

# **Development of EET350 in Podcast Format**

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Final Report

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# Abstract

The method used to convert a conventional ODU Electrical Engineering Technology lecture course to Apple iPod<sup>®</sup> format is shown. Included are course pedagogy development; methods of creating PowerPoint slides, including graphics, animation, and text; file format conversion; file editing; and final production of iPod-compatible material. Additional information is included regarding the selection and testing of various types of commercially-available file capture, file conversion, and media editing software.

## **I. Introduction**

### **History of EET350**

Old Dominion University's EET350 Fundamentals of Electrical Technology is a 3-credit course for non-electrical majors offered by the Electrical Engineering Technology program and taught by EET faculty. It is intended to provide the student with fundamentals of electrical circuit analysis, semiconductor electronics, digital circuits and an introduction to electrical machines. The catalog course description is

*Pre- or corequisite: MATH 211. A comprehensive course in electrical engineering technology for nonmajors. Major topics are basic electricity (AC and DC), circuit analysis, linear electronics and digital electronics. Not open to electrical engineering technology majors except as a substitute for EET 110 in special cases.*

The course offers the non-electrical student with the underpinning to complete the electrical engineering technology minor at ODU. Historically, the course has only been offered in traditional classroom format and in live television broadcast format via ODU's TELETECHNET distance learning system. However, in 2001 ODU entered into a contract with the US Navy to offer, among others, a General Engineering Technology degree program through the Navy College Partner system. At that time, EET350 was developed in a CD-ROM (.wmv) format for use in that system.

Since the advent of EET350 in the TELETECHNET television broadcast system, a shortage of broadcast time slots and other resources has limited the scheduling of the course to once every two years, during the summers of even-numbered years. It quickly became apparent that this was not often enough to satisfy the needs of ODU's distance education students, and the course needed to be available more often. At the same time, the course material contained in the Navy College CD-ROM-based course was outdated and did not fit well with a newly available textbook. It was obvious that both problems could be solved by overhauling the CD-ROM course, streamlining the lectures, utilizing newer technologies, and bringing the material in line with the available textbook. By making the course available to TELETECHNET students in an asynchronous format, it would be easier to offer it more often. Also, by using the same course materials in both the TELETECHNET and Navy College versions of the course, duplication of effort could be avoided.

### **Course Delivery and Pedagogy**

At the outset, several delivery methods were considered, including web, CD-ROM, DVD, and iPod. Because of the anticipated file sizes, web delivery was immediately disqualified. CD-ROM and DVD were good candidates, but lacked portability, a feature that could be well utilized by the Navy College component of our student body. Because iPod-based courses could be viewed either on an Apple iPod or on a desktop

or laptop computer via Quicktime, it was decided that iPod delivery would be the best choice.

By nature, engineering courses are visually intensive. It is difficult, if not impossible, to deliver any course material to students without the use of equations, graphs, charts, diagrams, mechanical drawings, photographs, and schematics. For this reason, the target iPod for this project was chosen to be the 30 Gb and 80 Gb iPod. This device contains an integrated 320 x 240-pixel color LCD display.

In addition to the display, another important issue was whether the iPod contains enough hard drive space to be able to store an entire course. The file size for each lecture would be a function of the type of video used. Movie-based lectures in which the instructor delivers lectures using frontal and overhead cameras (similar to the TELETECHNET broadcast classroom environment) would require extremely large file sizes, and was eventually deemed to be impractical. Generally speaking, the size of iPod video files (.m4v format) are determined by the amount of motion contained in the video. If, instead of using a "talking head" format, we use a slideshow-with-narration format, file sizes can be kept to a minimum.

