CBI Courseware Development – Lessons Learned

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Abstract

This paper presents our experiences while developing computer based instruction (CBI) materials for an Electrical Machines course for the NSF-funded Greenfield Coalition (NSF-GC) for new Manufacturing Education. Greenfield Coalition for new Manufacturing Education is a partnership of six diverse educational institutes and five manufacturing companies, the Society of Manufacturing Engineers and Focus: Hope, a civil rights organization that serves the Detroit community. The Center for Advanced Technologies (CAT) is Focus:Hope's multi-level training facility. Greenfield Coalition was conceived to develop an innovative manufacturing technology and engineering curriculum.

The electric machines course introduces industrial electric power sources and industrial applications of motors, generators, and transformers to associate level manufacturing engineering and technology students. The course is developed from an industrial electric systems perspective rather than from an electric circuit perspective.

The goal of writing this paper is to partially enable future developers of CBI material, especially in mathematically intensive courses, to understand the dimensions of such developments. This project involved developers, specialized in electrical engineering, responsible for the technical content, an industry partner to provide feedback and inputs on material relevant to manufacturing, instructional technologists to insure ease of visual learning, specialists to help in devising modes for assessing learning of CBI material, graphic designers to create professional drawings and figures, multimedia specialists to develop animations based on written descriptions of the developers, and authoring tool experts to develop the material on Authorware and Flash screens.

1. Introduction

The growing need for improved education in technical fields has led to the development of innovative methods of instruction. Similarly, advances in computers have enabled the introduction of sophisticated delivery of instruction. Traditional methods, supplemented by audiovisual demonstrations and other learning vehicles, have been in use for the past seven years. The projects funded by the NSF and the U. S. Department of Education [1, 2] demonstrate the use of these techniques. There have been four instances [3-6] of multimedia approach to electrical engineering and technology courses. A more recent trend is towards devising Computer-Based Instruction (CBI) to provide an individual student with a self-paced learning environment. Three universities have developed instructional material CD-ROM's in areas of thin film technologies, materials science and electric circuits [8-10]. A versatile analysis of learning styles and active learning techniques along with courseware approach for electric circuits is reported [11]. Student response to CBI [8] serves as a pertinent reference. Other sources include the IEEE Transactions on Education [12]. An electroscience development for the

Greenfield Coalition manufacturing curriculum has been reported [13]. A module approach to modularized electric machines teaching in the United Kingdom is also reported [14]. However, a concise, realistic and practical summation of the experience that developers accumulate must be made available in order that the already invested federal funds are justified.

2. Methodology

The Electric Machines course emphasizes practical concept applications in electrical machines and stresses the fundamental phenomena that underlie their operation. This instruction is intended to be learner driven and provides computer-based instruction (CBI), and self-paced laboratory experience. This development is carried out in coordination with the Focus: Hope's CAT facility. The initial phase of the project involved the inputs of Focus: Hope students about their shop floor experiences. Familiarity and mutual discussions of the project team with CAT facility engineers have helped devise suitable/pertinent applications. Discussions with the Greenfield Coalition authoring and design team provided available resources.

The course material is divided into seven modules. Module 1's contents are fundamental concepts of electroscience [13]. The development of Modules 2-7 is the core task of this project. The instruction material is being developed on '*Authorware and Flash*', tailored for CBI. Content is devised to provide distinct material otherwise unavailable to enhance student learning. Another important feature of the CBI is to provide an interactive student environment. In addition, providing helpful hints and feedback for solving the problems through the interactive screens is to assure consistency in learning. Providing appropriate navigation tools for effective access to the already available core material and other reference material is to effectively utilize resources. Utilizing additional instructional videotapes on electricity or any other topic is to supplement the course content.

The Greenfield Coalition adapts its own methodology called 'Water-fall' in its curriculum [13]. The coalition holds regular developer workshops, makes ongoing developments and experiences known and provides key points for each stage of development. The complete process of development consisted of (i) Planning and classifying core material into modules, (ii) Creating PowerPoint story-boards for all modules (iii) Review and feedback of story-boards, and multimedia elements (iv) Multimedia development and (v) Delivery.

(i) **Planning of modules:** A well thought out plan for each of the modules is made. This begins with formulating the material for inclusion into each module. The core learning material is devised as one of, or a combination of, an identified resource material in the form of published literature, a course pack, a certain portion of a text book, an Internet site or a CD-ROM. Self-assessment and actual assessment of students' learning are part of each module.

(ii) **Story board generation:** The IT/multimedia team provides the developers with templates on which the material has to be entered in *Power Point*. These screens would have the appearance of an *Authorware* screen. The graduate students and the faculty arrive at the wording, graphics, equations and any other multimedia elements and prepare the storyboards. The student and faculty team has to make sure that the boards are almost in finalized stage at that time, and that animation description is passed on along with the storyboards, graphics, photographs, summary, list of objectives, formulas, definitions and video/audio clips to the IT/multimedia team. A rather back-to-front or end-to-beginning approach needs to be implemented in developing the storyboards. Developing relevant screens with what we want to test students in the end in mind seemed to appeal to us. Other approaches seemed to result in too many screens and provided no set direction. According to learner specialist's guidance, it was decided that each module would not have more than 100 story boards/*Authorware* frames. Also placing text on the right and the graphics on left was agreed with no more than five or six text lines with font 24 or 16 minimum. Up to 4 to 5 topics per module were considered. Providing proper module references, relevant graphics titles and a suitable graphic on the *Power Point* frames were considered absolutely essential.

