

# INTERDISCIPLINARY TEAM TEACHING OF ENVIRONMENTAL ENGINEERING DESIGN PROBLEMS TO FRESHMEN ENGINEERING STUDENTS

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## ABSTRACT

Four (4) fourteen week courses were developed to introduce freshman engineering students to “realistic engineering” through the design and analysis of an environmentally based problem.

The design experience for each individual freshman course was:

1. Siting a Municipal Landfill in a Residential Community.
2. The Design and Siting of a Municipal Wastewater Facility.
3. The Siting of a Hazardous Material Manufacturing Facility(in a Residential Community).
4. The Siting of a Roadway to Minimize Air Pollution.

In addition to homework assignments, students were required to make an oral presentation and to write a report on their solution to the design problem. Student evaluations indicate that the course is well received and is a worthwhile experience.

These courses involved faculty from the Department of Civil and Environmental Engineering and the Department of Chemical Engineering, Chemistry and Environmental Science team teaching the course. This type of offering is ideal for interdisciplinary collaboration by faculty, requires very little resource investment, and is easily instituted by other institutions.

## ENGINEERING DESIGN PILOT COURSES

In response to a perceived need for curriculum innovation in the freshman year, a philosophy of introducing “engineering up front” was developed. This approach involved the development of engineering design courses and introducing them in the freshman year. The course content was to introduce students to concepts of teamwork, “realistic engineering”, independent work, oral and written communication aspects of technical reporting, and experimental measurements and analysis.

In an attempt to meet these goals, a series of four (4) interdisciplinary environmental based freshman engineering design pilot courses were developed. The courses were team taught by faculty from the Civil and Environmental and the Chemical

Engineering, Chemistry, and Environmental Science Departments. The four (4) pilot courses taught over a span of three (3) semester were:

#### I. Siting of a Municipal Landfill in a Residential Community

The design problem was to site a municipal landfill for a community consisting of 45,000 households of typical size. The criteria provided were twenty (20) pounds per day of refuse generated for each household, a landfill life of twenty (20) years with maximum lift height of twenty (20) feet, using compactor trucks of 28,000 pounds capacity and with two (2) pickups per week. Site analysis was to be done for both no recycle and recycle scenarios. The students were divided into teams and were required to investigate three to five potential sites of their choosing. From the five or so sites they had to select the best site, investigate the cost of development and environmental, political, and social restrictions. The culmination of the course was a written team report detailing their considerations and recommendations to address the design problem followed by an oral presentation to their classmates and faculty. The course as taught was fourteen weeks in length meeting once a week for 130 minutes.

#### II. The Design and Siting of a Municipal Wastewater Facility

The problem in this course, which went for fourteen weeks, once a week for 130 minutes, was to design and locate a municipal wastewater treatment facility. The plant was to serve 45000 typical households using 80 gallons of water per day per person. Again the students were divided into teams, asked to locate and investigate three to five sites, look into cost and investigate political, social and environmental restrictions. Based on analysis they would select the most promising site, write a team report and present their conclusions to their classmates and faculty.

#### III. The Planning and Siting of a Manufacturing Facility Using Hazardous Materials

The class meets for fourteen weeks, once a week for 130 minutes. The problem is based on locating a facility, which uses materials that are classified as hazardous to manufacture a product. In this case the plant produces aspirin. As in the other case study student teams are formed and investigate the location of three possible sites from which they select one based on their analysis. Factors to be considered include estimated market share, plant safety, environmental, economic, political and social implications. Based on these factors a site is selected and a team report is written followed by an oral presentation to classmates and faculty.

#### IV. Siting of a Roadway to Minimize Air Pollution

A fourteen week course which met once a week for three hours per meeting. Student teams are presented with the problem of developing a four-lane expressway between two major highways. The proposed highway route was to incorporate consideration of land cost, social, political and environmental impacts. Air pollution levels

were found by use of CAS3QHC software, which allows calculation of carbon monoxide and particular matter from auto exhausts within proximity of the roadway. The culmination of the course was 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, USGS Quadrangle map, soil information (prepared by Soil Conservation Service, US Department of Agriculture), and other information regarding site selection criteria, engineering cost, soil investigation 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 the problems 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, restrictions, alternative design, determination of the design parameters, 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.

#### IMPACT OF THE COURSES

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

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 theories.
2. Students learn how to search for and make use of engineering design information such as cost estimate, maps (geological and geographic), regulations, building code, soil survey, etc.
3. Students use internet and computer software (word processor, spread sheet, presentation) for information searching, report writing, 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 facilitate engineering curriculum change.

Overall student reaction was positive to the case studies, and surveys indicate the students found the experience worthwhile, while the involved faculty 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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