Multimedia in Manufacturing Education MiME

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Abstract

This paper describes a project funded by the Technology Reinvestment Project (TRP) under the manufacturing education component (MET) to design, build, and evaluate interactive multimedia courseware for manufacturing education. Interactive multimedia is defined as the combination of computer based text, sound, graphics, animation, video, and simulation. commercial and defense industries along with a professional society are collaborating on the project in an effort to address important dual-use issues. Advanced media technologies are being exploited to create virtual, time shifted, and/or remote visits to real world manufacturing systems. The foundations for our efforts and the experiences in the first year of this effort will be discussed in detail.

Introduction

Traditional classroom based engineering education often falls short of preparing students for the complete process of manufacturing — that is the complete cycle of design, engineering, production, marketing, and delivery of goods. McDermott [1] succinctly describes many shortcomings of traditional classroom based technical education:

- Ability to solve standard quantitative problems is not adequate criterion of functional understanding. There is little correlation between this type of performance and the ability to solve real-world previously unencountered problems.
- Traditional instruction does not generally produce a coherent conceptual framework in students for relating a number of concepts.
- Many conceptual misunderstandings are not overcome by traditional instruction. Students need time and opportunity to apply the same concepts in many contexts, to reflect upon their experience and to generalize from the results.
- Traditional instruction does not usually result in growth of general reasoning ability. Often students perceive a topic as a collection of facts and formulas.
- Connections between concepts, formal representations, and the real world are often lacking at the conclusion of traditional instruction.
- Teaching by telling, traditional lecture, is an ineffective means of instruction for most students. Instead, every student must become an active participant in his or her education.

Multimedia in Manufacturing Education (MiME)

Many institutions are experimenting with multimedia to address these problems. However, many instructors are finding the development of quality engaging courseware requires a new set of skills. Interactive multimedia development differs dramatically from traditional text or note preparation. Literature abounds with well intentioned examples of multimedia projects which succeed technically, yet fail to instruct in a meaningful way. More than just technology expertise or content knowledge is required. Clearly the successful interactive multimedia developer must understand far more than just hardware and software. Many faculty are eager to take advantage of multimedia but do not possess the time, skill, knowledge, or resources to do so. Help is needed. MiME is beginning on a local level at Georgia Tech and in the future we will disseminate what we have learned through workshops and seminars open to faculty across the country.

Goals of MiME

- Creation of the infrastructure necessary to deliver manufacturing related course material on-site at industry facilities through self-study interactive courses.
- Enhancement of new and existing manufacturing curricula through the addition of self-paced non-traditional interactive educational software.

