

Web-based Development and Delivery of Course Material on Maintenance Engineering

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ABSTRACT

The objective of this technology enhanced course material development is to create instructional objects that are suitable for both synchronous presentation and for use as web-based modules for students accessing the material *anytime and anywhere*. This project has been undertaken as part of the effort by the College of Engineering at The University of Tennessee for enhancing the delivery of instructional material. The development and demonstration of the web-based teaching material is focused on one of the modules used in the college-wide course entitled ***Introduction to Maintenance Engineering***. The module incorporates interactive course material, examples, PowerPoint slides, and video clips of rotating machinery in operation.

1. Introduction

Introduction to Maintenance Engineering is one of the courses that was developed under a National Science Foundation Combined Research Curriculum Development (NSF-CRCD) project at The University of Tennessee. This is presented as a distance education course and consists of twelve modules. The course presents the principles of various maintenance technologies as they are practiced by the U.S. industry. The module selected for web-based delivery and enhancement is entitled ***Vibration Analysis and Machinery Condition Monitoring***. The material enhancement has been developed in cooperation with the University of Tennessee Department of Instructional Technology, Curriculum, and Evaluation (ITCE) within the College of Education, and uses the *Macromedia Web Design Studio*. The course is currently delivered in the synchronous mode using the *Centra Symposium* platform. *Centra Symposium* is a platform for distance delivery of instructional material in the synchronous mode.

The important features of this technology enhanced course material development include the following:

- Design of a web-based module on *Vibration Analysis and Machinery Monitoring*. This module consists of several animations.
- Development of an interactive visual-based analysis of a second order damped vibrating system. This module, developed in FLASH Action script, has the capability to illustrate the effect of changing spring and damping parameters. The graphical plot and the physical animation are seen simultaneously.
- An interactive CD-ROM of the module that includes links to several related topics, PowerPoint presentations, video clips, and text material.
- Development of a data acquisition and analysis module that is integrated into the

classroom discussion.

2. Objectives of the Web-Based Course Material Development

The course enhancement features are being developed and incorporated simultaneously as the course is being presented. The basic course content and the modular format have been already developed. The primary objective of the web-based development project is to create instructional objects that are suitable for both synchronous presentation and for use as web-based modules for students accessing the material *anytime and anywhere*.

The new features also include interactive problem solving, animations, video clips, on-line data acquisition, and windows applications. A CD-ROM has been developed concurrent to the development of enhanced course modules. There is a need for a self-contained text (book, CD-ROM) in maintenance engineering. It is anticipated that the course enhancement project will result in the preparation of this *text* material.

The following tasks were completed as part of the project objectives:

- Organization of the text and PowerPoint presentations for on-line and web-based delivery. The lead investigator received training from the Innovative Technology Center (ITC) at the University on instructional module development and design and planning for online instructional material.
- Development of windows applications for instructional modules and interactive problem solving examples. These are incorporated into the text as well as the presentations.
- Preparation of animations and video clips for incorporation into the modules. This will enhance students' appreciation of engineering principles and minimize the boredom associated with non-synchronous web-based delivery.
- Development of web-based machinery data acquisition and visualization for a vibrations laboratory using an Internet Toolkit.
- Preparation of a CD-ROM text with windows applications, interactive engineering examples and animation/video clips.

The entire class session is digitally videotaped and is available for later viewing by the students using the playback feature of the *Centra* session.

3. Features of the Web-Based Instructional Module

All the classroom presentations utilize *Centra Symposium* and the *SmartBoard*®. The *SmartBoard*® is a device that essentially replaces the computer monitor for manipulating information displayed on its screen. This touch-screen monitor has a projection system that displays the computer monitor screen to the entire class. It is interfaced with the *Centra Symposium* server, and is thus used in a dual delivery mode. The following is a list

of features of the multi-media system.

- The PowerPoint presentation material and some of the course text on *Introduction to Maintenance Engineering* are incorporated into the course site and the CD-ROM.
 - A data acquisition and analysis module was developed and integrated into the classroom discussion. This is one of the windows applications being used as part of the lecture.
 - A MATLAB-based windows application was developed to demonstrate signal processing and transient data analysis using spectrogram.
 - Several digital video clips were generated from a VHS tape. These video clips illustrate eddy current testing and ultrasonic testing used in nondestructive examination (NDE). The video clips are executed in *QuickTime*. These clips are available on a CD-ROM and on the web site.
 - A new video-clip of the SpectraQuest vibration monitoring system was made and is available on the CD-ROM and on the web site.
 - The control page of the web site for the module on *Machinery Vibration Monitoring and Applications* is shown in Figure 1. The module is divided into smaller text sections, with links to various topics, animation, and simulation. Several animations have been developed. The module consists of eight subtopics as shown in the figure. An interactive problem solving is incorporated for studying the response of a second order damped vibration system.
 - A CD-ROM was also created for this module. The CD-ROM includes PowerPoint slides and video clips, in addition to the text information.
 - We used **Flash 5** for CD-ROM and **Dreamweaver** to design the web site. However, several of the images were created in Photoshop 6.
<http://www.engr.utk.edu/TECMP/upadhyaya>
- The CD-ROM version of the module on Vibration Analysis may be viewed at <http://www.engr.utk.edu/TECMP/upadhyaya/MODULE5.html>
- The instructions for the user are provided on the CD-ROM to help the user in navigating the contents. Examples include stepping to the next page, back to the main page, how to operate simulation, etc.
 - An interactive animation of a spring-mass-damping vibrating system was developed. The module, developed in FLASH Action script, has the capability to change the system parameters to illustrate the effect of changing mass and

damping on a vibrating system. This also includes an animation of the movement of the spring-mass system in synchronous with the graphical plot of the displacement. Students are able to experience interactive learning by simulation of various degrees of vibration damping

