

Changes in Freshman Engineering Students Bring Changes to Introductory Engineering Courses

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Abstract: All freshmen interested in engineering at UW-Platteville take both of our two credit courses: Introduction to Engineering and Engineering Computer Graphics. In this paper, we discuss the changes we have made to these courses in response to the changes we are seeing with respect to the incoming students. The two biggest changes are that many students are starting their academic careers at lower math levels, while most show marked improvement in general computer knowledge. These trends have led us to reevaluate the content of the introductory courses, as well as, the delivery of the content. The biggest challenge we have found is trying to introduce problems, including design, which can still be accomplished at a math level of college algebra, yet maintain the interest level of all the students.

Introduction

UW-Platteville's General Engineering Department offers two courses for the freshman engineering student: General Engineering (GE) 1020, Introduction to Engineering, and GE 1320, Engineering/Computer Graphics. The engineering freshman class of over 500 students comprises approximately half of the incoming university freshman class. More than half of the engineering students place at a math level of trigonometry or below.

Developed ten years ago, GE 1020, Introduction to Engineering has evolved into the course that is primarily taken by first semester freshmen. Through its evolution, the four primary goals of the course have remained. These goals are Introduction to the Engineering Profession, College Success Skills, Introduction to the University and College, and Development of Community. Researching the engineering disciplines, discussing engineering ethics, learning computational skills, listening to guest lecturers, and participating in group design projects are all a part of learning about the profession of engineering. Topics included in college success skills are learning styles and time management. Introduction to the University and College includes discussions regarding the academic advisor/advisee relationship, pre-registration issues, general education requirements, the engineering co-op program, and campus resources such as tutoring and counseling services. Throughout the semester, the students are encouraged to work in groups on design project assignments and form study groups for other courses in which they are enrolled in order to get to know one another for peer support.

A majority of the engineering students at UW-Platteville take GE 1320, the Engineering Computer Graphics course during the second semester of their freshmen year. With approximately 60% of the freshmen engineering students starting at the level of Trigonometry or below in math, we have a co-requisite of Calculus for GE 1320. This helps to reduce the workload in the department and push more of it into the spring semester to help balance the workload with GE 1020, which is primarily a fall semester course. In the spring, approximately 260 students are enrolled in GE 1320, almost all freshmen, while in the fall there are 150 students that are a mix of sophomores, transfer students and incoming freshmen. We will focus the rest of the discussion of this course on the spring semester.

Changes to GE 1020 – Introduction to Engineering

Currently GE 1020 is a two credit course which meets for one hour, twice a week, with 35 to 40 students. All incoming students interested in engineering which place in college algebra or higher are encouraged to take the course. Any given section may contain students in college algebra and up to and including second semester calculus. With this range of students, many instructors distribute a survey to their students in order to determine the needs, abilities, and interests of the individuals enrolled in their section. In these surveys, we are finding that more students are placing at lower math levels than before. At the same time, the general computer skills of all the students have improved every year. Now almost all students come in with excellent word processing and internet skills along with some basic knowledge of spreadsheets and presentation software. This brings us to the changes in the course content in which we try to take advantage of the better computer skills, but reduce the amount of problem solving requiring math solutions in order to make the course interesting for all students.

Depending on the mix of students enrolled in a particular section, instructors may find it necessary to adjust the covered topics or even delete a particular subject from the syllabus. When teaching a section with a high concentration of students in algebra or pre-calculus, the choice for the instructor is to adapt to the students or run a very high level of frustration which mirrors the students' feelings. For example, coverage of many of the computational skills such as solution of simultaneous equations, curve fitting, and the use of matrices can be useless on the part of instructor or student if the section is filled primarily with students just learning college algebra. This same group of students may find design projects that are more technically based just as demoralizing. However, there are design projects that can be assigned which have practical engineering applications. Rather than design an electronic circuit or a small structure, studying traffic flow at a local congested restaurant or intersection may be a much better choice of assignment. A favorite of many students is the design of a simple toy. In particular, encouraging students to study an existing toy and "think out of the box" can bring about terrific projects. Students discuss many aspects of product development including manufacturing costs, safety issues, and marketing ideas. Researching the various disciplines of engineering and discussions of engineering ethics can be done with no

respect for math level, as can all of the activities aimed toward learning the university and building the community of support.

Teaching basic computer skills to the freshman student has become a fairly simple task and in fact, is not necessary for most students. Whereas ten years ago, many students were struggling with word processing, now a sample spreadsheet has most completing the assignment within a very short period of time and they may even have better “shortcuts” than the instructor. Even five years ago, teaching word processing and the use of the internet took a week or two of time in class. It is rare to find a student today that has no experience with word processing, spreadsheets and the internet. The extra time can now be used for preparation of presentations, additional group projects, and creating their own web pages. Some instructors have used their expertise to move the students into more technical software packages, including AutoCAD or MathCad.

