
AC 2012-2997: TOOLS, TECHNIQUES AND CLASS EXPERIENCES WITH ON-DEMAND MULTIMEDIA CONTENT IN AN ELECTRIC MACHINES COURSE

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Tools, Techniques and Class Experiences with On-Demand Multimedia Content in an Electric Machines Course

Abstract

On-demand multimedia is a pervasive part of our lives. Content of all types is available from websites such as YouTube, Hulu, and Pandora. Individuals consume this content using home entertainment systems, personal computers, tablet PC's and cell phones giving them access to multimedia information at any time or place. Applying this approach to education gives students better access to course content, expands instructor time, assures uniform delivery, and can be constructed to engage students using several learning styles simultaneously. This paper documents the application of on-demand multimedia content into electric machines lecture-laboratory courses. It will explore software tools, application techniques, and student responses to on-demand video and screen capture course content. It reviews several software tools capable of producing video, screen capture content, and compares their performance. The paper then documents several methods of implementing video and multimedia into the course to engage students and enhance their learning experiences. Webpage monitoring and informal student surveys indicate media usage and student impressions of developed content.

Introduction

We live in a world saturated with digital content. This content consists of text, photos, audio and video files forming a rich multimedia online environment. We consume this content using personal computers, electronic tablets, and cell phones. Many people connect constantly to multimedia sources through one or more of these devices.

Individuals have become producers and consumers of digital multimedia through the Web 2.0 paradigm that gives websites read/write capabilities.¹ This capability gives people the ability to construct personal multimedia environments using easily obtainable software tools. Digital natives, those who were born after 1982, are well acquainted with the read/write web and make extensive use of texting, photo and video sharing via internet sites such as Facebook and YouTube.

Integrated educational multimedia constructed using low cost, easily learned tools can enrich students' learning experiences and provide them with on-demand learning opportunities and activities that parallel those found on social sites. Providing educational interactive web content such as animated presentations, tutorial videos, and video demonstrations help engage students and enhance retention of material.² Planning content structure and pre-recording materials outside of normal lecture gives course instructors time to refine presentations improving their quality. Once recorded, the material can be delivered repeatedly and uniformly every time the course is offered. Developing a library of multimedia content for courses expands instructor time since students can review course materials repeatedly whenever and where ever they need.

Students are free to interact with the content in a way that best suits their individual needs. They can refer only to sections that they failed to understand or procedures that were forgotten.

Well designed multimedia instructional materials will engage students with different learning styles. This is particularly important when instructors are designing courses for digital natives that are constantly utilizing Web content. Their digital world is “always-on” allowing them to instantly communicate, find information and socialize via digital devices.³ Web delivered multimedia allows the student to work individually yet still remain connected to the course. Students can use the types of media presentation that works best for their own learning style and meets their needs best.

Many examples of multimedia applications for engineering and technology exist. A literature search found multimedia applications in teaching electric circuits lecture and laboratories^{4,5}, engineering graphics⁶, strength of materials⁷, environmental laboratory⁸, computational methods⁹, and technical general education courses¹⁰. These efforts document online course delivery and hybrid course applications. They also record the evolution of the hardware, software and techniques used to develop and disseminate multimedia content to students. The general trend is toward web-hosted content.

This paper documents multimedia development and usage in two electric machines courses. The goal of this work was to improve student access to course lecture and lab content through the use of prerecorded presentations using low-cost easily available software tools. Course content was revised to be more engaging and interactive within a multimedia format. The first section of the paper reviews the software utilized in developing course multimedia applications. The second section lists and explains multimedia applications. The paper examines student impressions of the multimedia applications derived from informal surveys. The paper includes preliminary website tracking of page views as an indicator of student usage. It summarizes the findings and gives direction for future work.

Software Tools for Multimedia Development

Many software tools exist for creating presentations and delivering them over the Web. Table 1 lists the software used to create course content in the electric machines courses. It also lists advantages and disadvantages for each package. The software falls into five functional categories; presentation development, screen capture, audio capture/editing, video editing, and file format converters. Most software listed in Table 1 is available in freeware versions with the exception of MS PowerPoint and MathCAD. Freeware can be useful, but documentation and support are limited.