- The CD-ROM and the web site contain almost the same text. They are created by different software and are slightly different in design.

The students submit their homework and project material to the instructor via the e-mail. The information about the ongoing projects is also posted on the discussion board, which is part of the course site. The evaluation of the multi-media course by the students will be carried out in the future.

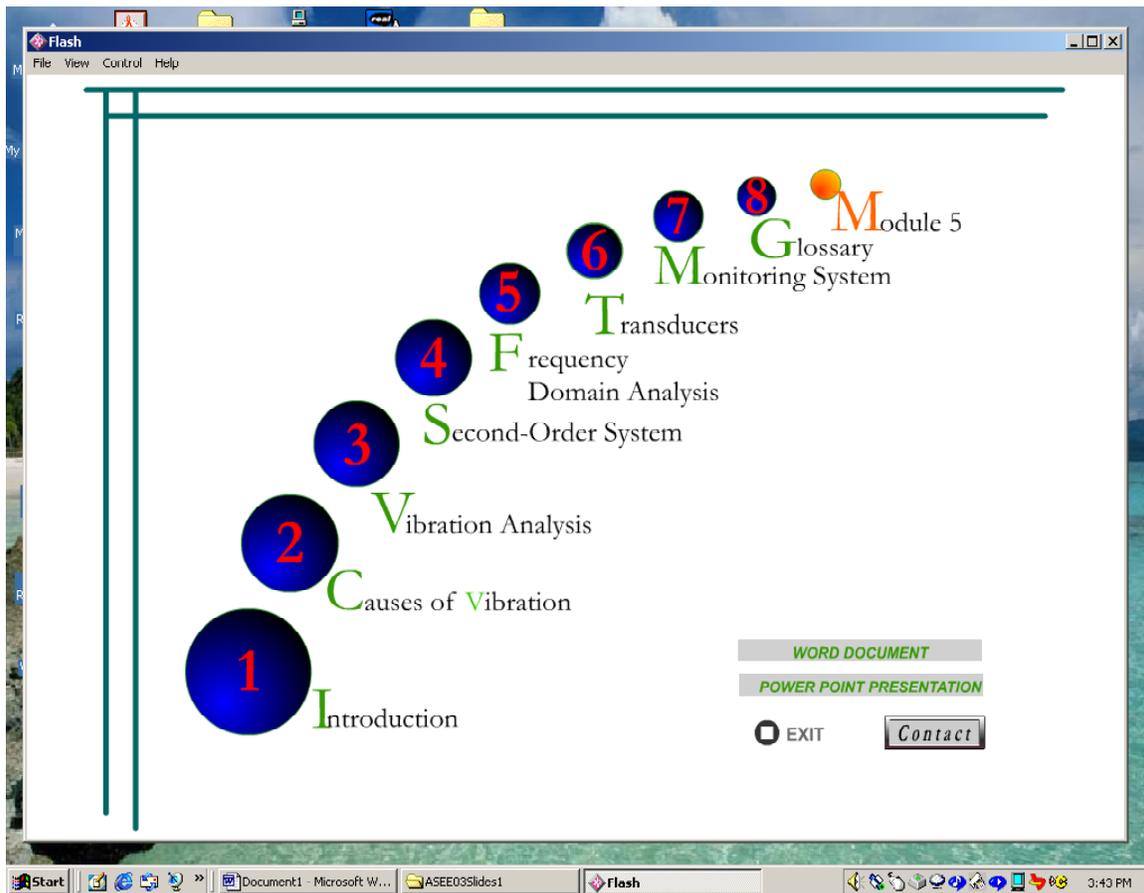


Figure 1. Control page of the course module web site on vibration analysis and machinery condition monitoring. This is labeled Module 5, one of the twelve modules presented in the course.

4. Concluding Remarks

The feedback from the students and the lead investigator's experience in teaching the course, both in-class and at a distance, indicate that it is necessary to improve the delivery format and to provide increased interactive problem solving opportunities for the students. The experience gained through this information technology project has enabled the development of effective web-based and interactive course material in maintenance engineering. The paper presents the details of the various features that could be incorporated into both web-based and synchronous instruction material and its effectiveness in distance education. The continuing work in this area includes expanding the features of the course to other instructional modules in maintenance engineering. Student assessment and feedback about this multi-media delivery is not currently available.

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