A Proposed Course
Integrating Civil Graphics Into CAD

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Abstract

In SPSU's Civil Engineering Technology program, hand-drafting, once a priority skill, now does not even exist as a course. This paper discusses the integration of hand-graphics and CAD into one effective course which meets students' needs and faculty expectations. Included are the critical elements incorporated from hand-graphics and examples of how this integration is accomplished. The paper closes with a summary of the benefits and shortcomings of the course as well as the recommendations to those departments facing major restructuring of courses.

Introduction

In the constant flow of curriculum changes, courses are merged, divided, and revised. The overall desire is to improve (or at least maintain) the quality of the program while satisfying all the forces prompting the change. In the midst of these transitions, occasionally a really good course, which meets the students' needs and faculty's expectations, emerges. The Civil Graphics/CAD course is one of these courses, which has popped to the surface after the turbulence of moving from a quarter system to a semester system. Several course combinations were necessary in the Civil Engineering Technology program of Southern Polytechnic State University to meet the Board of Regent's reduction in the CET major hours. This paper focuses on the benefits achieved from integrating hand-drafting and computer-aided drafting into a single course for freshmen.

The Trend

Historically at SPSU, the Civil Engineering Technology curriculum included three hand-drafting courses. These courses taught descriptive geometry, mechanical drawing, structural drawing, and subdivision/ road layout. A graduate from the CET program could instinctively draw quality sketches and engineering drawings.

In the 1980's, the desire to provide more design skills reduced the drafting courses from three into two. The areas left out, e.g. structural drawing and subdivision layout, were incorporated into the structures and surveying courses.

When the personal computer entered the drafting room, several problems arose. What software was best for the discipline? Which drafting course needed to be eliminated? Would quality drawing skills be developed in students by the time they graduated? In retrospect, hand-drafting skills and the ability to organize a drawing even in CAD decreased. The drawing aptitude of incoming freshman seemed to decline because of changes in the high school vocational arts programs. "Engineering" and "Drafting" were being divorced from each other.

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In a move to join the rest of the country's universities, the State Universities in Georgia restructured all of their programs from the ten-week quarter system to the fifteen-week semester system. The number of CET credit hours was reduced by seven percent to achieve the 128 total semester hours required by the Board of Regents for graduation. This forced the merging of the one remaining hand-drawing course with the CAD course into a 4 semester hour Civil Graphics/CAD course.

Course Philosophy

Because of the trend away from hand-drawing, eliminating that portion of material and enhancing the three-dimensional CAD portion was a real temptation. Through faculty discussions, the critical hand-drawing skills (for today) were identified and written as outcomes for the new course. These skills are introduced and practiced the first three weeks of the semester. When the CAD portion of the course begins, these hand-drawing skills are deliberately integrated into each assignment performed on the computer. The major principles maintained in this freshman course are 1) Graphics is a form of communication, 2) Every line on an engineering drawing has a specific meaning and is drawn in a certain way, and 3) CAD is only a drawing aid.

Hand-Drawing Skills

The platform of critical civil hand-graphics skills which civil CAD builds on includes orthographic projection, three dimensional sketching, drawing organization (line work, lettering, borders, title block, dimensioning), using an engineer's scale, understanding bearings, interpreting contour/ iso-concentration lines, and plan-profile layout. The students utilize only pencils, straight edges, protractors, scales, and grid paper. Accuracy is sacrificed in order to focus on the overall drawing concept: communicating to someone else in a different place at a different time what you observed today. Assignments include in-class sketching of small objects and civil projects as well as outside-class sketching of buildings, bridges, and detention structures.

Civil CAD

To give validity to the hand-drawing portion of the course, these hand-graphics skills are integrated quickly into CAD. For example, the first assignment in CAD included an orthographic projection of a masonry column section. Though struggling with the simple CAD commands they had just learned, the students were pleased with their success on this assignment. The struggling also motivated them to learn additional commands on their own. Every CAD assignment includes a generic problem that utilizes their new CAD commands and a civil problem that utilizes their hand-graphics skills within CAD. The result is fewer drawings with much more depth than in the past. An understanding of civil terminology and an appreciation for the variety of civil drawings are some of the by-products. Accuracy in the CAD drawings is a high priority which makes up for the lack of accuracy in the hand-graphics portion of the course.

A second method of integrating hand-graphics and CAD is used. The outside-class isometric drawings from the first three weeks of class are later redrawn in CAD. This reinforces the concept that graphics is communicating to someone in a different place and at a later time, what you observed.

A third method of integration is through larger civil projects drawn in CAD. Full-size drawings which include a road layout with dimensions, standard details of the road cross-section and curb/gutter, and a bridge section are produced during the semester. The original plans come from a project completed three years ago on campus. Because the students know the project, using it in the classroom validates the relevancy of the skills that the students are learning.

Descriptive Geometry pushed students to visualize three-dimensional arrangements of lines and surfaces. This subject matter was eliminated in the merging of the two courses. However, to incorporate the development of 3-D visualization, CAD is utilized as the medium rather than descriptive geometry. After learning the basics of 3-D modeling, three dimensional static's problems and applied descriptive geometry problems (e.g. display the true length and slope of a new tunnel connecting two existing tunnels) are drawn in CAD and discussed in class.

Benefits and Shortcomings

There are several benefits expected from the integration of hand-graphics and CAD into one course. These will be documented as feedback on the course is collected. The anticipated benefits are:

1) No separation of hand-drafting and CAD occurs in the minds of the students. Communication through graphics remains the focus.

2) Quality hand-drawing is promoted when the hand drawings are utilized in CAD.

3) Plan-Elevation-Cross-section drawings are viewed as orthographic projections rather than three independent objects.

4) Much more time is spent in CAD on civil related drawings, which improves the students' understanding of Civil Engineering Technology.

5) Students develop a greater appreciation for the complexity of designing and drawing civil projects.

6) An appreciation for drawing organization and format develops in the students.

The shortcomings of this merging of the hand-drawing and CAD include the loss of descriptive geometry skills, the loss of equipment drawing skills, the non-transferability of this course to a different discipline of Engineering Technology, and the amount of effort required to find and integrate relevant civil problems into the course work. An appropriate text is still being sought.

Recommendations

Engineering Technology education is changing rapidly, exchanging the "traditional" for the "innovative". Incoming students' abilities and interests are changing as well. The first recommendation is to identify the critical elements in the "traditional". Second, incorporate these elements in as many ways as possible into the "innovative". Third, come up with one to three big picture statements (a course philosophy) around which to build everything in your course. You may find, as SPSU has, that a quality course pops to the surface after all the turbulence subsides.

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