AC 2008-1202: FACE-TO-FACE, HYBRID, OR ONLINE?: ISSUES FACULTY FACE REDESIGNING AN INTRODUCTORY ENGINEERING GRAPHICS COURSE

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Face-to-Face, Hybrid, or Online?: Issues Faculty Face Redesigning an Introductory Engineering Graphics Course

Abstract

A hybrid introductory course was developed and piloted during the Fall 2007 semester in three laptop sections (i.e., all of the students owned and brought laptops to class each day). The online portion of the course included voiced-over content presentations, software demonstrations, and sketching examples as well as online assessments. Sections met in the classroom once each week where instructors discussed and demonstrated essential CAD and textbook content. This time was also used to answer student questions and give feedback on homework and CAD exercises. Outside of class, students were expected to view the online content, complete CAD and sketching exercises, and complete a weekly online assessment. No difference was found between final exam scores in the hybrid sections and the face-to-face sections. This paper discusses the implementation of the hybrid introductory engineering graphics course, summarizes data collected during the Fall 2007 semester pilot study, and offers some discussions about the relative advantages and disadvantages of face-to-face, hybrid, and all online delivery.

Introduction

Over the last several years, faculty in the Graphic Communications program at North Carolina State University have been developing courses for blended as well as complete online delivery. The motivation for developing online content has come from several different sources. The main driving force has been the continual search for the most effective way of delivering content – whether online, face-to-face, or hybrid/blended. Other motivating factors include pressures from administration to investigate more cost efficient ways of delivering instruction, being able to teach more sections of the course with fewer faculty, and - maybe most importantly - giving students more control over how and when they learn.

Courses which are taught completely online require some different instructional strategies and resources than hybrid or blended courses. Since hybrid courses involve some face-to-face contact with students, instructors can address issues that students seem to miss when taking a completely online course. In addition, addressing commitment and engagement in the course materials takes on increased importance as direct instructor contact is reduced. When surveying students who had dropped out of a completely online Graduate Certificate Program in Community College Teaching in the College of Education at North Carolina State University, faculty discovered that approximately 13% of those students listed lack of faculty contact and lack of community building opportunities as reasons why they eventually left the program [1,2].

In this current pilot project, we were interested in exploring how a hybrid offering of our introductory engineering graphics course might constructively address instructional efficiency, learning flexibility, and student engagement concerns while still delivering an instructionally effective course. This initial exploration is part of our ongoing instructional design study looking at leveraging best-in-class technologies and instructional strategies for effective graphics instruction.

Methodology

For this study, three laptop sections of GC120, Foundations of Graphics (72 students), were taught as a hybrid or blended instruction course. The other 14 sections of GC120 were taught in a face-to-face manner. The instructors of the hybrid sections organized the content of the course into a series of lesson pages (see Figure 1). Content for the hybrid introductory engineering graphics course was delivered in several formats. First, Flash videos of voiced-over PowerPoints (Figure 2), sketching demonstrations (Figure 3), and SolidWorks demonstrations (Figure 4) were created to deliver the textbook and CAD content for the course. Study guides were made available in a pdf format, and students were required each week to complete a 10-20 question WebCT Vista assessment (Figure 5).

GC120 | Lessons

Revised October 17, 2007

Lesson 8 - Dimensioning

Textbook Material

- Read Chapter 9.
- Lesson 8 Study Guide - *305KB*
- Dimensioning presentation 1 - *8:52*
- Dimensioning presentation 2 - *6:11*
- Dimensioning presentation 3 - *4:25*
- Additional material from Chapter 9.
- Lesson 8 Quiz *Due 8:00am Wed October 17.*

SolidWorks Modeling Activities

- Modeling the STOP BASE part, Figure 5.136, page 288 - *4:51 Due 6:00am Monday, October 22.*
- Creating the STOP BASE drawing - *7:06 Due 6:00am Monday, October 22.*
- Model and create a drawing of the RETAINER CLIP, Figure 5.152, page 291. *Model due 6:00am Monday, October 22. Print out of the drawing due in class on October 24.*

Sketching Activities

- DIM020 - *10:25 Due Wednesday, October 17 in class.*
- DIM040 - *5:05 Due Wednesday, October 17 in class.*
- Complete Step 5 for the Furniture Design Project: *Due Wednesday, October 17 in class.*
  - Complete detail drawing sketches for each piece.
  - Complete a pictorial assembly drawing sketch with a bill of materials.

