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The Success of Multimedia Courseware in the Manufacturing Engineering Education Partnership (MEEP) Program

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Abstract: One of the driving factors to revitalize standard textbook engineering curriculum is through the use of computers with the integration of multimedia courseware. Traditional textbook learning is one component for learning a subject, lab projects provide students with hands-on experience, but multimedia can synthesize and expand the learning process. This courseware offers students a chance to reinforce concepts, integrate different subjects, and to potentially expand subjects beyond the scope of classroom assignments.

With an 'active learning' project philosophy in the Manufacturing Engineering Education Partnership (MEEP), interactive multimedia modules were developed to complement lectured-based curriculum and laboratory instructions. Courses such as Product Dissection and Technology Based Entrepreneurship were used to develop interactive multimedia modules with Authorware software. These modules include exercises where the students 'virtually' dissect components or study the business aspects of product realization. We will describe our multimedia modules, their use and success in the classroom, and their potential in outreach activities for other universities or learning situations.

Introduction: In recent years, primarily through university partnerships, the academic environment has been changing at the undergraduate educational level. One such partnership is the Manufacturing Engineering Education Partnership (MEEP); a unique collaboration of three universities, a government lab, and over 100 corporate partners. The three universities (Penn State, University of Puerto Rico-Mayaguez, University of Washington) have strong engineering programs, and together these schools graduate approximately 2400 B.S. students a year. These graduates have the potential for significant impact on our nation's industrial competitiveness, and the institutions have made a commitment to graduate the best engineers through innovative changes in the curriculum and laboratory facilities. The universities have teamed with Sandia National Laboratories, a premier 'engineering' laboratory, with a rich history in science and technology research and development. Sandia provides the partnership with advanced capabilities including rapid prototyping, precision manufacturing, virtual reality, and electronic outreach. Sandia has been involved in a number of electronic educational activities, including the electronic textbook and multimedia development. All these educational activities are grounded in reality by the involvement of the corporate partners. They help guide curriculum development and provide industry-related projects for the new courses, including the Senior Design course.

This partnership draws on the special strengths of each member and provides a unique opportunity to share physical and intellectual resources and explore diverse educational approaches. The MEEP program promises to integrate a practice-based curriculum with advanced manufacturing facilities[1]. Its goal is to provide a new engineering educational experience that emphasizes the interdependency of design and manufacturing in a business environment. Two specific objectives of the education experience include: an engineering curriculum which balances analytical and theoretical knowledge with manufacturing, design, business realities, and professional skills; and secondly, a Learning Factory at each partnership institution, integrally coupled to the curriculum, for hands-on experience in design, manufacturing, and product realization. Today's industrial workplace has changed dramatically, and employers are seeking employees who understand and are competent in the combination of engineering science and engineering practice, where the employee is technology and information literate. The MEEP philosophy is to produce graduates who have these skills.

Beyond curriculum and facility innovation, another change in manufacturing engineering education is the inclusion and exploitation of electronic means for teaching and learning of course material. Engineering courseware with computer-based material can be used to assist engineering students in their learning process. Typically, this courseware takes advantage of multiple media formats, such as graphics, images, sound, video, and animation to illustrate engineering concepts, products, or practices. This multimedia software provides a new level of interactive learning, where the philosophy is that multimedia courseware will cross over all student's learning styles and even make learning fun.

With these and other new curriculum innovations, the world wide web (www) has been a starting point to provide and access course material, and it is hoped that sharing, integration, and synthesis are the new learning experiences for education. This paper will describe the development, implementation, and dissemination of the MEEP multimedia courseware modules.

Motivation to Develop Modules: The multimedia modules are an extension of curriculum development. As the three institutions became familar with the new curriculum through two or more semesters of teaching to refine the content, two classes were chosen for multimedia courseware development: Product Dissection[2] and Technology-Based Entrepreneurship. The modules are there to enhance both the traditional classroom and laboratory component of the MEEP courses.