The course instructor used presentation software to create course content. Most course materials existed in MathCAD or Microsoft (MS) PowerPoint files, but designed for face-to-face delivery in an overhead projector format. Pre-lab content existed of hand-written notes converted to Adobe PDF files so students could access them from course websites. The course instructor converted existing materials into an on-line delivery format by changing the page orientation, adding color to highlight topics, and using animations to control information display.

Table 1 -Software Comparisons

Software		Advantages	Disadvantages
Function	Name		
Presentation Development	MS PowerPoint	Widely available desktop tool. Integrated graphics, audio and video. Custom animations available	Limited math and formula displays Multimedia creates large files that must be downloaded. No streaming.
	MathCAD	Easily displays complex equations and graphs. Changing parameters reflected automatically	Not designed to create presentations.
Screen Capture	Panopto	Server-based system integrates multiple video signals, PowerPoint presentations and PDF content. Encoding completed on server. Designed for online courses	Editing tools crude and difficult to use in freeware version. No technical support for free version. IT personnel support required for installation on servers
	Camstudio	Free, simple to use screen capture. Creates avi format files Flash converter included	Flash converter has bug that requires html editing. Audio/video synchronizing problems for some encoder settings.
	MS Expression Version 3/4	Screen capture works well. Encoder allows editing of audio and video Can encode for Silverlight or other common formats.	Ten minute limit on screen captures on free download. Encoding is time consuming.
Audio Capture/Editing	Audacity	Provides simple audio recording and editing tools.	Freeware with limited documentation and support
Video Editing	Windows Live Moviemaker	Free download for Windows users Easy Editing digital recorder files. Add special effects	Resulting files require encoding for Web streaming
File Converters	ISpringFree	Converts PowerPoint files into flash movies. Easy to use. Has tools for embedding flash movies and UTube into presentations	Some animations incorrectly converted Features limited on freeware version.
	Prism Video File Converter	Free tool for converting video files to other formats. Includes encoding.	Free software has time-limited features. Some conversion formats expire after trial period.

This made presentations more visually engaging and comprehensible. The new format divided lecture materials into smaller sections for presentations up to fifteen minutes long.

The instructor completely revised pre-lab content to make presentations visually attractive and engaging. Animations illustrated complex topics and changes in laboratory configurations.

Original pre-lab face -to-face presentations lasted less than ten minutes. The new content design keeps the same time limits.

Screen capture software turns a view from the computer screen into a video file. All packages listed in Table 1 allow recording of a synchronized audio sound track. Panopto and MS Expression provide inputs for another video source, such as a webcam. Camstudio and MS Expression 3/4 allow the user to select a portion of the screen for capture. Screen capture software is ideal for creating software tutorials and adding sound tracks to presentations. All listed screen capture software includes encoding programs that converted the captured video/audio into a format for streaming over the Web.

Panopto is software designed for course content capture and online presentation.¹¹ It installs on a server and has a desktop client that records screen images, webcam output and PowerPoint presentations. The user can upload supporting documents in PDF format. Encoding takes place on the server with Panopto. The full version of this program supports user accounts and content access limits. The free version comes with no documentation or user support and requires server space and information technology personnel support to install and maintain. Video/Audio editing is very limited in the freeware version and makes content modification difficult.

MS Expression V3/4 screen capture and encoding tools are part of a complete Web development package.¹² This software installs on the desktop and can integrate video from a user-define screen window, a webcam, and audio. The software supports file encoding into a number of popular formats including MP4 and WMV. Its output produces an HTML wrapper file that loads a Silverlight player in a browser window for viewing the encoded multimedia file. A free version of the screen capture and encoder is available for download, but is limited to ten minutes of recording time.

CamStudio is free screen capture software that consists of video capture application, a movie player and an AVI-to-Flash converter program.¹³ This simple-to-use software can record screen video in either AVI or SWF (Flash movie) formats. The Flash converter application produces a HTML file that plays the screen capture file in a browser window. This software has two bugs that affect its usage. Certain combinations of frame rates and playback speeds cause loss of synchronization between video and audio. The Flash converter HTML file has an error that requires manual editing of the code to correct. Support websites document these bugs and outline the fixes.

Audio editing¹⁴, video editing and format conversion software complete the tool set used to create multimedia content for the course. The audio capture and editing software allows the user to record and modify voice tracks associated with screen capture or MS PowerPoint. Video editing software, such as Windows Live Moviemaker¹⁵, gives the course instructor an easy to use tool for adding titles, editing digital video, and adding special effects to camcorder or webcam recordings.