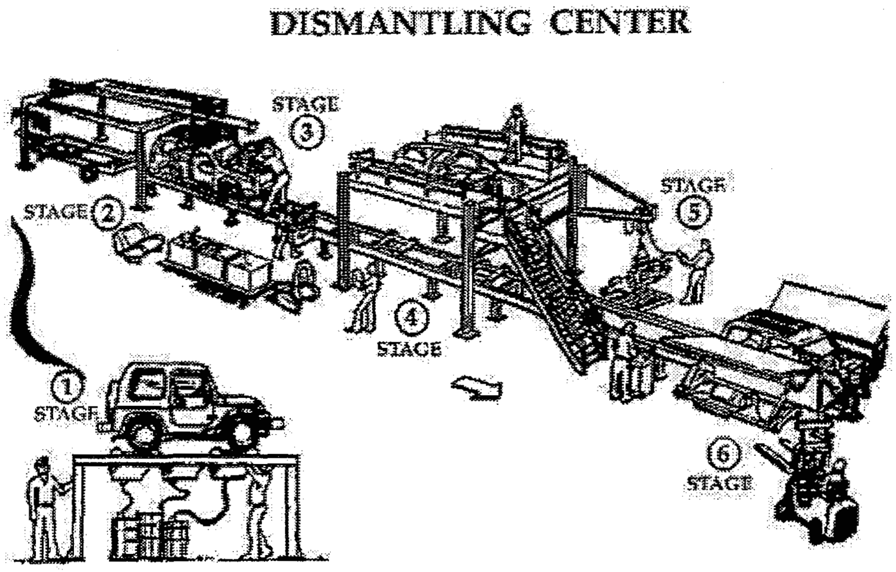

Figure 1. Demanufacture Overview Graphic

- Demonstration of the effectiveness of learning theory centered multimedia-based instruction across the entire manufacturing education curriculum.
- Support faculty in the creation and use of educational technologies for manufacturing education.

Project Resources

Three main activities encompass this program: 1) the creation of a manufacturing focused multimedia development resource, 2) rapid infusion of educational technology into the manufacturing curriculum, and 3) the production and dissemination of interactive courseware for use on both Macintosh and Windows based computers. MiME serves as the focal point for an interdisciplinary campus wide effort focused specifically on the needs of manufacturing education.

Specifically, we have created a dedicated resource center staffed by a small number of professionals and graduate students including an instructional designer, a graphics artist, a psychologist, a programmer, and a technical writer. This staff is working with groups of faculty and industry personnel to implement a set of manufacturing related curricular materials employing multimedia in an instructionally sound and consistent manner.

A dedicated development laboratory has just been completed to support this effort. Included in the laboratory are 3 Power Macintosh 8100s, 1 Power Macintosh 7100, 1 Macintosh Duo 280c portable, for testing, 2 Pentium based Windows machines, and 2 base systems for compatibility testing (Quadra 610 and 33Mhz 486). Media digitizing capability includes 2 color flat bed scanners, 1 35mm slide scanner, 2 video digitizing stations with motion JPEG compression/decompression accelerators, and 16 bit 44kHz sound input capture. Approximately 16 GB of disk storage are available for media processing operations. Output media capabilities include video tape, a color printer, a CD-ROM recorder, and a digital slide maker. A Power Macintosh 9150 acts as a general purpose server for shared files, http, ftp, smtp, and print services. These resources are available only for project specific work at this time. Faculty, students, or staff developing materials related to MiME are free to use these facilities. General use by the entire faculty is not yet possible; however, those who demonstrate a desire to work with the group are encouraged and supported as resources permit through a informal network of cooperation.

Currently, all multimedia authoring for CD-ROM is done in Macromedia Director 4.0, and Authorware Professional 3.0. Director provides a complete scripting language allowing for complex animations and interactivity; however, no direct instructional support is included. Authorware on the other hand was designed from the ground up as a instructional development tool. It includes easily developed interactivity along with automatic learner tracking which can be used for record keeping, adaptation of content, or modeling of student performance. Director is more powerful, Authorware is more easily learned.

Development Activities

A number of curriculum development projects are currently underway. The first completed project involved the development of a multimedia case study related to demanufacturing automobiles. Still pictures, text, graphics, sounds, and short