Storyboards are also included for the assessment of student's learning of each module. For the CBI material, topic-wise self-checks are provided to enable the students learn at his/her own pace. These have fill-in, multi-choice, drag-and-drop or visualization type of examples for which a grade is not attached. The module assessment includes CBI, in-class and/or laboratory type of assessment. Also considered are the hands-on work experiences of the students, which would contribute towards components of a particular module. The final grade is determined by contributions from each module.

(iii) **Review and feedback:** The multimedia team examines the material and provides feedback to content developers about consistency, notations, student understanding and feasibility of programming based on the authoring tool.

(iv) **Multimedia development:** The multimedia team gathers all components and compiles for entering them on to *Authorware* screens. Individual screens are mostly typed with certain notations imported as objects into *Authorware*. The animations are separately developed on *Macromedia Flash* and included while programming.

(v) **Delivery:** The delivery of the CBI material follows the development stage. Per the current status of the project, the delivery of this course entirely based on the CBI is scheduled in the upcoming months, when the developers will be able to include the experiences from the student evaluation and feedback. In order that the developers gain experience from the audience for the course, the course was taught once already this summer at the Focus: Hope's CAT facility.

Software tools that have been utilized in the development are: Macromedia's *Authorware* 4.0, and Macromedia's Flash, (ii) VISIO Technical drawing 5.0, (iii) Pspice, (iv) MathCad, (v) Matlab, (vi) Magsoft's Flux2D. All these tools enabled creation of simulation and visualization components.

Laboratory sessions for the current project are videotaped demonstrations of experiments conducted in the Instrumentation Laboratory of WSU's Division of Engineering Technology. Digitized versions of the videotape contents will be provided for inclusion on to the CD-ROM. A load monitoring setup based on a lathe has been developed and its video clips are provided on the *Authorware* screens. Also targeted to build are inquiry-based projects to demonstrate practical relevance of the theoretical contents of the modules. The ultimate structure of the CBI courseware is expected to interactively involve the student in each of its screens. However, currently it is planned to supplement each module with at least two multimedia components.

3. Team

Owing to the several aspects involved in the development, the project utilizes the capabilities of the Greenfield Coalition multimedia team and the technical content expertise of the developers. The first four authors of the paper constitute the technical team, with an educational consultant from WSU. The fifth author is a representative of the multimedia team. An industry partner provides inputs that are to help suit content for a manufacturing engineering environment. The two graduate students assisted in the generation of graphics and visualization examples and development of the data acquisition system.

4. Our Experience

The following summarizes our experience:

(i) Even with hundreds of hours spent in revisions, it appears that reaching higher standards to attribute maximum visualization is far away. A span of one year to two seems to be so little for such intensive work. The challenge appears to lie in attributing value to each bit of information provided on screen and assuring if enhanced student learning is possible.

(ii) Translation of an animation idea through the multimedia team seemed to provide several inputs that would not have been easily apparent if developed by us. In the sense, when the written animation description was forwarded to the multimedia team, their feedback about the difference between static and dynamic screens and their impact enabled us do its thorough review and revision.

(iii) It also appears that time pressures and project deadlines mask novelty that can be built into the visualization components and make developers settle for less.

(iv) Several of the numeric calculation examples that were planned for the *drag and drop* type of questions on assessment were deemed not suitable as those resulted in longer *Authorware* programming especially when the variables to be dragged are more than two. Hence these examples were included in the self-check section where the dragging choices of students are not tracked. Instead, type of problems, such as identifying part of a machine or a device was deemed an ideal fit for the assessment category. Numeric calculation problems were concluded best handled as fill-in or multiple-choice questions.

Some of the experiences which seem to consume the maximum time are of managing notations, decimal points in calculations, units and cases which very often in class rooms are understood by students without further explanation. These arise when the computer managed instruction system really has to track the answers inputted by the students and make decisions based on the acceptable inputs for the answers. One another example was the literal translation of the animation description by the animation team, which brought out an entirely positive and valid perspective to what was originally perceived. Some experiences are very good and some very tiring due to the amount of detail which goes into the development of each module. At the point of writing of this paper, the developers report that the right inputs from the right personnel at the right time, in fact bring out very effective CBI materials for enhancing student learning. The development aims to finally make this material available on CD-ROM and utilize it to supplement the course instruction.

5. Conclusion

Our experiences of developing an electric machines course for a NSF-funded Greenfield Coalition for new Manufacturing Education is provided. Significant features of the development are described. The intention of providing the detail of our experience was to set some of the "Do's" and "Don'ts" for such developments. The effectiveness of the courseware as enhanced by utilizing multimedia components is highlighted. It appears that serious learning of technical material, which normally occurs only once in a student's learning career, has to be carefully kept in mind in order to prevent CBI courseware comparison to video games. However, providing effective interactions on each screen of the technical material appears to be an eternal challenge to us. The project's assessment and evaluation for its overall usefulness as a means of instruction will be made in the upcoming year or two.

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