Experiments were conducted with small 10- to 15-minute lectures and the resulting file sizes were extrapolated to estimate the space required for an entire course. From the results of these initial experiments it was determined that by using the narrated slide show format for the lecture modules, the entire course could easily be contained in less than 5 Gb of hard drive space. The conclusion therefore, was that an entire course could be preloaded into a 30 Gb or 80 Gb iPod, thereby making the course completely portable. Additionally, by keeping the total size of the course files below 5 Gb, the course can be delivered to the student via data DVD. This also allows the student to drag all of the course files from the DVD into iTunes and hotsync into the iPod, or to simply watch the lectures on the computer using Quicktime.

## **II. Required File Formats**

At the outset, creating and assembling the lectures seemed to be a rather daunting task. An obvious choice is that lectures with narration would be developed in Microsoft PowerPoint. However, from this point many other types of support application software would be required in order to generate equations, schematics, sketches, and photographs, and then to translate the resulting composite PowerPoint slideshow into the .m4v file format needed by the iPod.

### **Selection of Software**

**Equations** were created in MathType. This was a simple decision because MathType integrates seamlessly into Microsoft PowerPoint. Additionally, the author had been using MathType for many years prior to this project, so there was no learning curve.

**Graphs** were created in Microsoft Excel or MatLab and imported into PowerPoint using Windows clipboard or TechSmith's Snag-It.

**Schematics** and **mechanical drawings** were created in Microsoft Visio, copied, and pasted into PowerPoint.

**Photographs** were taken in digital .gif format using a digital camera, and imported directly into PowerPoint.

**Animations** were done in PowerPoint using its animation feature. This had somewhat of a slow learning curve, but after some practice it was determined that the extent of animation that can be done in PowerPoint is only limited by the ingenuity of the user.

After assembling each set of PowerPoint lectures slides, voice narration was added and re-saved in PowerPoint thereby creating a complete self-pacing presentation in which each of the slides is timed by the length of the accompanying narration. It was then necessary to convert this .ppt file into .m4v iPod format.

### **File Conversion Software and Capabilities**

At first, it appeared that Camtasia (TechSmith) would be capable of performing the necessary conversion of .ppt files into .m4v format. TechSmith advertises Camtasia as having the capability to import PowerPoint slideshows and then output them in iPod .m4v format. After purchasing and installing the software, it was found that the conversion is not a true file conversion, but instead is done by performing a screen and audio capture of the slideshow in real time as it actually runs on the computer. This creates drawbacks.

First, the maximum screen resolution available is only as good as the screen resolution setting for the computer at the time the capture is performed. Since the target device (iPod) only has a 320 x 240 pixel screen resolution, this may not seem to be a problem. However, it was found that if the computer is not set to a high screen resolution when the capture is performed, the quality of the final 320 x 240 video is degraded (softened), and artifacts can be detected in the video. This may be due to pixel dithering and averaging that is done in the resolution conversion process.

Second, if the slideshow contains smooth animations and slide transitions, the animations and slide transitions in the resulting .m4v file will be "jerky". The reason for this is that when Camtasia is performing a screen and audio capture, the additional resource loading on the computer's processor is such that frames of video are skipped, resulting in "jerky" animations and slide transitions when the file is viewed on the iPod. The author attempted to alleviate this by killing unnecessary processes that were running on the computer such as the virus checker, LAN drivers, and other resource loads. However, these did little to alleviate the problem. Next, assuming that there may be a bottleneck in the computer's video processor, the author installed a video

accelerator board in the computer and shut-down the on-board video processor. This too did little to solve the problem.

After many hours of trials with little improvement, it was determined that the jerky video problem could best be solved by finding a program that could convert the PowerPoint .ppt file to a Camtasia-importable format without using a capture process; in other words, actually perform a file conversion. It was deemed desirable for the lectures to pass through Camtasia because it has extremely good video and audio editing capabilities including video zoom and pan capability, and audio leveling and noise reduction.