Figure 1. Example of a Lesson Webpage.

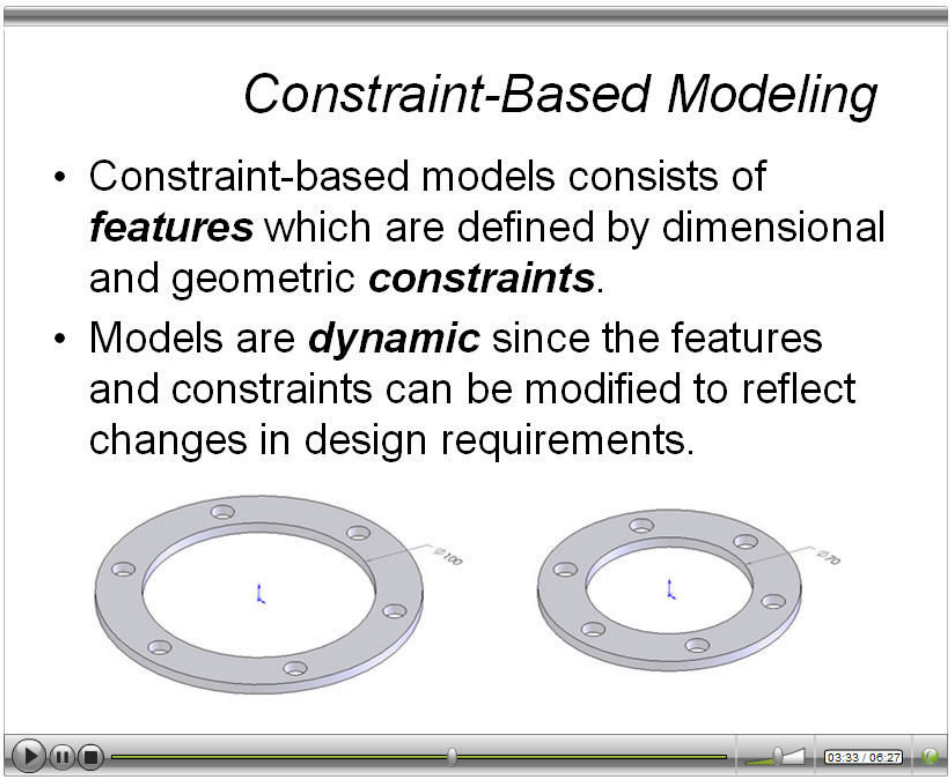


Figure 2. Example of Voiced-Over PowerPoint.

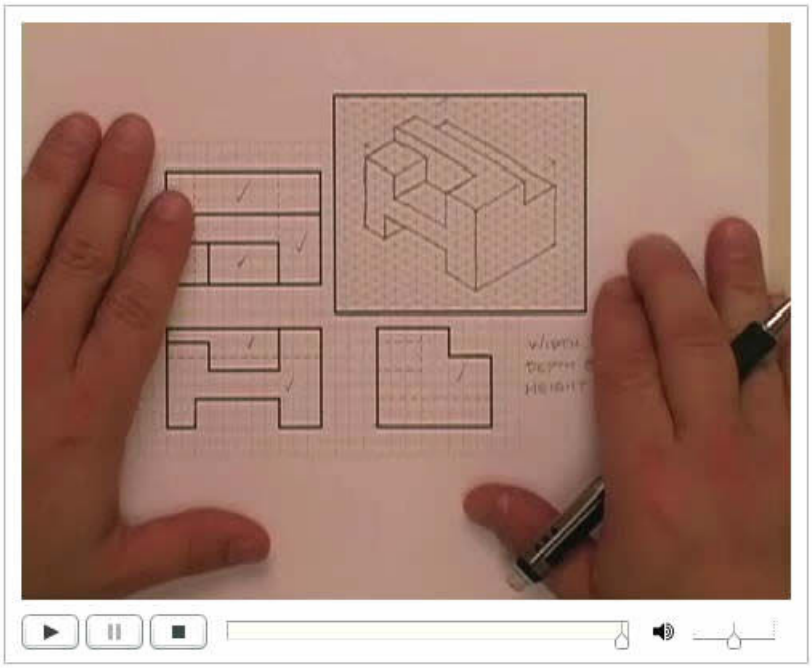


Figure 3. Example of Sketching Video.