Another utility for multimedia is to increase the throughput of students in the MEEP curricula. For example, the Product Dissection course is labor and facilities intensive, where the students receive 'hands-on' experiences by dissecting different products. This type of learning is a vital and necessary component in the MEEP curriculum; unfortunately, the class size is limited and typically the maximum student enrollment is 25. By creating these multimedia modules, hopefully, the students can view a module first before laboratory dissection. This will allow more efficient use of laboratory time and permit increased student enrollment. Note, the modules *cannot* replace the laboratory experience; it is important that the students participate in the 'hands-on' laboratory.

Essentially, the modules complement the MEEP classroom and laboratory curricula. The student can use the modules to review previous concepts, view new concepts, and synthesize this information with lecture notes and lab experiences. These modules are easily utilized in other basic engineering classes to explain engineering theories and practices. The modules help teach the necessary skills needed in industry today.

Development of the Modules: From the beginning, it was essential to achieve collaboration between the students, the content experts (faculty or industry partners), and an advisor who was familar with multimedia development and the software program Authorware. This interaction is very important to ensure the content and delivery of the information is correct for most students and their learning styles.

A student from each university worked closely with a faculty member to develop one module. To learn the basics of the multimedia software package, Authorware, these students attended a one week class at Sandia. All multimedia software packages have steep learning curves to understand and utilize the power of these programs; in one week, a student can learn the basics but only begin to comprehend the power of the program.

To maintain progress and cohesiveness in the modules, the students had an Authorware mentor at Sandia for help and direction on multimedia development. The students and

the Sandia advisor had monthly conference calls to discuss the development of modules. In addition to the conference calls, the Sandia mentor developed a module to provide format and content instructions to the students. In approximately one year, four modules were created: three modules for the Product Dissection course and one for the Technology-Based Entrepreneurship course.

At this time, the modules are being grouped with the MEEP courseware for distribution on CD-ROM. The Learning Factory website[3] (a website of the MEEP program) contains the lecture-based MEEP curriculum and may give access to the modules; however, copyright issues need to be resolved.

Description of the Modules: The three modules complementing the Product Dissection course consist of expanding the student's mind about a well known product. This is done by interweaving text, graphics, and video to discuss the history of the product, explain the operation of the product, dissect the product, discuss manufacturing issues, and describe potential improvements of the product. The three products are the telephone, the electric drill, and the engine. Each module has a similar format in graphics and menus for easy maneuverability between the modules.

The Technology Based Entrepreneurship module discusses the issues related not only with new designs or processes, but with the business and marketing issues. Videos from industry-based projects are shown along with entrepreneurship strategies.

Of the four modules, only one will be described in this paper- the electric drill. This example is to illustrate the basic contruction and operation of the module. Figure 1 shows the basic format for the Product Dissection modules, with the menu of choices to move around in the module. Further into the module, another screen contains different videos to teach the student how to disassemble a drill, where one frame is shown in Figure 2.

This module complements the Product Dissection course, where the course examines the way products and machines work: their physical operation, the manner in which they are constructed, and the design and societal considerations that determine the difference between success and failure in the marketplace. In class the students will disassemble different products, understand the engineering and design choices, and then re-engineer a chosen product for improvements (by some standards chosen by the students and/or industry). The multimedia module helps reinforce class and laboratory learning and explains concepts not covered fully during lecture. This module can also be used in a class that does not have the student dissect a drill, but as another example of product dissection.