After many hours of research into available software, it was determined that the best choice to perform this conversion is Presentersoft's PowerVideoMaker Professional. PowerVideoMaker (PVM) can convert a .ppt file directly to .wmv, .mpeg, and .avi formats, any of which can be imported into Camtasia. It has the capability for the user to select video resolution up to 800 x 600 and the audio sample rate and resolution. Additionally, since it performs a true file conversion (not a screen capture), the process can run in the background without skipping video frames, even when the computer is concurrently performing other tasks. The author chose to use .wmv file format for this conversion. The result is smooth artifact-free video that can be directly imported into Camtasia.

Once the .wmv file has been imported into Camtasia, an audio edit is performed to remove background noise. Also, since the iPod screen has low resolution, fine details of the graphics that would not be viewable on the iPod screen are zoomed and panned in Camtasia. After the lecture module is completely edited, reviewed, and ready for final production, the file is output from Camtasia in .m4v format.

It should be noted that the conversion from .avi or .mpeg to .m4v format could also be done with WinXMedia Software's WinXMedia AVI/MPEG to iPod converter. However, although the program was purchased and evaluated, it was not used in this project because it lacked the audio and video post-production features that are contained in Camtasia.

### **III. Course Development**

It should be noted that prior to beginning course development, several months of preparatory work was done including the selection of software tools, testing of best audio and video formats, development of PowerPoint animation skills, and practicing post-production editing in Camtasia. During this time, many trial lectures were developed, two of which are currently being used in other courses as supplemental lectures.

The course material was divided into small lecture modules, typically 2 to 6 modules per textbook chapter. In the end, 49 lecture modules were developed, each being 10 to 35 minutes in length. Although this totals less than the time included in a conventional

3-credit classroom-based course, consider that the lecture modules do not contain time-sinks that normally occur in the conventional classroom that detract from the time spent on actual lectures. These include student-instructor interactions, interruptions for questions and answers, taking of the roll, taking up and distributing papers, and going over homework problems, tests, and exams. This is not to say these actions do not exist in an iPod-based course, but instead they exist outside of the recorded iPod lectures thereby significantly reducing the total recorded lecture times.

One additional initial concern was the time that the iPod would operate on a single battery charge. With a course that requires video material to be constantly viewed, the iPod screen backlight will be on constantly, which will significantly shorten battery life. If battery life is very short, it would be necessary to break the lecture modules into smaller segments. Apple specifies that the iPod will play video up to 5 hours on one charge. This was tested experimentally, and found that run times in excess of 3 hours were the norm. This was determined to be sufficient to allow the student to view 6 to 12 lecture modules between battery charges.

### Folder and File Names

Because there are several support files required for each lecture, files associated with a particular lecture were all given the same filename (but a different extension) in order to make it easier to find specific files, and prevent confusion. For example, the first lecture PowerPoint file could be *00-00 Introduction.ppt*. The supporting files and object files, and their purposes are shown below.

<i>00-00 Introduction.ppt</i>	PowerPoint Lecture file (contains voice narration)
<i>00-00 Introduction.vsd</i>	Visio graphics file (contains schematic diagrams)
<i>00-00 Introduction.gif</i>	Photograph of the instructor
<i>00-00 Introduction.m</i>	MatLab m-file
<i>00-00 Introduction.wmv</i>	Windows Media file (output from PowerVideoMaker)
<i>00-00 Introduction.camproj</i>	Camtasia project file
<i>00-00 Introduction.m4v</i>	iPod-compatible output file

All of the above files were placed in the folder *00 Introduction*. Then, for textbook chapter 1 material, the file numbers began with 01-01, then 01-02, and so forth. All lectures within a chapter were grouped into a folder names for the chapter number (01, 02, 03, ...). By using the chapter# - lecture# format for the first part of file names, the computer automatically organized them into the correct order when the files are viewed in the file Explorer.

