

2006-1793: TEACHING A COMMON ENGINEERING DESIGN COURSE TO FIRST YEAR ENGINEERING AND ENGINEERING TECHNOLOGY STUDENTS: A CASE STUDY

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TEACHING A COMMON ENGINEERING DESIGN COURSE TO FIRST YEAR ENGINEERING AND ENGINEERING TECHNOLOGY STUDENTS: A CASE STUDY

Abstract

This paper describes the conversion of ET 002 (Introduction to Engineering Technology) and ED&G 100 (Engineering Design and Graphics) to a common course that provides an opportunity to both first-semester engineering and engineering technology students at the Altoona College of The Pennsylvania State University to learn engineering design process, write and present technical reports, and use appropriate software packages. The ET 002 course is a one credit-hour course required for all the first-semester engineering technology students at the Altoona College of The Pennsylvania State University. The ED&G 100 (Engineering Design & Graphics) course is a three credit-hour course required for all the first-semester engineering students at The Pennsylvania State University.

As a result of this blending and transformation of ED&G 100 and ET 002, both engineering and engineering technology students are now able to learn engineering design methodology and apply it to design problems.

The manuscript provides a detailed description of the above-mentioned transformation of ED&G 100 and ET 002. Additionally, information regarding the course assessment techniques used in the recently transformed ED&G 100 and ET 002 courses is presented.

Introduction

Over the past several years, the first-year engineering courses have evolved from standard problem solving, graphics, and computer programming courses to a format that emphasizes an early realization of engineering design, collaborative learning, and highly interactive classroom environment [1]. These courses allow engineering and engineering technology students to become involved in engineering design process at an early stage. There are many educators who now realize the need to teach engineering design to freshman engineering and engineering technology students. This manuscript focuses on developing a common freshman engineering course that teaches engineering design to the first-year engineering and engineering technology students at the Altoona College of The Pennsylvania State University.

Engineering Design and Graphics 100 (ED&G 100) is an introduction to engineering design course for all freshman baccalaureate engineering students at the the Pennsylvania State University. Upon completion of this three credit-hour course, students should be able to:

- Use computer software packages to assist and document the design procedure
- Communicate effectively through oral and written presentations
- Demonstrate basic lab work skills such as data collection, report writing, and teamwork
- Carry out the design process from problem statement to final design

ED&G 100 consists of three components with each component meeting for a single two-hour period once every week. This gives a total class meeting time of six hours per week for fifteen weeks. The first component of ED&G 100 introduces students to computer application skills using CAD. It also develops student design competencies in the topical area of communication. Topics covered include Internet navigation, website design, word processing, presentation software, and computer aided design and drafting using AutoCAD.

The second component of the course deals with manual graphic and drafting skills. Students are introduced to the fundamentals of orthographic projection. The topics covered include multiview projection, dimensioning, lettering, oblique and isometric projection, sectional views, tolerances, scales, and selected topics in descriptive geometry.

The third component of ED&G 100 focuses on team-based engineering design projects. Working together in teams, students work on design projects selected from various disciplines of engineering. This component of the course introduces students to principles of engineering design practice while developing design competencies in problem definition, idea generation, evaluation and decision making, implementation of teamwork, and process improvement.

Introduction to Engineering Technology (ET 002) is a one credit-hour course which in the past has been used to teach basic computer skills to all the first-semester engineering technology students at Altoona College of the Pennsylvania State University. Traditionally, this course has been a combined lecture and laboratory course focusing on topics such as microcomputer fundamentals, word processing, electronic spreadsheets, and basics of computer programming.

Current state of Engineering Design at the Altoona College

Currently ED&G 100 [3] introduces freshmen to engineering design and teaching them the drawing, CAD, and design skills that they will need throughout their college career; however, it also intended to increase the freshman engineering student knowledge and enthusiasm for engineering. At Penn State University Park, it is taught with one instructor per course section. This allows for fluid integration of the design, drawing, and computer tools topics. At Penn State Altoona College, ED&G 100 has historically been taught by three instructors on a rotation. As one instructor taught the design material for one section as the second taught the computer tools and the third, drawing materials for two other sections at the same time, then the class sections would rotate. This method allowed three class sections to be taught concurrently. This also most effectively used the three specialized classrooms that were needed. A technology classroom was needed for the computer tools topics. A drafting classroom was needed for the drawing topics and a laboratory classroom was needed for the design topics. It was decided to change to one instructor per section due to the changes in the curriculum for the Bachelor of Science degree in Electro-Mechanical Engineering Technology (EMET), an objective of the faculty to make a relevant introduction to engineering technology, and the blending the engineering technology student into the same program,.. It was necessary to adjust both the engineering topics and the engineering technology topics to accomplish the use of one course for both.

