Session 1793

Sophomore Introduction to Civil Engineering Systems

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Abstract

A sophomore level course is described which provides an introduction to the field Civil Engineering and Civil Engineering practice. It uses the area of Land Development as a model which naturally encompasses Surveying, Environmental, Transportation, Geotechnical and Water Resources Engineering and some aspects of Structural Engineering as well. The topic material is based on city and county regulations and design requirements and requires only basic mathematics skills for analysis. The course also provides an introduction to CAD and uses these skills for both homework and projects.

Introduction

Many schools do not introduce the major engineering disciplines until the junior year, at which time the students are expected to understand why they take a broad range of engineering courses and why and how those courses relate to each other. Among the consequences of this delay are lost interest, frustration, and student withdrawal from the major or even the college. None of these outcomes provides the motivation to induce outstanding students to stay for the last two years of college.

The Civil and Architectural Engineering Department at the University of Wyoming instituted a sophomore level course in Spring 2003 to help combat these shortcomings. Entitled "Introduction to Civil Engineering Systems Via AutoCAD", the three-hour course has three objectives. The students are introduced to elements of the major areas of civil engineering practice, to plan reading and drawing, and to AutoCAD. This is accomplished through the process of modeling land development engineering. The course has been offered two semesters and is a required course for this year's sophomores. This paper will discuss the background of the course, its objectives, its syllabus and the relation of the lab to the course.

Course Background

Just like a business, a department in a college is only going to be successful if it can attract students to join the department and then provides enough "value added" content to keep those students. Students commonly enter engineering at the suggestion of their high school counselor, their parents or their friends because they are "good in math and science". They may not have researched to get a good picture of what engineers do in general, and the types of activities engineers in each discipline area does. Many schools have implemented courses to introduce the freshman to the college and the discipline areas of engineering, but usually the depth of introduction is fairly shallow, maybe one lecture or less per discipline. Hence, students, whether they are declared or undeclared, often have only a fuzzy concept of what is common practice in a given discipline by the end of the first semester of freshman year. Unless they become active in the student professional society, most will finish freshman year with little more understanding than when they started freshman year, except that engineering involves a lot of calculus, physics and chemistry.

Students in some Civil Engineering programs take a course in Surveying during sophomore year. While this shows that civil engineering involves measuring the surface of the earth and determining boundaries, little more about the nature of civil engineering is determined. Finally, the students that have stuck it out hit the wealth of courses in Civil Engineering during junior year. However, each course is normally taught as a separate entity, usually relating very little to other courses being offered at the same time. It finally takes until senior year that the students have enough knowledge to be able to synthesize that civil engineering is a whole, with all the pieces working together to make a successful project. Indeed, that is one of the purposes of the senior design/capstone course.

Other academic programs have 1000 level courses, with titles like, "Introduction to Psychology" and "Introduction to Biology". These are survey courses and provide a broad overview of the discipline with sufficient depth of coverage that the students can begin to select their area of interest.

CE 2100 – Introduction to Civil Engineering Systems Via AutoCAD

"An Introduction to Civil Engineering Systems Via AutoCAD" was developed to fulfill three broad goals. It is to give an indication of the breadth of the field of civil engineering by touching on topics from as many CE courses as possible. It should also show that the courses are interrelated, that a design requires knowledge of all areas, not just a specialty area that the students may emphasize later.

A second goal is to give the students some experience in reading and creating engineering documents. Plans are available from projects of all aspects and all sizes from a six acre subdivision having eight sheets to the plans for the engineering building expansion that has several hundred sheets. There are examples of structures, dams, water and sewage treatment plans and specification books. Students are given assignments to select plans and to locate minimum and maximum elevations, lateral extends, foundation

types, and special features which can only be determined by working through the drawings.

The third goal is to teach AutoCAD. "Do you know AutoCAD?" is still the most common question students are asked during job interviews. By learning it during the sophomore year, it becomes a tool that they can use throughout their college career.

The course was developed to fit into the curriculum between Surveying in the Fall of sophomore year and the breadth of CE courses at the junior years. Because it uses land descriptions and legal documentation, Surveying is a prerequisite course. It also functionally limits the class to Civil Engineering students. The course also has a co-requisite of Mechanics of Materials to ensure that the students are serious about going into Civil Engineering. One purpose of the course is to prepare the students for the junior year courses and to indicate not only that these courses are valuable but also how the student will be applying that material when they are out working in practice.

The course is a three semester hour course with two hours of lecture and an associated three hour lab. A difficulty is that there does not appear to be a textbook that covers this type of material. Lacking a suitable textbook, selecting the topic material to fit the requirements for the course became more difficult.

Land Development Model

Having as broad requirements as was desired for the course, it was difficult to determine the best way to put the course together. While attending a county commissioners planning meeting, it occurred to me that questions came from all areas of practice. Also, the questions were technical but not highly theoretical. In setting up meetings with both the county and city planners, it became apparent that the course could be structured around land development with much of the work following city and county specifications. Secondly, in my own experience, I worked for a land development firm during the summer after my junior year. During the evenings, I would assist the engineer with water and sewer drawings and during the day, install them with the construction crew. Knowing that I was a laborer who was working from the construction documents I was drawing at night gave me confidence that students between sophomore and junior years could do similar drawings.

Local consulting engineers and surveyors, land developers, real estate agents, the city and county planners, the city engineer, the city attorney, title insurers and others were interviewed to get a clear picture of what topics should be covered. When all the pieces were put together, the course structure naturally included topics from surveying, environmental engineering, construction, transportation, hydrology, water resources, hydraulics and geotechnical engineering, with some structures available for small buildings like pump stations, small bridges and others. It included all area of practice that we teach yet it could be done at level requiring just algebra and trigonometry. What was truly interesting was that county and city regulations specified minimum design requirements that are adequate for most small scale developments.