File format converters change video formats or presentations into files that are more compact. A web browser can download and play the resulting file with the appropriate software plug-in. ISpringFree¹⁶ is a free software tool that integrates with MS Powerpoint. The software converts a presentation file into a Flash movie. The PowerPoint presentation can include an audio narration track and short video animations. ISpringFree converts these files correctly and efficiently

producing an HTML wrapper file that will play the Flash movie when loaded into a web browser.

Students access the content generated using the software described above through links provided on the course webpage.

Applications of Multimedia in Electric Machines Courses

Table 2 shows the multimedia applications for the electric machines courses. Two courses form a sequence that covers ac/dc machines and three-phase power over two semesters. The courses use web-based multimedia for lecture delivery, pre-lab preparation, software demonstrations, and test reviews. The course instructor, with help of a graduate assistant, developed this content over an eighteen-month period. The course instructor developed this content using various combinations of software to test the quality of the finish product and software capabilities.

Table 2 – Course Multimedia Applications

Course Application	Software(s) Utilized	Result(s)
Online Lectures	Panopto MS Expression 3 Camstudio	Link to streaming audio/video file Link to pdf file of presentation slides
Pre-lab Prep	Panopto MS Expression 3 ISpringFree	Link to streaming audio/video file Link to pdf file of presentation slides
Software Demonstrations	Panopto	Link to streaming audio/video file
Exam/Homework Solutions	MS PowerPoint MathCAD ISpringFree	Link to streaming audio/video file

Web lectures were the first multimedia application developed for the courses. The first software used was MS PowerPoint for presentation development and Panopto for screen capture. Students accessed the content from a link sent via email. Server security required students accessing the presentations to use Virtual Private Network (VPN) client software. Student had to obtain and install this software before viewing content developed using Panopto when they accessed content from outside the campus network. This led to a number of student questions and limited content usage. MS Expression V3 and CamStudio software produces encoded files for uploading directly to the course website eliminating the need for VPN software. Subsequent web lecture development took place using these tools. Another Web lecture alternative investigated was adding audio narration to the MS PowerPoint slides and posting this file to the course website. Students verified their review of lectures by submitting a written list of keywords mentioned in the presentation voice track.

Web lectures give students access to course content anytime and anywhere they have Web access. Different software products produce files that may have limited compatibility with user devices or require additional software to access. Ideally, students should be able to access Web content by using a browser with software plug-ins. A streaming format allows students to view

the content while it transfers to their local viewing device. Easy audio/video content editing allows instructors to quickly remove unwanted sections or remove mistakes.

Experience with the software and student feedback indicates that a combination of MS PowerPoint and ISpringFree give the best results for instructor time invested. Panopto requires students install the VPN client and has limited editing feature when using the free software. Screen capture of MS PowerPoint presentations using MS Expression or CamStudio produced good results, but produces a single voice track that is difficult to edit. Encoding video capture files can take a long time for some file formats. Adding narration and animation to PowerPoint and converting them to Adobe Flash format requires the least amount of development time. Editing the slide stack is easier than editing the audio and video files produced by other means.

Pre-lab presentations review key laboratory concepts and present procedures before students execute course experiments. Graduate teaching assistants (TA's) covered this content at the beginning of each lab period. Converting these presentations to on-line multimedia content with required viewing saves laboratory time and allows students to review material before writing lab reports. New presentations made extensive use of animations, graphics and color to make them more interesting and engaging.

The first software used for pre-lab prep presentations was Panopto. The last pre-lab prep presentation development used the MS PowerPoint/ISpringFree combination. Table 3 shows the number of applications developed using the various software tool combinations.

Table 3 – Software Usage

Application Software Tool(s)	Online Lecture	Prelab Prep	Software Demo	Exam/Homework Solutions
Panopto	1	12	9	0
MS Expression 3 Camstudio	3	6	0	0
ISpringFree Powerpoint	0	3	0	3

Screen capture is an ideal way to demonstrate software packages to students. Software companies use this technique to provide online training for their products.¹⁷ In the electric machines courses, students use MS Equation Editor, and Excel to add equations and graphs to laboratory reports. Students also receive an introduction to MathCAD as an engineering problem solving tool. TA's introduced this software in lab. Previous delivery of this content consisted of tutorial handouts distributed in class and available online in PDF format. Course instructors demonstrated the software during the first laboratory period.