For ED&G 100, the computer tools topics cover CAD (CAD at Altoona, solid modeling at UP), word processing, spreadsheets, and presentation software. The mechanical drawing topics

include views, projections, and other sketching and drawing techniques. The design topics include problem definition, idea generation, decision making, implementation, and teamwork [2]. Each topic got equal time of 30 hours per semester.

For the engineering technology students, the same topics were covered in three one-credit courses. ET002 was similar to the design topics in ED&G100. EGT 101 (Technical Drawing Fundamentals) and 102 (Introduction to Computer Aided Drafting) were very similar to the drawing and CAD topics. These three classes were each taught by individual instructors. The same amount of hours was used per course.

To track the changes to the students learning and perception of engineering design, we developed a survey to administer at the end of each change of the ED&G100 course. We administered the survey at the end of fall semester to the last ED&G100 class that was taught with three instructors. The survey consisted of 26 attitude questions and six knowledge questions on topics the students should have learned during the semester. The survey was designed to collect their thoughts on how to start a design project and their attitudes on the topics covered in the course. In spring 2006 there will be one class taught by one instructor, the students will be surveyed at the end of that semester. Fall of 2006, the first blended classes taught by one instructor will also be surveyed.

Table 1
The questions for the attitudes and their average responses for Fall 2005
Three instructors all engineering, n=25
1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree

CAD will be useful to me in my profession.	4.16
CAD concepts are difficult to understand.	2.10
Drawing will be useful to me in my profession.	3.96
Drawing concepts are difficult to understand.	2.78
Engineering design is logical and clear.	3.72
CAD is a boring subject.	1.96
Given the opportunity, I would take another CAD course after this one even if it is not required.	3.71
Drawing is a boring subject.	2.35
Given the opportunity, I would take another drawing course after this one even if it is not required.	2.97
I am confident that I can learn the content of this course.	4.33
I can relate engineering to things I have seen, done, or thought about in my life.	4.35
Engineering design is relevant to my interests.	4.40
I find it easy to explain an engineering topic to someone else.	3.84
Engineering design is an applied subject and should always be studied in a real world context.	3.86
I get a great deal of satisfaction out of solving an engineering problem.	4.07
I believe that this course will be easy for me.	3.92
Completing the material in this course successfully is important to me.	4.33
I feel that applied learning is vital to learning engineering.	4.32
The material in this course is difficult for me to understand.	1.81
I am confident in my ability to do well in this course.	4.47

The computer technology resources will be useful to my learning of the material.	4.18
The use of computer technology will be disruptive to my learning in this class.	1.54
The use of computer technology in this course will be important to my learning of the course content.	4.03
The use of computer technology in the class will promote discussion among the students.	3.26
The use of computer technology in the class will promote discussion between the instructor and the students.	3.48
The use of computer technology will be necessary in this course.	4.19
I feel that my homework problems will be more competently done because of the use of computer technology.	3.90
The computer technology will allow the instructor to expand the complexity of problems in this course.	3.89

Table 2
Knowledge questions short answer, n=25
Number of students who answered correctly

Spreadsheet knowledge	22
Drawing/CAD knowledge	25
Word processing knowledge	10
How would you start to solve a design problem?	8
How would you find engineering information about a specific product?	20
What are the major steps in the engineering design methodology?	9

From the data in Tables 1 and 2, we can see that the students in the traditional class did have good knowledge and experience with the spreadsheets, CAD and drawing parts of the course, but were not always sure how to start or work through an engineering problem. The questions on the usefulness of the topics “(CAD will be useful to me in my profession”, “Drawing will be useful to me in my profession”, “Engineering design is relevant to my interests”) all had an attitude level of 4, “agree”. The students did know how to get information for a product, but were unsure of what process they should go through to design a product.

The Transition

The first step in the transition occurred last year [Anwar, McClure]. ET 002 had been a one-credit computer tools course. As a response to the upper level EMET instructors, who noted that the upper level students did not know how to start research or design processes for their senior projects. The revised design based ET002 was taught for two semesters. The revised ET002 contained similar design topics as in ED&G100. EGT 101 and 102 were very similar to the drawing and CAD topic in ED&G100. The acceptance of a new EMET program starting the fall of 2006 has included the absorption of these three classes into ED&G100.