The basic course structure, topic list and timing are:

Introduction – A brief history of civil engineering, what it encompasses, how it relates to our courses and the direction of the class. (1 day)

Legal Structure – Starting with the U.S. Constitution and the nature of State's Rights down through the hierarchy of federal law and regulations, state law and regulations, county resolutions and city codes, and finally subdivision covenants which the engineer will commonly help produce. (2 day)

Ownership and Description of Land – Starting with the original patent rights on the land, legal title and ownership, title search and insurance, the public land surveys and land division, to surveying and legal boundary descriptions including length and bearings and curve descriptions. (3 days)

Planning and Zoning – Starting with ancient concepts of town layouts from the Greeks to medieval times, the colonization of the western hemisphere, Phillip II's Rule of the Indies, French and American city planning including railroad towns and modern inclusive communities. Achievement through code, zoning and covenants. (2 days)

County Resolutions – The laws and guidelines for developing in the county. Discussion of preliminary and final plats, lot sizes and limitations, easements, water wells and septic systems, easements, and roads. (5 days)

Wyoming Public Works Standard Specifications (2 day)

City Services – What are cities legal required to provide as specified by state constitution and statute, what the public expects a city to provide. Funding and taxes. (2 days)

City Codes – Preliminary and final plats, Laramie Developer's Guide, planning and zoning, rights of way and easements, subdivision grading, water supply from the watershed to the tap including storage and fire flows, sanitary and storm sewer systems from house outfall to the plant, storm water retention ponds, roads – slopes, intersections and vertical and horizontal curves. Planned Unit Developments (9 days)

Subdivision Design and Presentation (1 day)

The course material has been written in html and is currently available at

http://wwweng.uwyo.edu/classes/ce2100, however that site may change in the future.

CAD Laboratory

Given this topic material, it was important to integrate the CAD portion of the class into the lab. The lab time is devoted largely to development of drawing skills and

understanding of graphical presentation. A good set of texts by Shrock[1,2] provides the basic AutoCAD tools.

The course is integrated into the lab through the homework assignments.

Assignments include:

- Plat layout from a legal land description,
- Design of a septic system and drawing plan and profile,
- Hand sketch and drawing of a county subdivision on a topographic map,
- Drawing of a wooden bridge (This is the midterm project and is quite involved, the students work for two weeks on parts of the drawing and a third week bringing the parts together into a single scaled drawing.)
- Road cross-sections
- Road and sewer profiles
- Final Project
    - Preliminary Plat
    - Final Plat
    - One sheet of construction plans and profiles

The final project is based on designing a subdivision for a 105 acre plot in the city of Laramie. An actual preliminary plat was developed for the site, but no construction has taken place on it. Hence, the students have the legal boundaries, outside owners, topography, etc., but have an open space to design what they want. Though basically square, the site has a rather steep cliff going across the northeast corner of the property. This is a difficulty and the way in which the students design around that feature influences the final design. The final plat is based on one section of their preliminary design that includes three intersections. The construction drawing is then based on the plan view of the longest street section.

During the last class period, the students present their designs to the landowner. He then discusses the history of the site and the ideas that he has to develop the site in the present community and financial climate.

Student and Professional Support

At this point, the course is being taught a third time. Student response has been uniformly favorable. As it has not been a required course until this semester, many juniors and seniors have taken it because it teaches AutoCAD. They did not expect to gain much from the main course material. Many comments have come back saying "I wish I had taken this course three years ago", and "Now I understand why we did and assumed a lot of things in my junior and senior classes." Equally or even more importantly, the sophomores have indicated that they have a much better understanding of the field of civil engineering and are ready to take the junior level classes.

From a practical point of view, the students have realized that this is a very fundamental course and is very focused on engineering practice. The consulting engineers who have seen the notes have expressed their support of the course. I commonly hear statements like "I spent my first five years doing this 'stuff'" and "This is what my firm does for a living." The students know that bringing in their assignments and project work to interviews will give them a significant advantage in both summer work and their first job after graduation.

Local Codes Nationally

While this course is naturally built around the local Albany County, Wyoming Resolutions and the City of Laramie, Wyoming Ordinances, it has been observed that the general guidelines are similar throughout most of the country. Comparing city ordinances from Nome, AK to Newport Beach, CA to Las Vegas, NV shows a great similarity in the layout and the types of laws. It appears that many codes have been written based on model codes over the past twenty years, making the general code sections identical or similar. While local variations exist, the physical laws still hold true. There are generally accepted guidelines on minimum and maximum slopes of sewer lines, sight stopping distances on roads, minimum lot sizes, etc. Therefore, it appears that similar courses using local codes could be developed in a large number of communities.

Conclusions

A sophomore level course has been developed to introduce students into the field of civil engineering. Strongly based on the required Surveying course, the main body of the course is centered on local city codes and county regulations. This material is related to topics which the students will be learning in their junior and senior level courses. The course material is integrated into assignments for the laboratory session introducing AutoCAD. Student and professional acceptance of the course has been very high and consultants have been very supportive of the course as it addresses the work that they do. It appears that similar courses could be developed at other schools because the nature of city and county law is similar in many locations.

Bibliography:

1) Shrock, C.R. (2000a), "Exercise Workbook for Beginning AutoCAD 2000", Shrock Publishing, Newport Beach, CA. ISBN 0-9640934-7-2.

2) Shrock, C.R. (2000b) "Exercise Workbook for Advanced AutoCAD 2000", Shrock Publishing, Newport Beach, CA. ISBN 0-9640934-6-4.

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