

An Unique Approach to Civil Engineering Design Experience

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Abstract

The ABET required major design experience is fulfilled through a 2-semester course sequence for a total of 3 credit hours. The goal of the major design experience is to emulate the practice of planning and designing of a civil engineering project in a way that is similar to a typical engineering office setting. To achieve this goal, we have involved students from the freshman to the senior level classes, faculty, and the engineering community. In addition, we have executed the project within the constraints of a small program in a rural area. The objective of this paper is to share with colleagues our experience in “teaching” this civil engineering capstone design course and our plan to enhance the course further by involving the College of Business.

Introduction

The civil engineering program at Minnesota State University, Mankato (MSU) was approved by the Minnesota State Universities and Colleges in fall 2000. The program graduated its first class of civil engineering students in May 2003. One of the objectives during the development of the program curriculum was to offer students a realistic major design experience. Therefore, a 2-semester course sequence was included in the last year of the curriculum. The description and objectives of this design course sequence are not significantly different from the senior design courses in other civil engineering programs. We feel that the course at MSU is unique in the perspective of how the major design experience is organized. This paper presents our experience in “teaching” this civil engineering design course and the plan for further development.

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Civil Engineering Design

With the goal that civil engineering graduates should experience how a civil engineering project is planned and designed in a typical engineering office setting, the two-course design sequence focuses on both the overall design process of a project and on design calculations. The project team is also required to consider numerous non-technical factors associated with the project and to seek feedback on their preliminary design from the community. Moreover, the role of the students in the Civil Engineering Design courses resembles that of senior engineers in an engineering firm. They must plan, coordinate, communicate, and collaborate with each other. As a team, they are responsible for the quality and on-time delivery of the project. In addition to working with practitioners, the team obtains support from many other civil engineering and computer graphics classes for design calculations and drawings.

At the end of the year-long project, it is expected that the students will have an understanding of the professional practice issues in civil engineering such as: procurement of work; low-bid versus quality-based selection processes; how design professionals and construction professionals interact to complete a project; how the project impacts the economy and society; and how to be a team player in order to execute the project.

In most capstone design projects, the focus is in the activities within the design team and the interactions with the client and consultants (practitioners). The project team, senior design class, at MSU interacts or communicates with two additional entities—the **subcontractors** and **the public**. The subcontractors are the lower-division engineering or engineering elective classes which traditionally focus on a specific discipline of engineering. For example, the geotechnical engineering class is treated as the “expert” in soil mechanics and simple foundation designs. The public is the citizens who have interest in the project or may be impacted by the project. Figure 1 shows the organization, execution, and interactions among various parties of the civil engineering design project.

The project team, senior design class, is divided into specialized groups such as structural, geotechnical, transportation, and environmental engineering. When a design or analysis is needed from another class, the specialized group is responsible for defining the problem statement and providing the necessary guidance. The problem definition and the expected outcomes are then conveyed to the class (subcontractor) through a scope of work memorandum. For example, the structures group must provide the soil bearing pressure data in

order for the reinforced concrete design class to design the footings for the structure. To simulate a typical civil engineering office environment, the specialized groups also collaborate. For example, the structures group needs to get the soil bearing pressure data from the geotechnical group who in turn may have subcontracted the geotechnical engineering class for the analysis. The instructor of the reinforced concrete design class works with the structures group to ensure that the problem statement is well defined and the “subcontractor” students are prepared to perform the requested tasks. The reinforced concrete design students communicate directly with the structures group for any clarification, technical, and non-technical questions. A design report is then submitted to the structures group and to the instructor. However, it is the structures group that gives the final approval for the work with respect to the senior design course. The reinforced concrete design instructor assesses the performance of both the structures group and his/her class for technical performance and communication skills. The work performed by the subcontractors is counted towards the “subcontractor” course grade if the instructor desires. At the completion of the contract, the subcontractors and the structures group evaluate each other's communication performance. Communication and interpersonal skills are stressed extensively during this **subcontractor/consultant** arrangement. Project reports and memos are the official communication document between the subcontractors and the design team.

Almost all civil engineering projects have an impact on the public. The public’s concerns must be considered during a design process. The objective of the mock town hall meeting is to help the students recognize the societal impact of the project. In addition, it is an opportunity for the students to communicate with a less technically oriented audience.

In the academic year 2002-2003, the senior project, performed by five seniors, was the Cargo Facilities Addition at the Mankato Regional Airport. The project was suggested by the District 7 of Minnesota Department of Transportation. A summary on the organization and execution of the project and feedback from the students, faculty, and practitioners will be presented at the conference.

Remarks and Future Plan

The concept of the major design experience at MSU has been embraced by the engineering community throughout the State of Minnesota. The assessment result from the mock town hall meeting and final project presentation was very positive. In the 2002-2003 project, the design

team truly benefited from the critique of the mock town hall meeting. The final design offers a viable plan for the airport expansion. In addition to meeting ABET's major design experience requirement, this design experience also achieves the following:

- The major design experience is integrated throughout the program with minimal interruption to the more traditional curriculum.
- Students can gain a perspective of how different levels of their learning and knowledge contribute to a real-world civil engineering project.
- Students develop a good rapport with peers in their class and other classes and foster a mentoring relationship.
- The project forges more (perhaps better) interaction and communication among engineers, faculty, and students.

