Pirate's Cove is located on Illinosis Route 13, approximately ¼ mile east of the east bridge crossing Crab Orchard lake. The Pirate's Cove Marina areas has been utilized as a marina on Crab Orchard Lake for approximately 55 years. Activities included boat

storage, boat and motor sales and repair and for many years the only source of fuel on the lake. The Crab Orchard National Wildlife Refuge, U.S. Department of Interior (client) has created a new marina at an area known as Playport Marina. Due to this fact, Pirate's Cove is no longer utilized as a marina complex.

A boat launch facility exists immediately north of Illinois Route 13 across from the Pirate's Cove area. This facility has major problems with parking and water depth, thus the Refuge would like to close this ramp and create a new facility with adequate parking and additional ramps. The decision has been made to create this water access facility in the location known as Pirate's Cove.

Your firm has been retained to design a dual double ramp water access facility with parking for a minimum of 160 vehicles and trailers and 20 vehicles. The boat ramps are to be Portland cement concrete and the roads and parking lots are to be bituminous concrete. A concrete restroom and maintenance building with basement for storage will be needed in the boat ramp area. Also, the retaining walls will be required to be replaced through out the site.

In addition to the ramp/parking area, the Refuge desires the development of two picnic/pavilion areas to be developed on the southwest portion of the facility. Access will be through a keyed gate along the existing roadway or a new roadway with a small parking areas at each site (10 spaces). A central restroom will be needed in the area between the two sites.

Potential environmental concerns for the Pirate's Cove area:

1. The underground gas tank will need to be removed and remediated
2. The existing building will be removed
3. The boat storage area was a common area for draining lower units and old batteries. This area may also need to be remediated.

## Assessment

Tables 1-2 provide the results of the assessment of the capstone design project during a spring meeting of the Professional Advisory Board. The first two questions on the assessment survey provides an overall score of the three teams based on the scale 1=poor and 4 = excellent (Table 1). The four point scale is used in order to have a score that correlates with the scale used for student grades. Here one can see evidence that each team had a unique approach to their presentations.

Table 1: Overall assessment of senior design projects and presentation (scale: 1=poor 4=excellent)

	<u>Team 1</u>	<u>Team 2</u>	<u>Team 3</u>	<u>Average</u>
Overall quality of the presentation	3.91	3.00	2.82	3.24
Overall effectiveness of the presentation	3.64	3.00	3.00	3.21

In Table 2, the assessment focuses on the professional components of the overall design project (the scale is 1=disagree, 4=agree.) These questions correlated to the ABET program criteria of civil and similarly named engineering programs. As with Table 1, there is evidence that the teams approached the projects differently. The results also provide the Faculty and students with specific areas of strengths and weakness within the project and the curriculum.

Table 2: Assessment of specific program criteria (scale: 1=disagree 4=agree)

	Team 1	Team 2	Team 3	Average
The project incorporated engineering standards	3.09	2.55	3.00	2.88
The project design is feasible	3.18	3.55	2.91	3.21
The project team demonstrated strategies and skills needed for the procurement of work.	3.27	3.27	2.64	3.06
The project team demonstrated competence in the use of modern engineering tools necessary for engineering practice, such and spreadsheets and CAD.	3.55	2.82	2.82	3.06
The project budget addressed appropriate costs associated with a project of this scope	3.09	3.36	2.70	3.05
The project team conveyed their understanding of how the design and construction professions interact to construct a project.	2.45	2.55	2.45	2.48
The project addressed environmental impact	2.91	2.91	2.73	2.85
The project addressed health and safety issues.	2.82	3.00	2.73	2.85

## Summary

This paper has presented a general overview of the capstone design experience in the Department of Civil and Environmental Engineering at Southern Illinois University Carbondale. In the future, we plan to increase the professional diversity of our board to include architectural engineering in the hope that the specialized knowledge in the areas of architectural regulations and construction management will improve the projects. We believe that this is an exciting way to approach the capstone experience that is constantly evolving.