AC 2007-978: USING BASIC COMPUTER-AIDED DRAFTING AND DESIGN COURSES AT THE FRESHMAN LEVEL TO IMPROVE TECHNOLOGY STUDENTS COMPETITIVENESS IN OBTAINING EARLY ACADEMIC CAREER INTERNSHIPS

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Using Basic Computer-Aided Drafting and Design Courses at the Freshman Level to Improve Technology Students Competitiveness in Obtaining Early Academic Career Internships

Abstract:
Many students have the desire to have internships and part-time employment during their academic careers. Often students in their freshman and sophomore years in four year engineering and technology programs find it difficult to be competitive against more senior students for these positions. This paper discusses how students, in the Mechanical Engineering Technology (MET) program at _____University, through taking CAD and Solid Modeling courses early in their academic careers are well suited to be competitive in obtaining internships and part time employment. This paper discusses the MET programs first two years' curriculum and how it prepares the students to enter into the workforce competitively against the more senior engineering students.

This paper also discusses the results from a departmental survey of students currently enrolled in the program as to how enrollment and completion of these early courses have impacted their viability for the part-time positions and internships, and offers further insight into how as faculty teaching these early courses can improve the chances for technology students to apply for and receive early experience in their chosen career field.

Introduction:
Many students have the desire to have internships and part-time employment during their academic careers. Often students in their freshman and sophomore years in four year engineering and technology programs find it difficult to be competitive against more senior students for these positions. This paper discusses how students, in the Mechanical Engineering Technology (MET) program at _____University, through taking CAD and Solid Modeling courses early in their academic careers are well suited to be competitive in obtaining internships and part time employment. This paper discusses the MET programs first two years' curriculum and how it prepares the students to enter into the workforce competitively against the more senior engineering students.

According US Department of Labor's Bureau of Statistics (Occupational Outlook Handbook, 2006-07 Edition) many employers prefer applicants who have completed postsecondary school training in drafting; this training is offered by many technical institutes, community colleges, and some 4-year colleges and universities. Interest is high in applicants with well-developed drafting and mechanical drawing skills; knowledge of drafting standards, mathematics, science, and engineering technology; and a solid background in. In addition, communication and problem-solving skills are important.

As many 4- year Engineering Technology graduates plan to take jobs in the design area, many students use the experience gained in the classroom through taking CAD and Solid Modeling courses early in their academic careers to obtain entry level drafting position or

internships. Since many employers pay for continuing education drafting has become a gate way job for student continuing with their education to become engineering technicians or engineers.

CADD systems have become more powerful and easier to use also and has limited the demand for highly skilled drafters as simple tasks are increasingly done quickly and easily by other interns or other technical professionals. Additionally, especially in large organizations, because some drafting work can be done in other locations using the Internet to send CADD files internationally, the off shoring of some drafting jobs has increased the need for individuals with the skills to manipulate drawings and design rather than those individuals with considerable experience with CADD systems.

Early Curriculum Offerings at ODU

The Mechanical Engineering Technology (MET) program at _____University currently has four emphasis areas Marine Engineering Technology, Manufacturing Systems, Mechanical System Design, and Nuclear Technology in its TAC of ABET accredited degree program. Within the existing MET program, students have the flexibility to choose senior electives within those options in Mechanical Systems Design, Manufacturing Systems, Nuclear Technology or Marine Engineering Technology. However this differentiation into the various emphases does not begin until the junior year. The first two years are used to establish a technical basis on which the student can build upon. One of those fundamental technical areas is computer aided drafting and design.

Year and Semester	Course (Dept., Number, Title	Category (Credit Hours)				
		Communications	Mathematics	Physical & Natural Science	Social Science & Humanities	Technical Content
1-1	MET 100, Engineering Graphics					3
	ENGN 110, Explore Engineering & Tech I					2
	MATH 162M, Precalculus I		3			
	CHEM 115N, Foundations of Chemistry			4		
	ENGL 110C, English Composition	3				
1-2	MET 230, Computer-Aided Drafting					3
	ENGN 111, Explore Engineering & Tech. II					2
	MATH 163, Precalculus II		3			
	PHYS 111N, General Physics			4		
	Gen Ed, Literary Perspective (L)				3	
2-1	MET200,Manufacturing Processes					3
	CET 200, Statics					3
	MATH 211, Calculus I		4			
	PHYS 112N, General Physics II			4		
	ENGL 131C, Intro to Technical & Scientific Writing	3				
2-2	CET 220, Strength of Materials					3
	OTS 231, Materials and Processes Technology					3
	MET 240, Computer Solid Modeling					3
	COMM 101R, Public Speaking	3				
	Gen Ed, Social Science Perspective (S)				3	