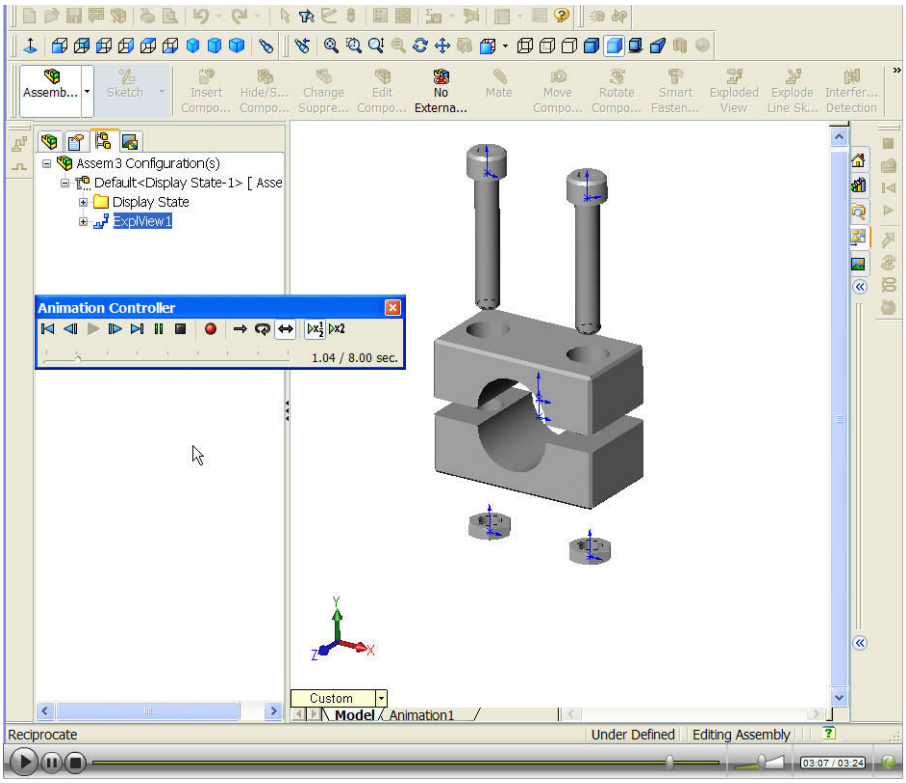
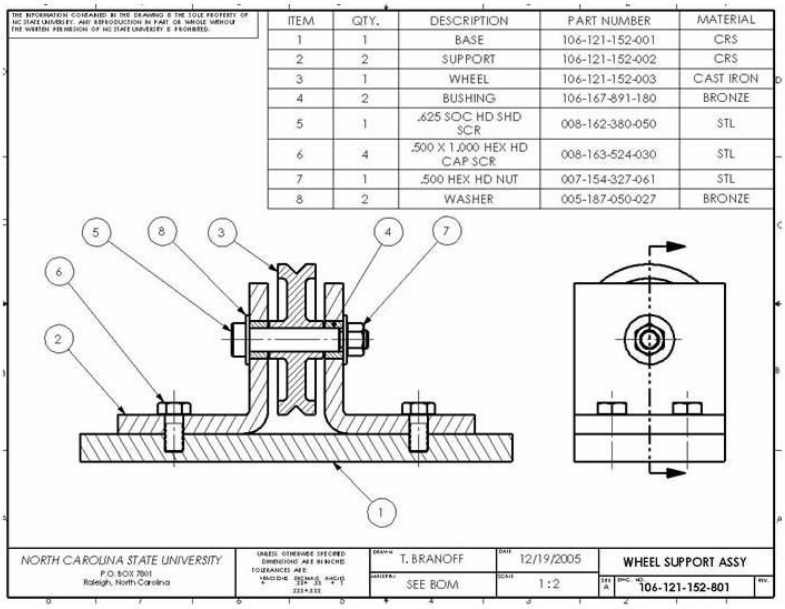


Figure 4. Example of a SolidWorks Demonstration Video.