## PowerPoint Development

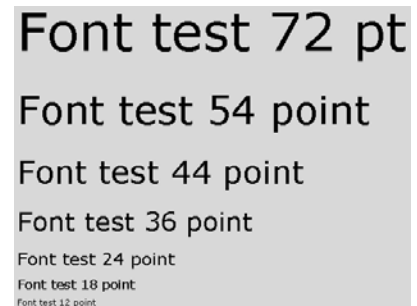
Since the iPod is foremost an audio reproduction machine, insuring high audio quality for the project was a relatively simple matter. However, because of the small 320 x 240 pixel screen size, optimizing the video portion of the project was time-consuming. Many weeks of initial experimentation was undertaken prior to recording the course lectures in order to choose screen colors, type font, font sizes, graphics management, and animations to determine both the limitations of the low-resolution iPod screen and the optimal way to present material on the screen for best readability.

### Slide Color Selection

The ODU Center for learning Technologies was consulted regarding the selection of slide colors (background and font color). CLT point out that the best readability of a slide can be achieved by having a high contrast between the background and font colors. Obviously, white background and black letters would be the best selections, but would also result in very boring slides, not to mention a waste of the exceptional color rendering capability of the iPod screen. After some experimentation, light blue background (RGB values 185, 220, 255) and black lettering and graphics (RGB values 0, 0, 0) produced an esthetically pleasing screen, while maintaining readability. These two colors were used throughout the lecture series with two exceptions: 1) The ODU logo appearing on the first slide of each lecture module used the university-specified blue (0, 0, 102) and gray (204, 204, 204); and 2) other brighter colors (red, orange, bright green) were used to highlight important items on the screen.

### Font and Font Size

The Center for Learning Technologies specified that for best readability, the optimal font is Verdana, mainly because it is simple and contains no serifs. To determine optimal font sizes, a test screen containing Verdana script in various point sizes with blue background and black letters, shown in Figure 1, was developed in PowerPoint, processed into iPod .m4v format, and loaded into an iPod. From the results of this experiment, it was visually determined that any text smaller than Verdana 24 points in PowerPoint would not be readable when viewed on the iPod. Note that Figure 1 has been sized so that if this document is printed, it will be the actual size as viewed on the iPod. Therefore, the font and font size chosen for this lecture series is Verdana, 24 point minimum.



**Figure 1 - Font Test Screen**

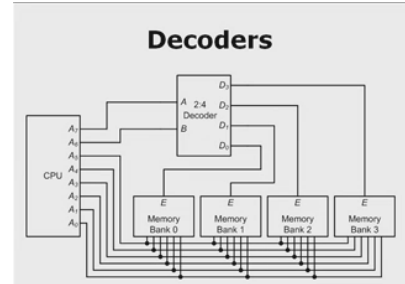
### Graphics

By nature, engineering graphics are intricate and sometimes large, making them especially problematic to display on an iPod screen. Placing an entire electrical schematic diagram on an iPod screen would shrink every component in the diagram

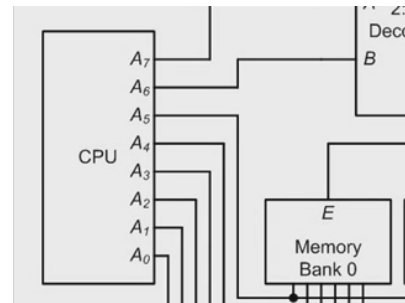


and render the entire schematic unreadable. Initially, it was decided to break the diagrams into parts and show each part on separate PowerPoint slides. However, after some practice with Camtasia, it was determined that its zoom and pan features would be ideal in solving this problem.

Figure 2 illustrates how the zoom feature in Camtasia was utilized to make portions of electrical schematic drawings more readable. In this figure, which illustrates how digital decoders are used to construct a simple computer memory, it is difficult-to-impossible to read the text contained in each of the component boxes. Therefore, for this part of the lecture, the slide in Figure 2 is initially introduced as a typical memory layout consisting of a CPU on the left, decoder on the top, and four memory chips on the bottom. Then, when the narration turns specifically to the CPU itself, the picture is simultaneously zoomed and panned to the left so that the CPU block fills the screen, as shown in Figure 3. Notice in Figure 3 that all text lettering is now readable, while this was not the case in Figure 2.



