

A New Dimension for Civil Engineers

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Dear Professors Hon-Yim Ko and Milan Halek:

As a senior civil engineering (CE) student at the University of Colorado at Boulder, I am writing to suggest an area of potential development in the CE curriculum: I propose that the three-dimensional (3-D) AutoCAD class, AREN 1027, be incorporated into the education of CE students because they are expected to design in 3-D AutoCAD. I propose this for several reasons. First, a CE must be able to interact with an architectural engineer. Moreover, civil engineers need 3-D AutoCAD to apply its additional features to design. Finally, CE students need to know 3-D AutoCAD in upper division classes. CEs are not required to learn 3-D AutoCAD because the college assumes that architectural engineers will be the only ones doing detailed design work. However, it is no longer the case that only architectural engineering students need higher-level design classes such as

3-D AutoCAD. This is due to the increase in computer usage in the CE work force.

Enclosed is a copy of my research on this issue as well as suggestions of how to incorporate 3-D AutoCAD into the CE curriculum. I look forward to your prompt reply.

Sincerely,

Shannon K. Bonjour

Enclosure

Curriculum Background

In the current curriculum, CE and architectural engineering students are required to take Engineering Drawing (AREN 1017). This course is divided into two sections. The first section of the course teaches techniques of drawing by hand, and the second section covers similar drawing techniques in two-dimensional (2-D) AutoCAD. The following course, Descriptive Geometry (AREN 1027) teaches how to apply 3-D AutoCAD to design and is a requirement for architectural engineering majors, but not for CE majors. Since AREN 1027 is not a 3000-level or higher class, this course cannot count as a technical elective for a CE student. My understanding is that 3-D AutoCAD has long been a necessity for architectural engineering majors because employers expect them to know details of design and the tools used in designing. In previous years CE was not a field that dealt with design details, as did architectural engineering. Therefore knowing 3-D AutoCAD was not considered a necessity for civil engineers. However, this is no longer the case.

Computer Interface between Architectural and Civil Engineering

Employers now prefer that civil engineers have the same level of 3-D AutoCAD experience as architectural engineering majors and expect the same level of performance by employees in the different disciplines. One reason an employer wants civil engineers to know 3-D AutoCAD is because civil engineers and architectural engineers often interact on the same project. The architectural engineers design the layout of a structure and the civil engineer makes the design structurally competent, given the location and materials. The civil engineer needs to be able to look at the work of the architectural

engineer and understand what was done and know how to change it. Since the majority of design is done in AutoCAD, a civil engineer will be dealing with AutoCAD in two and three dimensions. If the civil engineer does not know 3-D AutoCAD, then the engineer cannot revise the design plans.

To ensure better work communication between the two disciplines of engineering, employers are putting a greater demand on employees knowing 3-D AutoCAD. One example of a lack of communication between the architect and the civil engineer occurred during my own internship. The architect gave the civil engineer a 3-D AutoCAD drawing of a roof design to modify. The civil engineer did not know how to operate 3-D AutoCAD, so he made the modifications by hand and gave them to the architect. The architect did the best that he could to change the AutoCAD drawing, but he did not know how to interpret the civil engineer's hand drawing, and the changes were not exactly what the civil engineer had suggested. Due to this miscommunication, the building constructed was faulty. A contractor even lost his life because the part of the roof he was standing on could not support him and his equipment. Because of this tragedy, the company now requires all of its engineers to know 3-D AutoCAD, so even common designs do not end up in disaster.

New Developments of AutoCAD

The developers of AutoCAD are trying to advance the program so that material properties can be assigned to the individual elements in the design. This new development will be allow us to determine the stress and strain properties of the design, and the engineer will be able to make changes before the design is sent for approval by

the professional engineer. You may wonder why these applications could not be done in 2-D, since that is what civil engineers know already. However, since projects are not built in a 2-D world, it is more appropriate to design in 3-D (see example below).

When the new edition of AutoCAD is implemented, the civil engineer will be able to do the job more efficiently with knowledge of 3-D AutoCAD. If the engineer were designing a foundation, for example, more information would be derived from only the new edition of AutoCAD if the foundation design were in 3-D as opposed to two. A 2-D foundation looks like a rectangle from any view (top, bottom, right side, etc.). This rectangle does not tell you whether the design will hold once it is fixed in the ground. Moreover, the stress and strain of the foundation wall cannot be accurately determined using this method. If the contractor laying the foundation is very experienced with the process, perhaps he would make judgment calls if something is not correct with the design. Yet incorporating the material properties with a 3-D design can reveal an assortment of information. The engineer will be able to determine whether the foundation has a slope and where the slope is located. Moreover, she/he can determine whether there are any inconsistencies in the walls and with the other walls. The engineer would also be able to see where extra supports would be needed by applying the material properties to a 3-D drawing. She/he can also see how the foundation would deform once the soil had settled while the amount of stress and strain on the walls remained constant. By designing the foundation in 3-D AutoCAD, any errors that might be in the design would turn up during this process and could be prevented. With 2-D AutoCAD, even if you could assign material properties, you would not be able to determine how the foundation is reacting

because you lack the depth required to evaluate the properties.

Need to Know 3-D AutoCAD for Upper Division Courses

A more immediate reason for knowing 3-D AutoCAD is that professors of upper division CE courses expect the students to have this knowledge already. The more advanced classes a student takes, the more AutoCAD knowledge becomes a necessity. For example, my independent study project in the course Finite Element Analysis (FEM) is based on a 3-D AutoCAD drawing. The project is to design a canoe for the American Society of Civil Engineers Concrete Canoe Competition, and use FEM to make sure the canoe is sound. After thinking of a general design, I need to create a 3-D model of the canoe in AutoCAD so I can do my analysis. That analysis is done in the FEM computer program SAP 2000, which expects the drawing to be in 3-D. Before I can learn the material of the FEM course, I need to go back and learn 3-D AutoCAD. A course like AREN 1027 would help solve these types of problems. You may be wondering why I do not simply take this class. It is not that easy: almost every semester AREN 1027 has a waitlist. Administration fills the class with architectural engineering students first. Worse yet, if a student is enrolled in AREN 1027 as a CE major and an architectural engineering student is on the waitlist, the CE student will be automatically dropped from the class because it is a requirement for the architectural engineering student to be in the class. Unfortunately this has happened to CE students like me. Because of this problem AREN 1027 needs to be made a requirement for CE students.

Conclusion

I believe one way to incorporate AREN 1027 into the general CE curriculum is to make the class a requirement and increase the minimum hours for the degree from 128 to 130. Another suggestion would be to make AREN 1027 a requirement and reduce the number of technical elective design credits required for graduation. Currently a four-credit technical elective is required for general CE, but because there are no four-credit design courses, many students opt to take a three-credit and a two-credit course to fill that requirement. AREN 1027 is a two-credit design class. This would be helpful to the student because there are already other two-credit technical electives offered in the general CE curriculum, such as Timber Design (CVEN 4565) and City Planning (CVEN 3207). Usually students cannot take both classes to fulfill this requirement, due to time conflicts. Currently there is no four-credit technical elective for general CE. With AREN 1027 students will fulfill the ABET design requirement, be able to plan their schedules better, and most importantly have the knowledge both employers and professors want them to have.

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