8. Question 10.8 (Points: 10)

Which part in the assembly below is made of cast iron?



ITEM	QTY.	DESCRIPTION	PART NUMBER	MATERIAL
1	1	BASE	106-121-152-001	CRS
2	2	SUPPORT	106-121-152-002	CRS
3	1	WHEEL	106-121-152-003	CAST IRON
4	2	BUSHING	106-167-891-180	BRONZE
5	1	.625 SOC HD SHD SCR	008-162-380-050	STL
6	4	.500 X 1.000 HEX HD CAP SCR	008-163-524-030	STL
7	1	.500 HEX HD NUT	007-154-327-061	STL
8	2	WASHER	005-187-050-027	BRONZE

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T. BRANOFF | 12/19/2005 | WHEEL SUPPORT ASSY
SEE BOM | 1:2 | 106-121-152-801

- 1. .625 SOC HD SHD SCREW
- 2. BASE
- 3. SUPPORT
- 4. WHEEL

Save Answer

Figure 5. Example of a WebCT-Vista Assessment.

The three hybrid laptop sections met face-to-face on Wednesdays. The instructors used this time to talk about and demonstrate key solid modeling topics, check homework, and answer questions about assignments. Since sketching assignments and WebCT Vista assessments were due on Wednesdays, students were required to view the online content some time before coming to class. Modeling assignments were due early Monday mornings. Instructors used Mondays to electronically evaluate students' modeling assignments and email feedback to the students. Students were given space on a university server to save files. Faculty could copy students' work to their own computers and then open individual files. Below is a sample email sent to a student regarding three SolidWorks activities.

> John: Below are my comments for your Lesson 5 SolidWorks activities (the HINGED CATCH and the BRACKET). Please make corrections per these comments and show the modified parts to me in class Wednesday. I will then re-evaluate your grade. There is no need to resubmit the parts to the locker workspace.
>
> ***HINGED CATCH (100/100):*** Good.
>
> ***HINGED CATCH drawing (92/100):*** Centerline in front view is not centered.
>
> ***BRACKET (85/100):*** First sketch is not fully constrained. Missing 3.75" dimension. Also, the geometry in Sketch1 is not correct. There should be vertical lines tangent to the large circle on both sides. Finally, add a .063 fillet to the small rounded corners.

In the sixth week of class, students were asked to complete an anonymous survey which was used as a formative evaluation of the course up to that point. The survey included the following questions:

1. Have you ever taken an online course?
2. Have you ever taken a hybrid course?
3. What is your instructional preference?
4. In what general order did you complete the online material related to the textbook?
5. If you were not required to complete the WebCT Vista assessments, what would be your approach for doing the readings?
6. In what general order did you complete the modeling assignments?
7. What is your preference for solid modeling instruction?
8. In what order did you complete the sketching assignments?
9. What is your academic year?
10. What is your major?

Results

Sixty-two students (86%) completed the survey. Table 1 shows the academic major of the students. Table 2 displays a summary of their academic year.

Table 1. Academic Major.

Major	Frequency	Percent
Aerospace Engineering	3	4%
Biological Engineering	1	2%
Chemical Engineering	2	3%
Civil Engineering	18	29%
Computer Engineering	2	3%
Computer Science	2	3%
Electrical Engineering	1	2%
Engineering Undesignated	2	3%
Environmental Engineering	1	2%
Graphic Communications	1	2%
Industrial Engineering	2	3%
Mechanical Engineering	26	42%
Left item blank	1	2%
TOTAL	62	100%

Table 2. Academic Year.

Year	Frequency	Percent
Freshmen	8	13%
Sophomore	35	56%
Junior	11	18%
Senior	7	11%
Left item blank	1	2%
TOTAL	62	100%

Although the course is open to anyone at the university, the data in Table 1 indicate that enrollment favors engineering majors. Since GC120 falls in the sophomore year in most engineering curricula, it is no surprise that a majority of the students are in their second year.

Students were asked whether or not they had taken or were currently enrolled in an online course or a hybrid course. Tables 3-5 summarizes this data.

Table 3. Previously Taken an Online Course.