**Figure 2 - Graphic Example**

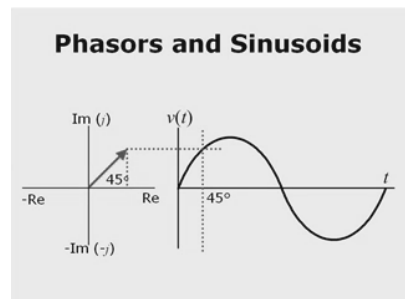


**Figure 3 - Zoomed Graphic**

Once the CPU discussion is completed, Camtasia is again used to zoom back to the full schematic, and then zoom and pan to the next component to be discussed. By illustrating intricate graphics using smooth zooms and pans, the student always maintains a perspective of where in the diagram a particular zoomed component is located and its relationship to other components.

## Animations

In engineering lecture material, animations add attention to lecture slides, illustrate how things work, and add realism to electromechanical illustrations. Animations can enhance the lecturer's ability to impart difficult concepts to the student and show how mathematical equations and graphical data relate to actual working devices. Figure 4 shows an illustration that relates a phasor (vector) in a Cartesian coordinate system on the left to a waveform on a time-domain graph on the right. In this illustration, the phasor on the left was rotated counterclockwise and projected onto the graph at the right, thus allowing the student to immediately see the relationship between rotating phasors and sinusoidal waveforms.



**Figure 4 - Phasor Animation**

Although Camtasia contains some animation features, these are limited to highlights, markups, and scrolling title slides. It is incapable of performing animations on pre-embedded graphics. Therefore, all animations were added in PowerPoint. Although

there is a somewhat slow learning curve on PowerPoint's animation features, after some practice, it was found to be capable of some relatively impressive animations. Occasionally, this requires some negative thinking. For example, if we have a full schematic, and we wish to have parts of the schematic fade-in as they are discussed, we would hide the parts by covering them with empty text boxes. Then when we want to reveal a particular section of the graphic, we fade out the text box covering it.

In the end product, animations were used to fade in/out equations, show how to connect measurement equipment to circuits, illustrate current flow and voltage polarities, draw XY graphs in real time, and illustrate rotating motors and generators.

### Slide Narration

Slide narration was added using PowerPoint's "record narration" feature. For this portion of the project, it was found that a headset microphone performed best because it maintained a constant distance from the narrator (thereby maintaining a constant volume level), it minimized ambient room noise, and by careful adjustment of its position, it also minimized pop and breathing noises. PowerPoint imbeds the recorded narration within the .ppt file, but also tracks the narration for each slide individually. The result is a single PowerPoint file containing all slides and narration while still retaining the capability to re-record the narration for any individual slide.

## IV. File Production

Before processing the narrated PowerPoint presentation into other file formats, it is extremely important to watch the entire lecture and fix errors in either the graphics or narration. The author found that since errors are not so obvious to the one who made them, it was also very helpful to have a colleague review each presentation. Because the post production is a two-step process each requiring 30 to 120 minutes, it is highly recommend that the PowerPoint presentation be as error-free as possible. After post-production, it is very time-consuming to fix errors.

### WMV File Production - PowerVideoMaker

PresenterSoft's PowerVideoMaker was used to convert the .ppt file to .wmv format. PVM is also capable of converting to .mpeg and .avi formats, but after some experimentation, it was decided that .wmv format resulted in the best video and audio quality. Experimentation also showed that by setting PVM for the best possible audio and video qualities, some improvement in the final iPod audio and video was achieved. Therefore, as shown in Figure 5, PVM was set for a video resolution of 800x600, a frame rate of 20 fps,