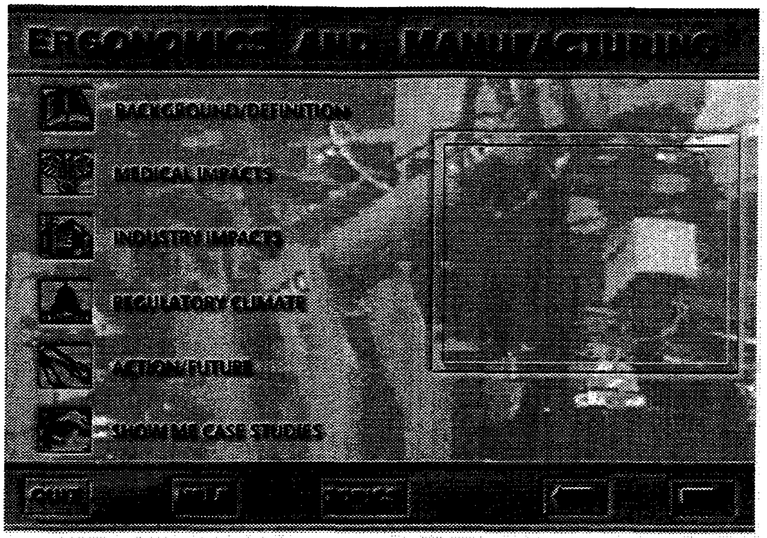

Figure 2. Introductory Screen to Ergonomics Courseware

digital video segments were included. This material was developed as part of an engineering design class by a group of graduate students along with the MiME staff. Subsequently, the case study was integrated into a senior mechanical engineering elective course entitled Environmentally Conscious Manufacturing. Here students were required to analyze the material in the case study, answer a number of open ended questions, and perform a cost analysis of various trade-offs in the demanufacturing process. Subsequent evaluation revealed that students in general like the WWW presentation of the case material; however, they did not like the open-ended questions included. Initially, no effort was made to determine any kind of cognitive gain as a result of interacting with the multimedia case study. Future plans call for a more in-depth analysis of learning outcomes. On the technical side it immediately became apparent that only very short digital video segments can currently be delivered in a timely manner using a network. The case study can be freely accessed through the url address listed at the start of the paper.

The second project initiated attempts to enhance the effectiveness of undergraduate controls engineering classes through the use of multimedia based lectures. Initial evaluation revealed that students in general prefer these kinds of lectures but did not necessarily retain the material presented any better. As a follow-up we are developing interactive simulations linked to tutorial material so that students may individually perform "what if" analyses of various control parameters. The main goal of this project is to provide an explicit link between the mathematics of controls and real world examples of practice. Currently, the courseware is being targeted for supplementary purposes only.

A third project has been initiated in conjunction with the Society of Manufacturing Engineers (SME) to develop an individualized interactive training program on ergonomics in the manufacturing workplace. SME is providing existing video content and eventually plans to market the final product produced. This product is targeted at both defense and commercial industries as they struggle to comply with expanding ergonomic regulation by OSHA. Included in the learning environment are a hypertext version of the ANSI (American National Standards Institute) ergonomic standard, the proposed OSHA (Occupational Safety and Health Administration) ergonomic regulation, a self-paced introductory tutorial, an interactive exploratory video, and a simulated task analysis trainer which requires the learner to analyze real cases. Initial formative evaluation was conducted with a volunteer class resulting in many suggestions for improvement. Future plans include full-scale deployment and testing both at Georgia Tech and throughout industry.

Our fourth project deals directly with the training issues of a defense contractor, Boeing Defense and Space Systems. In this project we are enhancing an existing non-destructive testing training course through the introduction of an intelligent tutoring system. In order to collect the necessary information we visited their facilities, attended the current course, and collected relevant data, including written materials, as well as videotapes and interviews. This material has been analyzed and our prototype intelligent tutoring system is under construction according to the specifications of the contact group. Once we have acquired the expertise of developing one such product, together with our ongoing theoretical work, we expect to make recommendations for the actual design of the materials, as well as assisting in the implementation stage. We also plan to collect follow-up data to assess the effectiveness of these materials in improving transfer of concepts from the classroom/ laboratory into the field. Non-destructive testing plays an important role in the manufacture and maintenance of products across many commercial and defense related industries.

Conclusion

Multimedia courseware provides enhanced opportunity for engineering students to connect what they learn in the classroom with real world application. MiME has undertaken a number of collaborative projects with industry, a professional society, and a university demonstrating this potential. Our goal is not to replace instructors but instead to augment and improve the engineering learning environment by offering new experiences previously unavailable through traditional instruction.

References

[1] McDermott, L.C., "How we teach and how students learn - A mismatch?," American Journal of Physics, vol. 61, no. 4, April 1993, pp. 295-298.

Acknowledgments

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