

**Town Government, Industry, and University Involvement
in the Capstone Design Course at the
University of Hartford**

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Abstract

The capstone design project at the University of Hartford requires students to work on a “real” civil engineering project that is mentored by an engineering practitioner. This format is an excellent way in achieving many of the ABET 2000 outcomes. Finding projects that both enhance the educational experience of the students and meet the sponsor’s project requirements is a very time intensive process. Alumni, town engineers, state agencies, and engineering consultants have been requested to sponsor most of the design projects. Recent experience has shown that the university is also an excellent source of civil engineering projects. Discussions between the chairman of the civil engineering department and university officials identified several design studies that met our criteria for a successful project. This paper describes a project where students embarked upon designing several alternative conduits for connecting the university to a shopping area in the neighboring town of Bloomfield. Students were required to work with university officials, a town planner, a town engineer, and engineers from a local consulting firm. At the conclusion of the project, the students presented the alternatives and recommended design to the Bloomfield Town Planning and Zoning Commission.

I. Introduction

The civil engineering curriculum at the University of Hartford requires a capstone design project in the senior year. In 1993, the department revised the capstone design course so that students work on industry or town sponsored civil engineering design problems that include an engineering practitioner as part of the design team. This approach both technically challenges the students and also provides them with an opportunity to learn about the professional aspects of being an engineer. In addition, this format for the capstone design course is one of the most effective ways in achieving many of the ABET 2000 outcomes.

The capstone design project is taken after students have completed required courses in structural, transportation, geotechnical, water resources, and environmental engineering. Students are given a list of projects that incorporate one or more of the above areas of civil engineering. There are more projects than student groups so that each student can obtain professional experience in their area of interest. This arrangement requires that the sponsors understand that their project may not be selected.

II. Design Project Selection Criteria

From our experience, there are several criteria that must be met for a design project to be successful. With the proper preparation, a university sponsored design project can satisfy all of these requirements. First, a successful design project requires the commitment and cooperation of the students, sponsors, and instructor. Most students are excited about being involved in a project that will benefit the university and, therefore, will work hard to produce an excellent design report. The university officials must feel that the students can do a professional job and be willing to provide the students with all the necessary project information. The student's design team should also include a town engineer and engineers from a consulting firm. Including these practitioners in the design project will significantly enhance the students learning experience. This arrangement also benefits the town because their concerns can be addressed at the beginning of the project. Likewise, the engineering firm can benefit if the project moves forward into a detailed design phase. The requirements of the instructor include clearly defining the scope of the project so that it can be completed in a 15-week semester and promoting the active involvement of university officials, town engineer, and consulting engineer.

Capstone design projects also need to emphasize design, and not data analysis or research. The student's design should meet local or state design codes and the students should be aware of the permitting process required for completion of a civil engineering project. University sponsored projects that do not meet this criterion can still be used in other courses or as part of an independent study.

From our experience, students want "real" design projects and not just academic exercises such as designing a building that has already been constructed. This is especially important for students who have a difficult time being motivated by "academic" exercises. University sponsored projects meet the "real" design project criterion.

Modern engineering tools should also be available to the students working on their design project. If the department does not have the specific software packages required for a design project, the engineering firm involved in the university sponsored project is usually willing to provide the students access to their computer resources.

III. Example of a University Sponsored Design Project

The University of Hartford is actively involved in many projects that strengthen its relationship with the neighboring communities. For example, there is a desire to have the Town of

Bloomfield be more a part of the university community. By physically connecting the town with the University, it is hoped that this will improve the involvement of the town in university activities. Discussions between the chairman of the civil engineering department, university officials, and the Bloomfield town planner led to the “North Campus Road” project.

During the first class meeting of the senior design course, students received a description of all the design projects. Both groups that were interested in working on a transportation project selected the North Campus Road project. The interest expressed by both groups to work on this project indicated the excitement that students had for being involved in a project sponsored by the University. A coin flip was used to determine the team that would work on the North Campus Road project with the “losing” team working on a project sponsored by the Connecticut Department of Transportation.

For the North Campus Road project, the students were required to meet with university and town officials, determine the objectives of the project, obtain necessary data, go on a site visit, design alternative horizontal and vertical alignments that met town specifications, and perform a preliminary cost estimate. All design groups were required to make an oral presentation and write a final report.

The students had a meeting with University officials, the Bloomfield town planner and engineer, and a consulting engineer to better understand the objectives of the project. The students were also informed about the properties that the university was interested in purchasing. Having lived on campus for the last four years, the students also knew that there was a need to have better access to shopping. With the existing network of roads, students either had to travel about five miles to reach the shopping center in Bloomfield or had to go to West Hartford. The proposed road would reduce the distance to the shopping center in Bloomfield to about one-mile. From their own experience, the students also recommended that the road include both a sidewalk and a bike path. From this meeting, the students determined that the objectives of the project were to:

- Connect the Town of Bloomfield to the University of Hartford
- Provide convenient shopping access to the 3400 students living on campus

The group then listed the following design goals for the project.

- Design road to meet the “Standard Specifications for the Design and Construction for Subdivision Improvements for the Town of Bloomfield”
- Maximize the use of existing right-of-ways
- Minimize wetland impact
- Maximize the amount of land adjacent to road that could be developed by the University
- Provide an impressive entrance to the University
- Include sidewalk and bike path
- Minimize cost of the project

A meeting was also held at the consultant engineer's office to learn how an engineering firm would perform a preliminary design study. Topics discussed included wetland permitting requirements, federal versus State of Connecticut wetland classification, design of railroad crossings, and importance of documenting your work.