Collegial discussion has ensued with respect to changing the co-requisite of this course by adding a higher math level. However, many who teach this course believe that the math level is not an indication of the student’s ability to succeed in engineering, but many times it is an indication that the student’s high school was not able to offer a higher course in math or that at the time of choosing courses in high school, a higher math course was not selected by the student. Historically, studies at UWP have found that although the math scores of a student are a strong indicator of success in engineering, they are not the only indicator and therefore we would be foolish to ignore the group of students below that level. Some argue that we can wait to offer this course to students when they are in Calculus. However, by that time, many of these students will have had other interests put before them and they will no longer consider engineering an option. Spending the resources during the students’ first semester maintains their interest in the profession, stresses the benefits of becoming an engineer, and encourages them to focus on moving through their education. By assigning excellent, caring instructors to teaching this course, the students will hopefully discover a mentor or coach who will be able to assist them when they might be struggling with a personal or academic problem.

Other discussions for change to the course have included maintaining separate sections of the course, based on your chosen discipline or creating separate modules so that students can focus on one or two of the engineering disciplines in which they are interested. This discussion continues as some are wary of how to deal with the many students who have not yet chosen a specific discipline or the students that may choose to study a completely different discipline at a later date. Another question stems from the hypothetical situation of teaching an electrical engineering based section of the course, and soon after a student decides on civil engineering. What skills were perhaps not covered for that civil engineer in the electrical course, that the student might need as a pre-requisite to other civil engineering courses? The idea of modules has many colleagues shying away because of the possible tracking/book-keeping nightmares that could ensue as the students move from module to module.

Changes to GE 1320 – Engineering Computer Graphics

Engineering Computer Graphics is a two credit course which meets twice a week for 110 minutes. The classroom is equipped with 20-25 workstations currently running AutoCAD 2002. The majority of students in this course begin with good hand sketching skills from high school, including some that have had years of excellent drafting classes. Most have done orthographic projections by hand, but fewer than 20% have a useable knowledge of a CAD system. This allows us to focus more on using the computer as our drafting tool of choice rather than relying on hand drawings. Also, the improvements in the recent versions of AutoCAD, in particular, the enhancements of the 3D capabilities, and the increase in computing power available, allows the students to do more drawings in a shorter time period which allows us to cover more topics throughout the semester.

While we continue to enhance and emphasize the CAD component of the course, there are two reasons to continue to require the sketching component of the course. The first is that it is still useful to be able to create a simple sketch of an object, whether it be for a homework problem in school, or a meeting with a client to help clarify a point about a design while on the job. The other reason is more of a logistical one for the class itself. In order to give a fair final exam to all the students, we give it to all of the classes during one 2 hour period during finals week. As a college, we have approximately 100 computers available for classroom instruction. With 260 students in the spring, we are unable to seat all of them at a computer, even in two back-to-back sessions. This makes it necessary to utilize hand drawings as the primary method of examination for the final exam. With most students entering with hand drawing experience, we have modified the course to include the hand drawings as a way to introduce the concepts of orthographic views, isometric views, and auxiliary views. We then provide individual help to any student that may need it.

After each basic introduction using the hand drawings, the bulk of the work, including most of the complex problems, is done using AutoCAD. Using this approach allows coverage of all the necessary drawing topics, as well as teaching a software program which they can use as their tool to complete the work. This allows more in-depth use of the software program and gives the instructor an opportunity to demonstrate many different drawing techniques. The student is given ample opportunity to practice these techniques through in class/homework assignments. During these assignments, they are encouraged to try the different techniques to determine which method works best for them. The in-depth use of the program now includes more 3D work. We are now able to do more 3D solid modeling at the end of the semester. While AutoCAD is very different from other solid modelers, it still is very useful in improving visualization skills. Most of the time spent on 3D modeling is spent taking 2D orthographic views and creating the solid object. This visualization practice is helped even more by the improvements in graphics where a student can now rotate the solid so it may be viewed from any angle.

Another advantage of teaching many different drawing techniques is that it provides flexibility in creating a specific drawing. This is especially useful when transferring the

drawing skills to a different but similar software package. Many UWP engineering students take a semester off for a co-op experience, or they are able to find summer employment as an engineering intern during their academic careers. The thorough knowledge they gain in AutoCAD allows the student to quickly adapt to any CAD software package used by their company. With a quick introduction to a different package, the student should be able to accomplish all drawing tasks required of an intern.

Summary

Engineering education is by definition an ever-changing field. Most of the time, these changes are to adapt curriculum to changes in laws or standards, or to introduce new technology in the classroom. However, in our freshmen engineering courses we have found it necessary to adapt the courses to the changes we observe in the skills of the students. With our students entering with better general computer skills, but at lower math levels, courses must be modified from year to year and sometimes, class to class, in order to pique their interest in engineering and to teach them many skills which will assist them during their academic careers.