Yes/No	Frequency	Percent
Yes	12	19%
No	50	81%
TOTAL	62	100%

Table 4. Previously Taken a Hybrid Course.

Yes/No	Frequency	Percent
Yes	21	34%
No	41	66%
TOTAL	62	100%

Table 5. Previously Taken an Online Course by Academic Year.

Year	Frequency	% of Year
Freshman	0	0%
Sophomore	5	14%
Junior	2	18%
Senior	5	71%
TOTAL	12	

Nineteen percent of students had taken or were taking an online course. Thirty-four percent had taken or were taking a hybrid course (other than GC120). By year in school, 14% of sophomores (5 of 35), 18% of juniors (2 of 11), and 71% of seniors (5 of 7) had taken an online course. Not surprisingly, none of the first semester freshmen had previously taken an online course.

Students were also asked whether they preferred face-to-face, online, or hybrid instruction. Table 6 shows the results of their instructional preference.

Table 6. Instructional Preference.

Instruction	Frequency	Percent
Face-to-face	18	29%
Hybrid	42	67%
Online	1	2%
Left item blank	1	2%
TOTAL	62	100%

Over two-thirds of students prefer a hybrid course, and just under one third prefer face-to-face instruction. Analyzing instructional preference by academic year revealed that 63% of freshmen, 71% of sophomores, and 73% of juniors prefer a hybrid course over the other types. Seniors were equally split between face-to-face and hybrid instruction, while none of the seniors preferred completely online instruction. Only one student of any year preferred (complete) online instruction.

To determine the order in which students completed the online material related to the textbook, solid modeling, and sketching assignments, each student was given a list of the activities in that section and asked to put them in the order that they generally completed them. If they generally completed two items at the same time, they were asked to give them the same rank number.

There were 19 different strategies used to complete the textbook material. Analyzing the order in which students completed the activities, the top three strategies were:

1. Watched the voiced-over PowerPoint(s), read and reviewed the chapter(s), and then completed the WebCT Vista assessment (30%).
2. Read and reviewed the chapter(s) and then completed the WebCT Vista assessment (11%).
3. Read the chapter(s), watched the voiced-over PowerPoints, and then completed the WebCT Vista assessment (7%).

Students completed the solid modeling assignments using 20 different strategies. The top three strategies were:

1. Took notes during the classroom modeling demonstration, watched the online video of the modeling demonstration, modeled the object in the online demonstration, and then modeled the other assigned problem (25%).
2. Watched the online video of the modeling demonstration, modeled the object in the online demonstration, and then modeled the other assigned problem (20%).
3. Watched the online video of the modeling demonstration and modeled the object in the online demonstration at the same time, and then modeled the other assigned problem (11%).

There were 15 different strategies used to by students to complete the sketching activities. The top three strategies were:

1. Started the sketching assignment in class, viewed some of the online videos, and then completed the worksheets outside of class (18%).
2. Started the sketching assignment in class, and then completed the worksheets outside of class (11%).
3. Viewed some of the online videos, and then completed the worksheets outside of class (10%).

In addition to these analyses, final exam scores between face-to-face sections and the three hybrid sections were compared. It was hypothesized that there would be no difference between the face-to-face sections and the hybrid sections at the $\alpha=0.05$ level. Since the sample sizes were different and a normal distribution was not assumed, a Wilcoxon, Mann-Whitney U test was used to determine if a significant difference existed between the means. Table 7 displays the means for each group and Table 8 shows the results of this analysis.

Table 7. Final Exam Score Means for Face-to-face and Hybrid Sections.

Group	N	Mean	Std. Dev.	Minimum	Maximum
Face-to-face	204	81.65	8.80	54	98
Hybrid	65	82.78	8.70	61	97

Table 8. Wilcoxon, Mann-Whitney U (Rank Sums) for Final Exam Scores.

Group	N	Sum of Scores	Exp. Under H0	Std Dev	Mean Score
Face-to-face	204	27036.50	27540.00	545.77	132.53
Hybrid	65	9278.50	8775.00	545.77	142.75

Wilcoxon Two-Sample Test Statistic		9278.50
Normal Approximation		
Z		0.9216
One-Sided Pr > Z		0.1784
Two-Sided Pr > |Z|		0.3567

The final exam mean for the hybrid sections was slightly higher than the mean for the face-to-face sections. The analysis revealed that this difference was not significant ($Z=0.9216$, $p=0.3567$).

