Practical Issues Associated with the Use of Electronic Media in the Engineering Classroom

Robert LeMaster, Ph.D.¹

Abstract

This paper describes an electronic based instruction format that is a cross between the traditional engineering lecture and a totally online course. It uses electronic media and web tools in conjunction with classroom lectures. Eight practical lessons learned while implementing and maintaining this system are presented.

Introduction

In a typical engineering lecture, the instructor is tasked with presenting students with material that is detail intensive and mathematical in nature. Students are shown the derivation of equations and receive instruction on how to apply them to both example problems and real world situations. Homework problems have traditionally been assigned to help students develop their skills and to test their understanding of the material presented in the classroom. The traditional engineering lecture involves the instructor writing information on a board while providing an explanation of each step. Students in turn copy the information written or discussed by the instructor into personal notebooks for later reference. The use of viewgraphs, videotapes, and paper copies to augment the traditional engineering lecture is common, and recently there has been much discussion concerning the use of web based on-line courses. There are many classroom environments that fall between the two extremes of the traditional engineering lecture and a totally online course. The purpose of this paper is to discuss the practical issues and lessons learned from implementing a classroom environment that falls into this middle ground.

An Intermediate Electronic Environment

The specific electronic classroom environment that is being used by the author involves the use of PowerPoint lecture charts and scanned images of homework problems that are accessed by the students via a website. The lecture and example problems for each class are prepared using PowerPoint. Equations and calculation examples are prepared using the Microsoft Equation Editor and graphics are drawn using PowerPoint or AutoCAD. Scanned images are also used extensively. Lectures are presented with a computer driven projector either on a movable “Computer on Wheels” or in computer labs that contain computers for each student. Solutions to homework problems are worked using traditional hand or computer methods.

Students may follow the material being discussed during lectures by looking at either the images projected on a large screen or computer screens. All lecture notes are available on a website, as are

¹ School of Engineering, University of Tennessee Martin, Martin, TN.
solutions to homework problems. The author is currently teaching three courses using this format - Statics, Dynamics, and Kinematics/Dynamics of Machines. Future courses will also be taught using this environment.

**Lecture Materials**

Lecture “briefing charts” are prepared using Microsoft’s PowerPoint. Graphics are used extensively to illustrate geometric features associated with derivations and problems. Graphics are prepared using AutoCAD, IDEAS, or PowerPoint. Scanned images and pictures of hardware obtained from industry websites are also used quite extensively. Figure 1 contains an example of a chart used in the Kinematics/Dynamics of Machines course to illustrate the Principle of Conjugate Action and show the interaction of forces acting between meshed involute gears. Companion charts show the teeth at different rotation angles and graphically demonstrate that the forces acting between two meshed teeth always act along the line of action. Figure 2 contains an example of a chart used in the Dynamics class to derive the equation for computing the work done in raising a weight.

![Figure 1. Example lecture chart](image1.png)

![Figure 2. Example lecture chart](image2.png)

**Website**

A website is maintained that provides access to lecture notes and solutions to homework problems. The ability to access the lectures and homework solutions from any location at the time most convenient to them is very attractive to students. The website is being developed and maintained using Microsoft’s FrontPage software and is hosted on one of the UT Martin College of Engineering servers. Class lectures are published on the website prior to each class and homework solutions are published after homework assignments are turned in. Both lecture notes and homework solutions are published using Adobe PDFDistiller. Distiller is used over the standard PDFWriter because it consistently handles Greek symbols correctly. Figures 3 and 4 provide example pages from the website.
Figure 3. Homepage for class resources website

Figure 4. Web page used to access class resources
Lessons Learned

A number of lessons were learned during the development and use of this classroom environment. Most of the lessons are associated with very practical issues that affect the overall quality and effectiveness of the method. The following paragraphs provide brief discussions of some of the lessons learned.

Lesson #1 – Information must be carried forward from previous charts.

In the traditional classroom, the instructor has a complete wall on which to write information. Many derivations and example problems require using the entire wall and it is common for the instructor to erase portions of a board while retaining others because the information is needed at a future point in the lecture. The instructor using electronic charts is faced with the same problem – the need to retain information for later use or referral. In an electronic media format, multiple projectors could be used, but in general only one is available. Another approach would be to flip backwards through the slides to find the required information – this is time consuming and not only confuses the students but often leaves the instructor confused when things are not where they are thought to have been. The approach used by the author is to attempt to make each chart self-sufficient by including information previously developed on the current chart. This is not always easy and in some cases not possible. Charts can become quite busy and difficult to read when projected on to a screen.

Figures 5, 6, 7, and 8 provide an example of a four chart sequence in which reaction information computed in slide two (figure 6) is carried forward to slides three (figure 7) and four (figure 8) so that students can readily refer to information previously computed.

Figure 5. Slide one of a four-slide sequence. Figure 6. Slide two of a four-slide sequence.
Lesson #2 – The time required to cover the same lecture material is approximately half that in a traditional lecture.