Courses developers initially used Panopto to record on-line lessons demonstrating all software tutorial topics. Lessons focused on a single facet of software usage and with presentation lengths of twenty minutes or less. Short screen capture demonstrations allow students to select topics that require their review without searching through long demonstrations. Shorter screen captures also take less time to encode for web delivery.

Slow mouse response made screen capture using Panopto difficult. The speed of the hosting PC cause slow response, however, other capture software worked more smoothly. Students needed to install the VPN client to view these demonstrations from off-campus location, which is also a limitation of this capture method. Subsequent screen captures made using both MS Expression and CamStudio on the same computer proceeded without mouse response delays. Editing the voice track of a screen capture can be difficult. It requires software tools to remove the audio track from the video. The course developers recorded all screen captures outside of class using a short outline to direct the narrations and limit the need for audio editing.

Creating multimedia presentations of homework and exam solutions allows student to review this content multiple times and outside the normal lecture structure. Posting solutions saves lecture time and gives student the opportunity to select a review level necessary for their needs. The multimedia content consisted of animated written solutions with a synchronized voice track explaining each solution step.

The course instructor prepared and released two examinations in multimedia format during the fall 2011 semester. Course exams consist of multiple-choice questions to determine students' qualitative understanding of topics and problem solving. Preparing the exam presentations required developing a numerical problem solution using pencil and paper or MathCAD. The instructor used MathCAD to solve the problems and prepared a solution document. The instructor cut and paste sections of this document into MS PowerPoint, added animations, and provided a narration. Converting the presentation with narration to a Flash movie using ISpringFree software compressed the file size and produces Web content viewable in a browser.

Student Utilization and Comments

Initial pilot testing indicates how the students utilized the multimedia content and their views on the delivery format. The course instructor began introducing course multimedia content in the fall 2010 semester. The course instructor and laboratory TA conducted informal student surveys during the spring 2011 and fall 2011 course offerings. The course instructor installed webpage tracking using Google Analytics during fall 2011 course to determine content utilization. This tool delivers a wide variety of statistical information on website's usage when properly applied. Course student enrollment during this pilot period was eleven and twelve during the spring and fall semesters respectively

The results of the informal surveys indicated that students reacted positively to the addition of multimedia pre-labs and lecture material. Most students had their own computer resources and could access multimedia content. Other accessed the content from university computers. They considered the material helpful in preparing for labs and writing lab reports because they could refer to the content after the lab. The online lecture material gave students control over how and when they viewed the material. They were able to access the lectures from home or campus computers anytime. They were able to stop, rewind and review confusing lecture topics providing them with a better learning experience and deeper understanding of the topics.

The informal surveys and instructor observations found other notable factors that can improve student's experience with the online multimedia content.

- Make content easily accessible. Many students had difficulty accessing Panopto-generated content due additional software requirements. Students found obtaining and installing the VPN client difficult and frustrating.
- Have computer hardware capable of multimedia playback and inform students of any additional hardware requirements. Not all campus computers could play the audio tracks. Students needed to purchase headphones to hear audio in campus computer labs. Some complained of additional cost and used it as an excuse from not using the content.
- Provide webpage links to obtain any software necessary to play multimedia content. A technical requirements section provides links to Silverlight and Flash player software. This allows students to install quickly the required software.
- Use a format that allows students to use multiple viewing platforms. Accessing the content from mobile devices such as tablet PC and smart phones gives students more viewing options. Students found they could access Flash movie Pre-lab presentation using their cell phones.

Revisions of the course multimedia materials address these items.

Webpage tracking has the potential to closely monitor student utilization of the multimedia content and give course instructors insight on how to improve it. Google Analytics uses tracking codes imbedded into webpage source HTML to gather data regarding number of views and time on page.¹⁸ The course instructor monitored eleven weeks course homepage access during the fall 2011 semester.