As the civil engineering program matures and the class size increases, we plan to require the project team to perform additional analysis and/or design. For example, students may be required to perform their own economic impact analysis instead of using the results of existing reports. We also plan to incorporate legal issues in civil engineering practice such as contract writing. The College of Business offers a course in Contracts, Sales, and Professional Liability which is an approved technical elective for our civil engineering program. We believe it is beneficial for the project team to work with the Business Law class to draft acceptable written contracts between the civil engineering design team and the subcontracting classes.

The senior civil engineering design course-sequence at MSU offers the students an experience of planning and designing a project in a typical civil engineering office environment. The design concept is integrated throughout the curriculum. The societal impact of the project is dealt with directly through the mock town hall meeting. Future plan to involve the College of Business would provide a true multi-discipline team work experience to our students. One important aspect of this senior design project concept is that it does not require a major reorganization of the curriculum and it can be implemented even in a small program. However, it does require faculty to interact, coordinate, and communicate more frequently.

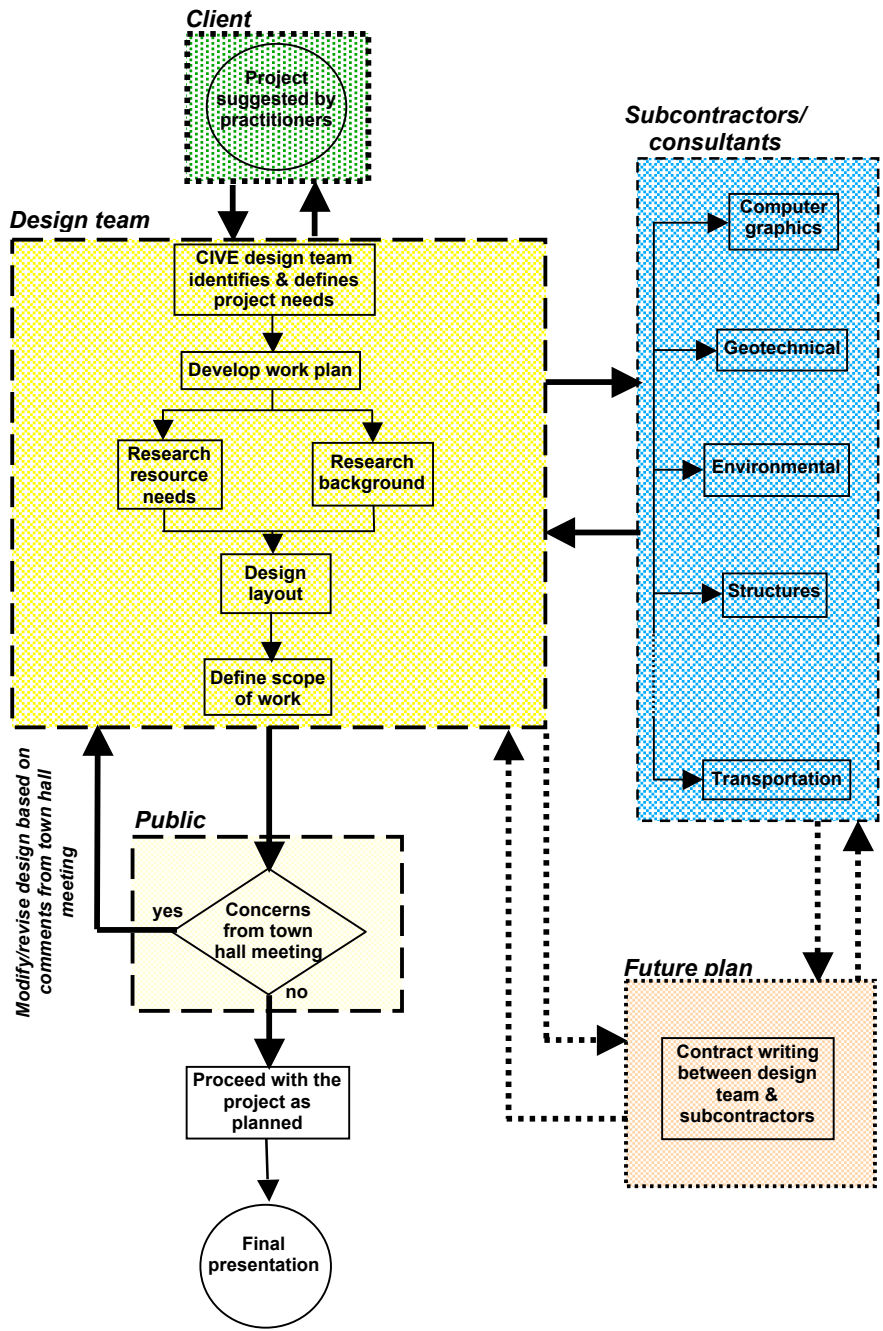


Figure 1. Organization and execution of civil engineering design project at MSU