Discussion and Conclusions

The data from the survey revealed several interesting themes. Providing instructional materials linked off of a website gave students multiple ways of navigating through the activities. Although this gave the students quite a bit of flexibility, further research is needed to determine whether this was an effective way of balancing students' desires for learning flexibility with optimal approaches to instruction (as determined by the instructors). This is especially true when examining the number of students who chose not to view any of the online instructional videos. For the text material, 13% of students did not use a strategy that involved watching the voiced-over PowerPoints outlining and expanding on the textbook content. Twenty percent of students did not view any of the sketching videos. Having the instructional materials on a regular course webpage did not provide instructors with any feedback on how students were navigating through the content. In the future, materials may be organized under WebCT Vista. Since instructors are able to track each student's WebCT Vista activity, viewing videos inside of a learning management system could be required as part of the class participation grade. This would encourage video watching while still giving students flexibility in the order in which they viewed them.

When designing the hybrid sections, faculty wanted to develop instructional materials in a way that would encourage good study habits – including the use of the required textbook. During the Fall of 2006, Branoff [3] investigated the effectiveness of online assessments as a tool for motivating students to read the textbook in an introductory engineering graphics course. Students were asked to read the assigned textbook material and complete a WebCT Vista assessment each week before the content was covered in class. Students' mean scores on the assessments correlated with their final grade in the course. The mean score did not correlate with their performance on homework, the midterm exam, the final project, or the final exam. Almost all students (95%) reported reading or reviewing the material before taking the assessments. When asked about what their approach might be if they were not required to take the assessments, 75% reported that they would probably look at the textbook material only when studying for exams. In the current study, only 5% of students' reported preparation strategies for the WebCT Vista assessments did not include reading or reviewing the textbook.

In addition to collecting data through the student surveys, faculty also compared performance on the final exam between the hybrid sections and the face-to-face sections. Students in the hybrid sections scored slightly higher on the final exam than students in the face-to-face sections, but this difference was not significant. As far as the textbook content for the course, it appears that students in the hybrid sections understand the material just as well as students in the face-to-face sections.

From the perspective of the instructors, several issues are worth noting. First, meeting face-to-face only once per week created some urgency on those days. Although most of the course content was provided for the students online, the instructors could not be sure that students had looked at all of the material. The only feedback received was whether students had completed the online assessment. The survey revealed that completing the assessment did not necessarily mean the content had been viewed. Based on this knowledge and formative assessment of student content mastery in class, instructors sometimes felt that content had to be covered in class.

Regular sections of GC120 have the burden of sharing one computer lab between 2 or 3 sections. This means that an instructor might only be able to get into the lab every third class meeting. The advantage is that the computers are consistently maintained, and students and instructors experience few software problems. Conducting the hybrid sections as laptop sections gave instructors the flexibility to meet in any classroom and have the software available every class meeting. When offering online or hybrid classes, additional support for both faculty and students is required [4]. Unfortunately, this created quite a few logistical issues that instructors and students had to manage. Some of the issues included: installing SolidWorks on the laptops during the first week of class; problems with the software related to different operating systems (Windows XP, Windows Vista, and MacOS); making sure students had the correct network file transfer software and knew how to use it; students having to authenticate with university servers more than once since they were using several programs; and having enough power outlets in classrooms for the laptops.

A final point is worth noting for all instructors using a constraint-based modeling program. Throughout the process of developing this hybrid course and evaluating student performance, the instructors continually discussed the most important things that students should be able to do at the end of the semester. High on the list was making sure that students understand the power of a constraint-based modeler and that they are able to create dynamic models with the appropriate design intent. In order to properly evaluate a student's understanding of dynamic modeling, an instructor must probe the student models, typically through examining a student's model files. This is manageable when teaching only one section of the course. When teaching more than one section, instructors are faced with markedly increased grading time, often leading to only a visual inspection of a single print-out. Automatic evaluation processes are possible [5,6], but they can become extremely complicated when trying to integrate them into a campus computer network. Faculty should continue to develop dynamic modeling activities that are easier to evaluate and give students a better understanding of the software [7].

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