Figure 1 shows the course homepage access for the last eleven weeks of the fall 2011 semester. Enrollment in ET332a during this period is twelve students . Peaks in access correspond to the scheduled course laboratory. Students seem to be viewing the pre-lab materials just prior to performing the weekly lab. The semester ended with an hourly exam on December 8 and a final on December 12. These events account for the heavy page views during the last ten days of the semester. This plot would suggest that students are using the content. Future work will include tracking of each multimedia webpage to determine if students are accessing the content and viewing it completely.

Conclusions and Future Work

This paper reviewed low or no-cost software tools for producing multimedia content. It documented course applications of multimedia in electric machines courses that included pre-lab presentations, lectures, software demonstrations, and homework/test solutions. The course instructor developed different applications using various software tools. Freeware tools can produce acceptable multimedia results for these applications but require instructor time to learn and resolve software bugs. Some freeware tool contain features or usage limits that can be restrictive. Most tools listed in this paper function well and are learned easily.

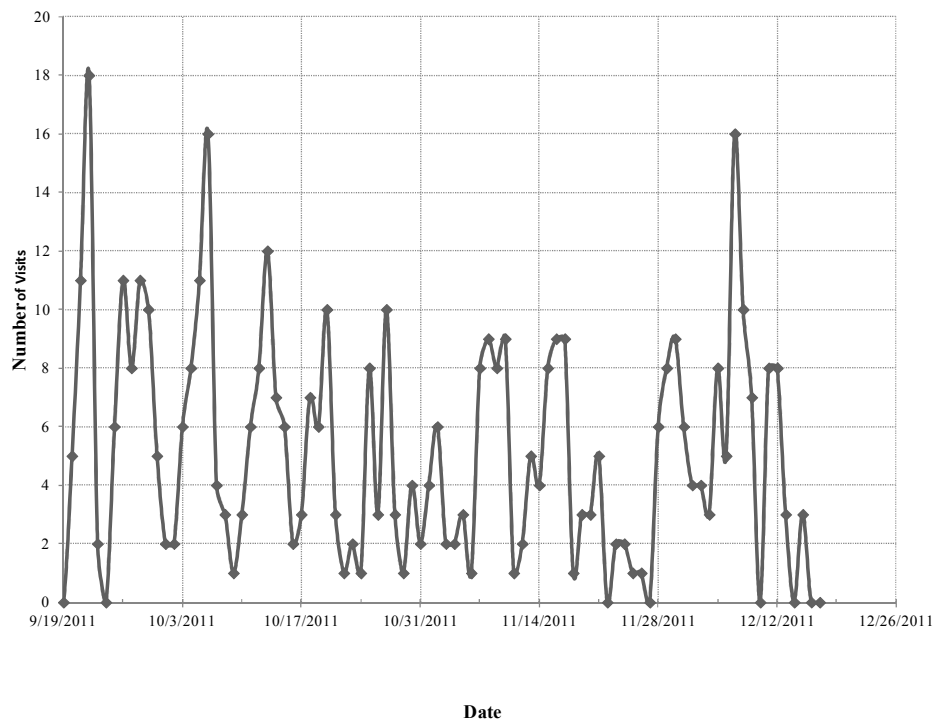


Fig. 1. Homepage Views ET 332a Fall 2011

Course instructors wishing to use multimedia should determine the project scope and resulting work product and then select software tools that produce the best result with minimum additional training and time investment. Instructors should experiment with various tool combinations to determine what tool set works best for their skill level and application. The final product should use a format that students can view on many platforms including mobile devices. The final tool combination used for future electric machines course development is PowerPoint/iSpringFree for pre-lab, lecture, and homework/exam solutions and Expression 3/4 for software demonstrations.

Avoid multimedia applications that require students to install special software to gain access, such as VPN clients or other restrictive software. Providing webpage links to content viewers helps users set up their hardware for viewing multimedia. Inform the student population of all computer hardware requirements at the beginning of the course and resolve these issues early.

Students exposed to a world filled with online multimedia expect educational materials to reflect the same free content access found on other online sources. Students maturing in an "always-on" digital world select and utilized the content to suite their individual needs. Applying webpage-tracking tools help an instructor determine how students are actually using course content. Initial site racking shows that students are accessing the course homepage with a pattern indicating that they are using it to prepare for laboratory activities.

Future work will include more detailed tracking of the course websites. Tracking webpages that access multimedia content will give more details on how students utilize the materials. Tracking

access to each multimedia content page will also give more information about how long students stay with the presentations and if they view them repeatedly.

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