Figure 1

Three course in the first two years are dedicated to drafting and design. Those courses are:

MET 100 – Engineering Graphics
Course (Catalog) Description
Lecture 2 hours; laboratory 2 hours; 3 credits. A modern treatment of the basic principles of engineering drawing, including graphing, orthographic projection, sectional views, multiview drawings, pictorial views and an introduction to tolerancing, utilizing both manual and computer based drafting methods.

MET 230 – Computer Aided Drafting
Course (Catalog) Description
Lecture 2 hours; laboratory 2 hours; 3 credits. A study of the principles of computer aided drafting including the story of CAD Systems components, their relationship to each other and methods of editing, manipulation, visualization and presentation, with a major emphasis on "Hands On" practice using AutoCAD software in the microcomputer laboratory.

MET 240 – Computer Solid Modeling
Course (Catalog) Description
Lecture 3 hours; 3 credits. Prerequisite: MET 230. A treatment of modern 3-D parametric solid modeling techniques including introduction of the software utilized sketching, parts and assembly creation techniques, orthographic views extraction and manufacturing drawing generation. Presentations include exploded views and animation.

Using Advisory Board Input
Previous employer feedback on visual communications was a 3.98 on a 1-6 scale (Exhibit). In response to feedback, and recommendations from the members of the Industrial Advisory Committee, a new course in computer solid modeling (MET-240) was added to the MET curriculum in Spring 2003. This course was initially offered as a junior level course (MET-340). However, it was moved to the sophomore level to provide students more time to master the skills during subsequent courses. This course uses AutoCAD Inventor and is offered during fall and spring semesters. In addition a course was added later to the curriculum in Geometric Dimensioning and Tolerancing at the junior level.

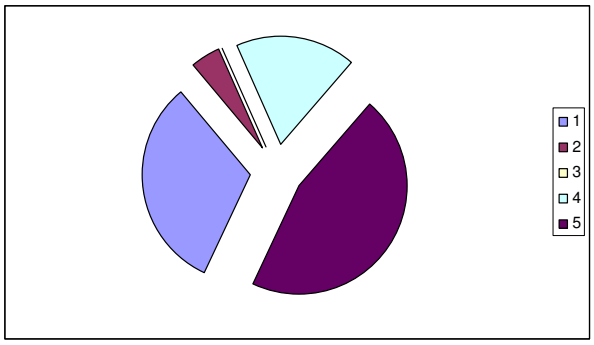
General Satisfaction	**MET** (Avg. Rating)
7A ODU ET graduates are prepared to present ideas and technical material to audiences using: **written** means (reports, memos, etc.) .	3.85
7B using **oral** communication (meetings, presentations, etc.)	3.82
7C using **visual** means (graphics, plots, presentations, etc.)	3.92

Figure 2

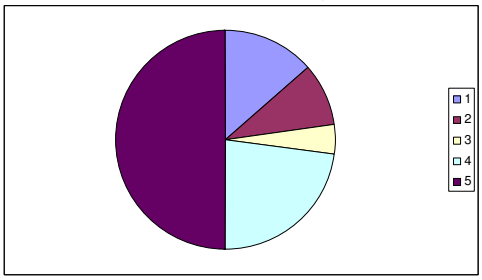
Survey Results

A departmental survey was developed and given to students currently enrolled in the MET program's three computer aided drafting and design courses in the fall of 2006 to ascertain how enrollment and completion of these early courses have impacted their viability for part-time engineering/drafting positions and internships.Of the 74 respondents 22 were currently employed in the engineering field (30%). Of those 22 currently employed, their responses are presented graphically below on a five-point scale where 1 means strongly disagree and 5 means strongly agree.