The instructor spends considerable time in a traditional lecture drawing figures, writing information on the board, walking from one board to another to refer to previously developed information, and waiting on students to catch up in their note taking. When briefing charts are used, the figures are already drawn, equations are already written, and the instructor doesn’t have to walk across the front of the room. Time saved can be used to answer questions, solve additional problems, relate the material to real world situations, or give quizzes – the author’s favorite.

Lesson #3 – Students must have access to the lecture notes.

Students furiously copy everything that they can from the material written on the board and the explanations provided by the instructor during the traditional classroom lecture. When briefing charts are used, the students don’t have time to take notes so they rely on having access to the briefing charts. Access can be provided in several ways. One method is to provide paper copies – this was done by the author prior to the development of the website. The “handout” feature found in PowerPoint’s print dialog box enables six miniature charts to be printed on a single page. This significantly cuts down on the paper needed for handouts. Students prefer to have a copy of the lecture charts in front of them during the lecture so that they can make notations based on the explanations provided by the lecturer. Prior to the having the website, the author provided PowerPoint “handouts” prior to each class. The students are now responsible for obtaining their own copy from the website prior to class.
Lesson Learned #4 – A scanner makes it very easy to include material from outside sources.

In the traditional classroom lecture, the instructor can bring material to supplement lectures (i.e. handouts, viewgraphs, etc.). However, if this material is not the norm, the instructor will spend time making Xerox copies of the material that the students will quickly lose. When briefing charts are used and organized on a website it is very easy to include scanned material from textbooks, manufacturer’s data sheets, or pictures of engineering structures and mechanisms. The instructor is not confined to referring to pictures in the textbook, but can include material from many diverse sources. The author has found that scanned images of engineering hardware adds greatly to the student’s appreciation of the real world application of the material being presented in the classroom. It has been extremely beneficial in the Kinematics/Dynamics of Machines class in illustrating different types of mechanisms and applications. Figures 9 and 10 provide examples of how scanned images are used to compare parallel helical gears and crossed axis helical gears.

![Figure 9. Example use of a scanned image.](image1)

![Figure 10. Example use of a scanned image.](image2)

Lesson #5 – It is easier for students to lose concentration during lectures.

In the traditional classroom lecture, students are active as a result of their need to take notes. When access to the briefing charts are provided either as handouts or via a web site, the students can concentrate on what is being said instead of on their note taking. Students have frequently made positive comments about not having to take notes. However, students have also indicated that it is easier to lose concentration when briefing charts are used because they don’t have to take notes. It’s also easier to skip class because the lecture material is easily obtained.

Lesson #6 – Briefing charts are time consuming to prepare.

Out-of-class preparation time is significantly increased when briefing charts are used. On the average, the author has had to spend approximately three hours on each lecture that contains approximately 12-15 charts. Time is required to draw figures, prepare derivations in Equation Editor, work example problems using Equation Editor, find appropriate graphic material, etc. Time spent working homework problems in sufficient detail so that they are legible when scanned is also...
more time consuming. Prior to making the solution to homework problems available on the website, the author did not work all homework problems out of class. This was because the problems could be worked quickly with no preparation if a problem was asked in class. The author now works all homework problems in a neat and detailed manner. The number of questions asked by students about homework problems has decreased now that they are available online.

**Lesson #7 – Detailed charts are more legible on a computer screen.**

It is best if the students can view the charts on a computer screen during the lecture. The amount of detail included on some of the charts makes it difficult for students to see the information when it is projected on a wall screen. Subscripts and fine detail that is easily seen on a computer screen is often blurred just enough to make it difficult to see. For this reason, the author prefers to present lectures in one of the computer labs so that students can look at the charts on the computer screens as well as follow what is being pointed out on the projector screen.

**Lesson #8 – Creating good “sequential” graphics is important.**

In a traditional classroom lecture, the instructor often uses “sequential” graphics in the lecture. A “sequential” graphic is a figure that starts out simple and has material added in a sequential manner as the lecture progresses. In this manner students are not initially overwhelmed by all the information displayed on a figure to solve a problem. In a “sequential” graphic they are able to see the figure develop as new information becomes available or is needed. This technique can also be used with briefing charts, but it is time consuming, takes patience, and a bit of artistic skill.

**Summary**

This paper has described an electronic based instruction environment that is a cross between the traditional engineering lecture and the totally online course. It uses electronic media and web tools in conjunction with classroom lectures. Eight practical lessons learned while implementing and maintaining this environment have been presented. In general the author receives more positive comments from students about the approach than negative ones. The time required to implement a system as described in this paper is time consuming and requires careful attention to briefing chart content. Companion textbooks used with the courses taught using this approach are quite good, and contain such detail and clarity that many students could actually teach themselves. However, the author has observed that students tend to rely on the briefing charts with little reference to the companion textbook(s).

**Robert A. LeMaster**

Dr. LeMaster is an Assistant Professor in the College of Engineering at the University of Tennessee Martin. He received his terminal degree in Engineering Science from the University of Tennessee Space Institute, an MS degree in Engineering Mechanics from The Ohio State University, and a BS degree in Mechanical Engineering from The University of Akron. He has over twenty years of industrial experience in design, analysis, project engineering and management. His primary research interests are in integrated design, analysis, and manufacturing systems.