The first topics to be blended together are mechanical drawing and CAD. The new syllabus blends them together in a parallel form. Students will first learn the basics of the CAD program and of drawing. Then as skills are introduced in the drawing classes, they will also be learned in CAD. In the three-instructor version of ED&G100, students received 30 hours instruction in

drawing and about 26 hours of CAD, in the one instructor version, the students will receive 16 hours in mechanical drawing, 14 in CAD and 14 in 3D solid modeling. The solid modeling was required to be added as a prerequisite to a junior level mechanical engineering course. The design topics will be blended in by implementing two design projects. The first one will be a disassembly and redesign of an existing product; the second will be a more involved design problem. The students will be required to produce supporting materials including market surveys, results of brainstorming, specifications, project management, prototype development, and testing. The total design topic hours will change from approximately 30 to 40.

One of the topics missing from the three-instructor version of ED&G 100 was teamwork. In the one instructor version, we plan to integrate teamwork training modules and assignments. This course will be taught by one instructor in the Spring of 2006. The information gained from that experience will be used to launch the blended courses in the fall of 2006. Each of these changes will be tracked and compared to the original group. There are also plans to find the senior level student at University Park and get information from them on what topics were the most useful for them in the transition into the engineering programs there.

Table 3
Syllabus Spring 2006

Date	Topic	Reading	Assignment
1/9/06	Engineering Design Process, Spreadsheets	Chapter 1 WBT as needed	Bad design, Excel assignment
1/11/	Visualization of 3D shapes, Sketching	Chapters 21, 22, 23	
1/13/	Multiview drawing, customer needs assessment	Chapter 3	
1/16/	Presentations, Engineering geometry	WBT as needed	
1/18	Design Project 1 introduction, Teamwork		
1/20	Product Specifications, Multiview drawings	Chapter 4	
1/23	Concept Generation, AutoCAD intro	Chapter 5	AutoCAD 1
1/27	Web research, Web pages, AutoCAD	WBT as needed	AutoCAD 2
1/30	Dimensioning AutoCAD	Chapter 19	AutoCAD 3
2/1	Design project 1	Chapter 6	Work on customer needs, define product specifications
2/3	AutoCAD		AutoCAD 4
2/6	AutoCAD, Sectional views	Chapter 16	AutoCAD 5
2/8	Design Project 1	Chapter 11	Work on concept selection and design
2/10	AutoCAD		AutoCAD 6
2/13	Drawing		
2/15	Design project 1 work day		
2/17	AutoCAD		AutoCAD 7
2/20	Project 1 presentations		Group presentations
2/22	Lettering		
2/24	Project 2 introduction		
2/27	AutoCAD		AutoCAD 8
3/1	Project 2 work day		
3/3	AutoCAD		AutoCAD 9
3/13	Isometrics		
3/15	Project management	Chapter 12	Develop project plan
3/17	Oblique		
3/20	Sectional views		
3/22	Prototyping	Chapter 7, 8, 9	
3/24	Testing		Develop testing plan
3/27	Solidworks		
3/29	Delivery		
3/31	Project 2 work day		Review design documents
4/3	Solidworks		
4/5	Design review Project 2		Present design choice
4/7,10	Solidworks		
4/12	Project 2 work		
4/14,17	Solidworks		
4/19	Project 2 work day		
4/21	Solidworks		
4/24,26	Final project test days		
4/28	Final project presentations		

Conclusion

The paper described the conversion of ET 002 (Introduction to Engineering Technology) and ED&G 100 (Engineering Design and Graphics) to a common course that provides an opportunity to both first-semester engineering and engineering technology students at the Altoona College of The Pennsylvania State University (Penn State Altoona) to learn engineering design process, write and present technical reports, and use appropriate software packages.

Although we did not expect many Engineering Technology students in the spring semester, approximately 20% of the class is either already registered as Engineering Technology or is interested in doing so. At the halfway point in the Spring semester, the instructor has seen no appreciable difference between the students planning to major in Engineering versus Engineering Technology.

The fall classes of 2006 will be the first classes with both four year engineering, engineering technology, and two year engineering technology students. The faculty will be tracking the students in this class to see if the combined classes made any differences in the ability of the students in their senior years. We will also be actively observing the number of hours spent on each topic and making adjustments as needed.

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