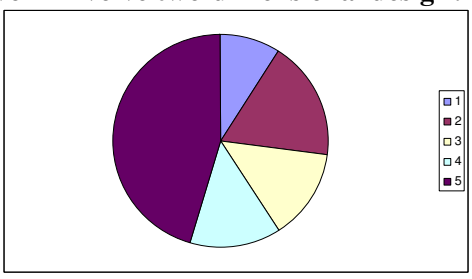
- **Does your work include the use of computer aided drafting software (CAD)?**



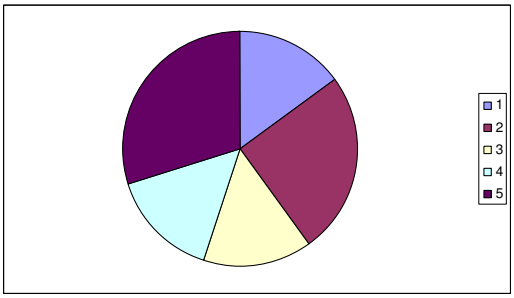
- **Does your work include dimensioning and tolerancing principles?**



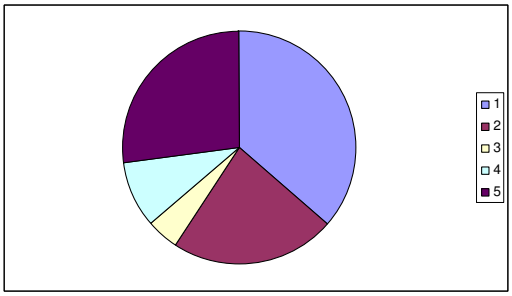
- **Does your work involve two-dimensional design?**



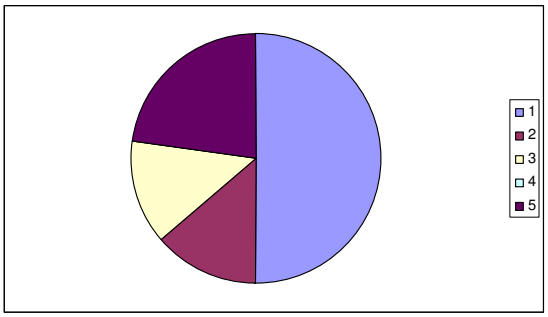
- **Does your work involve three-dimensional design?**



- **Does your work involve the use of solid modeling packages?**



- **Does your work involve finite element meshing of solid models?**



Additionally other information was ascertained in the survey and is represented in tabular form at the end of the paper.

Conclusions

Initial results show promise, but further survey deployment will be necessary to develop meaningful data for use in course development or curricular change. While it is clear from these early results that early education in drafting and design has an impact on the viability of student gaining employment early in their academic career, further research is necessary from both the student and the employer perspective. The information gathered from both students and employers would be used to enhance an already rigorous program that prepares students to enter the employment market with the most relevant and competitive knowledge of drafting and design.

Optimally, the program will take the input gathered from employers and use that information to refine the program into a seamlessly integrated process where the student is challenged in every course to rise to the highest level of performance in a real-world scenario based curriculum. Typically, the problems presented to employees in the real world are ill structured problems with multiple unknown variable and no clear prototypical solutions. Jonassen (2000), in dealing with designing instruction for ill

structured problems recommends a systematic approach to designing instruction in this particular case. First, begin with identifying the prerequisite concepts, rules, and principles necessary for the students to begin solving this level of problem. Next, identify the concepts and domain of knowledge necessary for the student to solve the problem. For example, to find the normal stresses due to bending for a cantilever beam with a concentrated load at the end, a student could use their skills in solid modeling to create this scenario to see that the normal stresses in graphic form. Once the student used the domain knowledge from the previous course of MET 240 to solve a MET 320 design of machine elements problem, the curriculum becomes integrated and purposeful to the student instead of segmented and irrelevant. After the students have been presented with the information necessary to solve the problem, the instructor must model problem solving performance and this may be done in a variety of ways, the instructor may demonstrate the solution themselves, bring in outside industry experts to model a solution either physically, through video taped presentations of previous class lectures, or in a live video conference. Once the solution is modeled, the student must have an opportunity to practice the newfound skills and use the newly acquired tools such as a new aspect of solid modeling software. During practice, students will often begin the search for options in solving a problem outside of the given domain of knowledge and the process of critical thinking should be encouraged at this point.

The use of industry input to gather real world ill-structured problems for students to solve using the skills developed in their graphics courses applied to their upper level engineering principles courses will satisfy all the requirements of industry for students to present ideas with written, oral, and visual means in their senior capstone courses such as MET 435 senior design project. This capstone course requires the student to synthesize all their knowledge from beginning drafting to advance engineering design principles to solve a real world ill structured problem.