The next task was for the students to obtain the necessary data for designing the alternative conduits. Because the proposed road would be located in both Hartford and Bloomfield, this turned out to be a time consuming task. Maps were obtained from the Metropolitan District Commission, the Town of Bloomfield, and an engineering firm that had worked on a housing project in vicinity of the proposed road. The students had to interpret the data because the maps contained conflicting information. Instead of performing a field survey which was not considered to be part of a capstone design project, the students visited the site to observe the location of existing culverts, the location of sanitary sewers that were installed about ten years ago, and the condition of the wetlands. Based on their observations and from discussions with the Bloomfield town engineer, the students incorporated all the data into one map.

Three alternative conduits were then added to the map. Each alternative had its advantages, but none of the conduits met all the design objectives. Before proceeding any further, it was decided to have second meeting with university and town officials. In order to hold an effective meeting, the students prepared a map showing the three alternatives and a handout listing the advantages and disadvantages of each alternative. The town planner eliminated one of the alternatives because that alignment would not have allowed the Town of Bloomfield to build a potential light passenger rail station. The other two alternatives were viable options, but required slight modifications. For example, the students were informed that the road should not bisect small parcels of land. This would make it difficult for the future development of the property by the University. The meeting was very successful because the students were well prepared and the town and university officials were committed to being actively involved in the project.

The students used Town of Bloomfield specifications to layout the horizontal and vertical alignment of the two alternative conduits. This demonstrated a number of ABET 2000 outcomes. For example, the student's showed the ability to:

- Apply knowledge of mathematics, science, and engineering;
- Analyze and interpret data;
- Design a system, component, or process to meet desired needs;
- Identify, formulate, and solve engineering problems; and
- Have knowledge of contemporary issues.

Also, industry involvement in the project allowed the students to "use modern engineering tools necessary for engineering practice". The students could have done the design work using civil engineering department software, but the road design was greatly enhanced by using state of the art software.

The North Campus Road project provided the students many opportunities to present their design to a variety of audiences. Students first discussed their design and cost estimate to university and town officials at an informal lunch meeting. The sponsors were impressed with the design work done by the students and the Bloomfield town planner recommended that the students present their work at the next Bloomfield Town Planning and Zoning Commission official meeting. Students prepared poster boards that clearly showed the design alternatives and prepared handouts for the Planning Board members. The meeting provided the students not only an opportunity to present their findings, but also to answer questions from planning board and community members. At the end of the question and answer session, one member of the board who was a professional civil engineer stated that he was very impressed with the quality of the presentation. He also compared it to his own experience as an engineer and commented that neither he nor his classmates ever had the opportunity to work on a real project like this.

At the end of the semester, all student design teams are required to make an oral presentation to their sponsors. The students working on the North Campus Road project were very well prepared having just presented their design to the Town Planning and Zoning Commission. There were many questions from faculty and students about the project because of its relevance to the university. The commitment by the university to the project was further enhanced when the president requested that the students present their design to the Board of Regents.

Documenting the results was a very important part of the North Campus Road project because other students and/or engineers will be referring to the preliminary design when working on subsequent phases of the project. This aspect of the design project is stressed in the course by having a technical writer co-teach the course. Examples of reports written by engineering firms are given to the students so that they can become familiar with the format of a professional report. Before correcting problems with sentence structure and grammar, the major emphasis is on the importance of writing a well-organized report that is easily understood. Students first hand-in a detailed outline and discuss it with the instructor. Next, students write a rough draft that is first reviewed by a technical writer. The technical writer meets with each group separately to discuss techniques that will improve the report and schedule additional meetings, as required. After correcting the grammatical errors, students meet with the instructor to review the technical content of the report. The final report is then written and submitted to the instructor and project sponsors.

IV. Continuation of the Capstone Design Project

University and town officials were interested in the project continuing into a more detailed design phase and were committed to staying involved in the project. Students are now designing the drainage for the road and are researching techniques that can be used to mitigate the wetland impact. The ultimate goal of this independent study is for the student to present their design to the Bloomfield Wetland Commission.

V. Assessment of the North Campus Road Project

Several tools were used to assess the effectiveness of the North Campus Road project for meeting the ABET 2000 outcomes. First, engineering professionals that attended the oral presentations were asked to evaluate the presentations. The evaluation form included ten questions about the technical content and organization of the presentation, student's knowledge of the subject, quality of the visual aids, vocal delivery, and ability to answer questions. Overall, the evaluations were excellent with scores ranging from 88 to 98 out of 100. The highest scores were received for the technical content and ability to answer questions. Areas that the students needed to improve were maintaining eye contact with the audience and eliminating distracting mannerisms. In addition to the formal evaluations, informal comments were solicited from those directly involved in the project. University officials stated that they were very pleased with the design and the professional work performed by the students. The engineering mentors commented that the experience gained from the capstone design project would significantly reduce the time required for students to become productive practicing engineers. The final assessment tool was student evaluations. In almost every category, the students ranked the North Campus Road project as excellent.

VI. Conclusions

Outside sponsored senior capstone design projects are an excellent method for meeting many of the ABET 2000 outcomes. It is important to select projects that benefit the educational experiences of the students and meet the sponsor's project requirements. Over the past 7 years, the civil engineering department at the University of Hartford has relied on alumni, town engineers, and engineering consultants on providing projects. Recent experience has shown that the University is also an excellent source of civil engineering projects. The active involvement of the university officials, town engineer, consulting engineers, students, and instructor can lead to a very successful design project. For the North Campus Road project at the University of Hartford, this cooperation enabled the students to present their design to the Bloomfield Town Planning and Zoning Commission. Similar opportunities may exist at other universities that use outside sponsored capstone design projects.

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