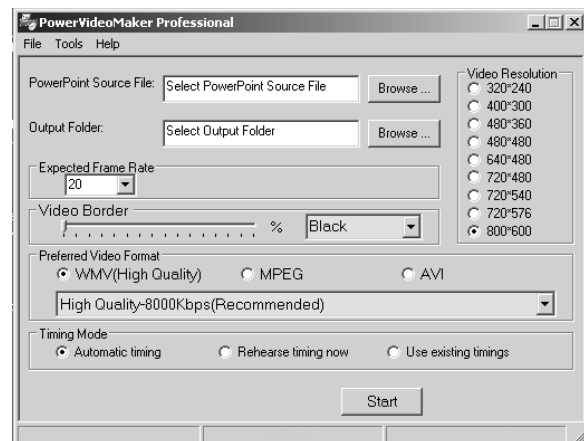


Figure 5 - PVM Setup

and audio quality of 8000 Kbps. Additionally, by checking the "automatic timing" radio button, PVM does an initial pass of the .ppt file to first determine slide timing. Unlike Camtasia, PVM does not have a batch mode, so .ppt files must be converted one-at-a-time.

### WMV File Editing - Camtasia

The next step is to load the .wmv file produced by PVM into Camtasia, add video zooms and pans, and process the audio for noise reduction. Zooming and panning is done using a timeline edit feature in which they are positioned as desired on the timeline and the speed of the zoom and pan is adjusted.