Undergraduate Survey

1) Are you currently employed in the engineering field?

Yes No

If you answered yes to question one, please go to the next question. If you answered no to question one, please skip to question 10

For the following questions please answer them based on the five-point scale where **1 means you strongly disagree** and **5 means you strongly agree.**

2) Does your work include the use of computer aided drafting software (CAD)?

1 2 3 4 5

3) Does your work include dimensioning and tolerancing principles?

1 2 3 4 5

4) Does your work involve two-dimensional design?

1 2 3 4 5

5) Does your work involve three-dimensional design?

1 2 3 4 5

6) Does your work involve the use of solid modeling packages?

1 2 3 4 5

7) Does your work involve finite element meshing of solid models?

1 2 3 4 5

8) Which undergraduate courses did you take at _____University? Please circle all that apply

MET 100 – Engineering Graphics

MET230 – Computer Aided Drafting

MET240 – Computer Solid Modeling

9) Your education at ODU in the above courses prepared you to better perform at your job

1 2 3 4 5

10) Have you been interviewed for a position in the engineering field since taking any of the above courses from question 9 at ODU?

Yes No

11) Did the *advertised job description* mention preferred CAD/solid modeling skills?

Yes No

12) Did the *interviewer* mention CAD/Solid modeling skills?

Yes No

13) Does the job involve CAD/Solid modeling skills?

Yes No

If you answered yes to any of questions 10 - 13, please answer the following by rating the statements on the same five point scale as before. If you answered no, please skip to question 24 below.

(Flip over for the rest of the survey)

14) I was comfortable enough with my CAD/Solid modeling skills based upon the job requirements to discuss them during the interview.

1 2 3 4 5

15) I was knowledgeable enough about CAD/Solid modeling in general to discuss the application of them in the position I was interviewing for.

1 2 3 4 5

16) My CAD/Solid modeling skills helped me during my interview.

1 2 3 4 5

17) I felt that a lack of knowledge in some part of CAD/Solid modeling skills hurt me during my interview.

1 2 3 4 5

18) Please briefly describe what you feel were the lacking skills if you felt that was the case

19) Did you receive the job you interviewed for?

Yes No

If you answered yes to question 19, please answer the following by rating the statements on the same five point scale as before. If you answered no, please skip to question 24 below.

20) My CAD/Solid modeling skills aided me in getting the job position.

1 2 3 4 5

21) A lack in CAD/Solid modeling skills made it more difficult to get my job position.

1 2 3 4 5

22) I feel that I learned what was needed in order to succeed in my job from the undergraduate CAD/Solid modeling courses that I took.

1 2 3 4 5

23) I feel that I am lacking skills in regards to CAD/Solid modeling that hurt my job performance – *please list these below if you feel this is the case*.

1 2 3 4 5

24) If you have any comments about the undergraduate drawing courses you took at ODU, please include them below.

Total Surveys Completed	74

Question	Answer Choice	Number
1	Yes	22
	No	52
2	1	7
	2	1
	3	0
	4	4
	5	10
3	1	3
	2	2
	3	1
	4	5
	5	11
4	1	2
	2	4
	3	3
	4	3
	5	10
5	1	3
	2	5
	3	3
	4	3
	5	6
6	1	8
	2	5
	3	1

	4	2
	5	6
7	1	11
	2	3
	3	3
	4	0
	5	5
8	MET100	17
	MET230	16
	MET240	16
9	1	0
	2	3
	3	4
	4	7
	5	6
10	Yes	26
	No	46
11	Yes	22
	No	24
	no answer	28
12	Yes	22
	No	25
	no answer	28
13	Yes	25
	No	21
	no answer	28
14	1	4
	2	4
	3	5
	4	14
	5	6
15	1	2
	2	2
	3	5
	4	16
	5	6
16	1	5
	2	3
	3	11
	4	6
	5	7
17	1	15
	2	6
	3	4
	4	5
	5	2
19	Yes	22
	No	10
	no answer	3
20	1	7

	2	0
	3	8
	4	7
	5	3
21	1	14
	2	3
	3	6
	4	2
	5	0
22	1	3
	2	3
	3	5
	4	9
	5	4
23	1	16
	2	6
	3	5
	4	2
	5	2

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