Session 3551

Using Concepts in Environmental Engineering to Introduce Freshman to Engineering Design

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ABSTRACT

In response to changing curricular requirements, industrial concerns and student retention problems, more and more institutions of higher learning are embracing the concept of introducing engineering freshman to design problems during their first year of study. The discipline of Environmental Engineering can provide numerous examples which are suitable for entering engineering freshman to study as a design exercise. At New Jersey Institute of Technology, faculty from the Departments of Civil and Environmental Engineering, and Chemical Engineering, Chemistry and Environmental Science team teach a freshman engineering design course in which student teams site and design a proposed roadway connecting two existing highways with the objective of minimizing adverse environmental impacts.

The students are divided into four (4) person teams in a course that meets once (1) a week for fourteen weeks. The students are issued maps and told where the highway connections must be made. The student teams must initially identify three (3) potentially feasible routes and justify which one they finally select. The culmination of the course is a written report and an oral presentation by the student group articulating the basis for their selected route to their classmates and faculty.

Based on student evaluations, the course is perceived as challenging and is well received.

INTRODUCTION

As an outgrowth of administration concerns and an educational initiative by the NSF Gateway Coalition, a series of introductory freshmen engineering design courses were developed in civil, mechanical, electrical and chemical engineering at New Jersey Institute of Technology (NJIT). The goals of the undertaking were to move engineering design into the freshman year, ignite interest in freshman about engineering by hands on experience, improve student retention and initiate curriculum change. The courses developed were coupled with humanities and computer components to integrate these course contents with the engineering course. The overall objective was to enable freshman to work on real engineering problems as they begin their education rather than leaving the design experience as a traditional senior capstone design course. Thus freshman would gain hands-on experience, learn how to develop feasible solutions to an open-ended problem, work in teams, and learn how to present the results of their effort orally and in written form.

In an attempt to meet these goals an interdisciplinary environmental based freshman engineering design pilot course was developed. The course was team taught by faculty from the Civil and Environmental and the Chemical Engineering Departments. The design problem was based on the siting of a roadway to minimize air pollution at neighboring sensitive receptors.

SITING OF A ROADWAY TO MINIMIZE AIR POLLUTION

A fourteen week course was designed which met once a week for three hours per meeting. Student teams are presented with the problem of developing a four-lane expressway to connect between two major highways. The proposed highway route is selected based upon consideration of land cost, social, political and environmental impacts. Air pollution levels (i.e., carbon monoxide concentration levels) are found by use of CAL3QHC[1] software, which allows calculation of carbon monoxide and particulate matter from auto exhausts within proximity of the roadway. The culmination of the course is a team generated written report and oral presentation. Student group size was a function of the number of students in the class with the team number being between three and five members.

In each study, a USGS quadrangle map, soil information (prepared by the Soil Conservation Service, US Department of Agriculture), and other information regarding site selection criteria, engineering cost figures and projected highway traffic volumes were provided to each group. Students were asked to prepare a work schedule early in the project. Professors then met individually with each group every week to assess their progress and discuss and resolve the problems they encountered. Their progress

was measured according to their proposed schedule. Work turned in from the previous week is evaluated and returned to the team.

The basic engineering design concept such as project planning and scheduling, site selection considerations, alternative design determination and decision making are learned through the design and analysis of an environmentally based problem. At least two professors worked together in each course. This type of case study is ideal for interdisciplinary engineering problems conducted through faculty collaboration.

COURSE PARTICULARS

In order to aid the students in completing their course requirements, the following materials and/or topics were presented:

- An introduction to the project and the scope of work expected from the students.
- A list of material and/or data that the students perceived as needed to complete the project, and suggestions regarding obtaining published data from the respective agencies reporting same.
- A lecture related to the chemistry of air pollution, the pollutants for which Ambient Air Quality Standards exist, and the potential for adverse impacts associated with specific air pollutants.
- A lecture on NEPA (i.e., The National Environmental Policy Act), and the contents associated with environmental impact statements as developed under the NEPA Act.
- A lecture on utilization of the CAL3QHC[1] and Mobile 5a[2] software available through the U.S.E.P.A. for estimating mobile emission levels from vehicular sources at various time horizons, and for estimating peak hourly carbon monoxide concentration levels at receptors close to the proposed highway.
- Introduction to construction cost manuals to assess, for the final alignment chosen, the cost to construct the proposed highway.
- Presentation of guidelines in preparing the written report and in developing oral presentation associated with the course.

In addition to the above, continuous (i.e. weekly) dialogue and feedback on the project was maintained between the student groups and the instructors during normal classroom hours. The weekly meetings insured that the students remained on schedule and were able to proceed through the course.

Students were also able to meet with the instructors either during their normal posted office hours, or by appointment. The intense interchange associated with the course provided the freshman students with a unique opportunity at that level to work closely with their instructors. The course also limits the enrollment to twenty students. As such, a maximum student to teacher ratio of 10:1 (i.e., two instructors are assigned to the course) enables both students and faculty to relate closely with each other. This course concept is quite different from the traditionally large student enrollment found in

many freshman classes, and this is probably an important factor in the value of this course to the students.

IMPACT OF THE COURSE

Students have benefited by taking the case study course in the following ways:

1. The case study course is designed for engineering students in the first year of their college study. This exposes students to the design process up front. It also makes them understand the practical aspect of design behind the theories they are being taught.
2. Students learn how to search for and make use of engineering design information such as cost estimates, maps (geological and geographic), regulations, building codes, soil surveys, etc.
3. Students use internet and computer software for evaluating air quality impacts, for information searching, report writing (word processor, spread sheet), and oral presentation.
4. Oral and written communication is taught and practiced in the class.
5. Students learn to work as a team.
6. This project can help to facilitate engineering curriculum change.

Overall student reaction to the case studies was positive, and surveys indicate the students found the experience worthwhile. The involved faculty also found the endeavor both challenging and exciting. This approach has led to positive changes not only in the freshman year but throughout the curriculum. An added benefit of this type of course and its format is that not only is it readily transportable to other institutions but it also requires little resource investment.

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