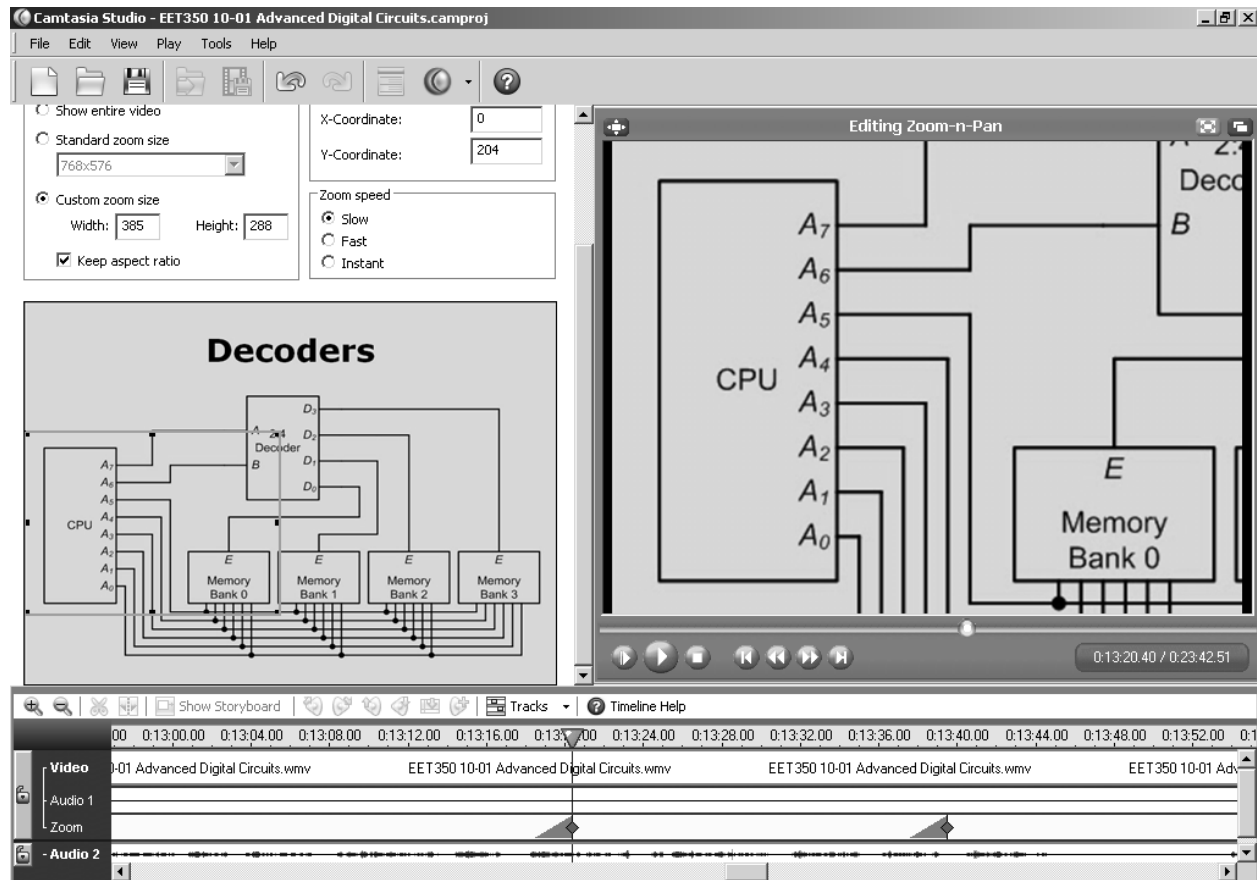


Figure 6 - Camtasia Zoom and Pan Feature

Figure 6 shows Camtasia's zoom and pan feature in use. The current zoom/pan is shown on the timeline at the bottom of the window. Notice that the cursor is placed on the zoom (the wedge shape) and the play window at the upper right shows the screen view at that instant in time. Above the timeline on the left is the window used to define the area of the screen to be zoomed. Notice in the left of this window is a selection box that can be sized and dragged to fit the desired target area. Once a zoom or pan is initiated, it remains in effect until it is modified by another zoom or pan.

Background audio hiss and low-level ambient room noise in the audio can be eliminated by switching on Camtasia's "Remove Noise" feature. This feature is extremely effective and adds little distortion to voice narration.

#### MP4 File Production - Camtasia

Once all video and audio edits are complete, the file is saved to a Camtasia project file (extension .camproj), and then the project is converted to .m4v iPod format. This is done by running the production wizard by selecting "Produce Video as..." in the menu. In the first production wizard window, select "Custom Production settings", and in the next window, select "iPod/iTunes". In the next window, select high iPod bandwidth. In the final wizard window, specify the output filename and folder and click "Finish".

Camtasia has a batch production feature. If several Camtasia projects are ready for final .m4v conversion, they can be placed in a cue and processed as a batch. For the EET350 project, as many as 10 projects were batch-processed overnight, thereby freeing the computer during the day for lecture development.

#### Relative File Sizes and Backups

For planning purposes, it is important to be able to extrapolate expected file sizes in order to insure that sufficient hard drive space is available both on the computer and in the iPod. File sizes vary according to length of the lecture and animated content. The amount of voice narration has a small effect on file size, but compared to the space needed for video storage, it can be considered to be insignificant. Typical file sizes below are listed for a 30 minute lecture.

.ppt Powerpoint with narration	21 Mb
.wmv file (output from PowerVideoMaker)	166 Mb
.camproj Camtasia project file	55 kB
.m4v iPod file	73 Mb

Using the production methods outline in this paper, a course will require 10 to 20 Gb of hard drive storage space. Because of the extreme investment in time and effort required to produce an iPod-based course, it is imperative to backup all files on a regular schedule. For this purpose, a large external USB or networked hard drive works well. As a general rule, the author backed up working files at the end of each work session at a minimum.

## IV. Results

At the time of this writing, the EET350 course production is completed and the Center for Learning Technologies is currently at work packaging the course media. Because current Navy College contracts require courses to be delivered in .wmv format and on CD-ROM, some additional post-production was required to take the audio and video-

edited Camtasia output back to an edited set of .wmv files. Since CD-ROM media is being used, several CDs will be required. The Navy College version of the course will start in the spring of 2008. The eventual goal is to package the course on a single data-DVD and market it to the Navy as an iPod-based course as soon as contractual arrangements permit.

In addition, an EET350 course has been setup for the spring of 2008 in order to test the course material with on-campus students. The course currently has 13 students. For this course, the lecture files are being delivered on data-DVD in both .m4v and .wmv format, thus allowing the students some flexibility. A syllabus, homework assignments, tests, and an exam are presently under development.