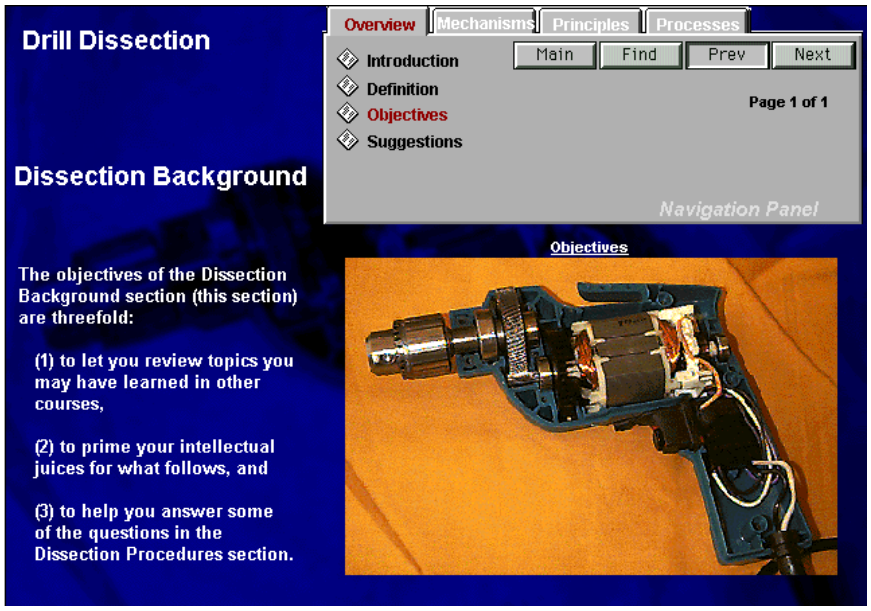

Figure 1: Dissection background screen from electric drill multimedia module.

Figure 2: Dissection video screen showing one video frame of electric drill dissection.

Use and Success of the Modules: At this time, the modules have had little use in the classroom since they were only completed this semester. These powerful multimedia programs require significant time to learn and the students developed the modules during the past year.

In the coming academic year, these modules will be utilized at the MEEP universities. It is expected that the product dissection modules will be helpful for students dissecting a phone, drill, or engine, and reapply the same principles of investigation to other products. Quantitative assessment[4] of the modules is in progress. The developers, the faculty advisors, and MEEP partners will assess the modules over the next few months. Students will assess the modules in the coming academic year. These results will be compiled and employed to improve their content and use.

After examining these modules, it is suspected that their utilization will be brief during the class semester. Students continue to gather and synthesize information at such rapid speeds that they will be ready for new modules. Even with widespread dissemination of modules between different partnerships, there will still be demand for new modules. The real key is for constant module development by integrating these new multimedia programs into the universities. Students working with the 'experts' must have access to the software to create new modules, possibly for individual student projects (e.g. Senior Design Project). With the Senior Design Project, the students work closely with faculty and industry experts, and the documentation of the project could be completed in a multimedia module. The limiting factor is the steep learning curve to these multimedia software packages. Some universities have established 'media centers' where the software is available and knowledgeable staff are there to help create these learning modules. This is a temporary solution, but these packages need to evolve to the level of familar software programs such as Word or Powerpoint. As standards for multimedia software are established, the ease of use will increase. To circumnavigate learning multimedia software, students have learned to mimic multimedia modules by creating websites which incorporate text, figures, and video. Unfortunately, this cannot take advantage of the power of multimedia software.

The other concern is access to the multimedia modules. Multimedia is a powerful tool, and the internet is a logical choice for dissemination. Copyright issues quickly arise because the software synthesizes all forms of media. At this time, the MEEP program has chosen to use CD-ROMs for limited access to the modules, with appropriate copyright agreements in place.

Potential for Outreach Activities: The multimedia modules and MEEP courseware will be available on CD-ROM and potentially over the internet at the Learning Factory website. We have obtained feedback from several universities on our new curricula and multimedia modules. The response has been extremely positive; the only concern is the size of the multimedia modules in relation to computer requirements (RAM, CD speed) to achieve the best quality and student interaction.

The CD-ROM will be pressed shortly and we hope a variety of universities will interact with the MEEP program for evaluation of the curricula and modules. This will speed the integration of new curricula and learning methods throughout the education community.

Conclusions: In summary, the success of the multimedia courseware is through the interaction of the student developers and the faculty curriculum innovators. Four modules were developed over a one year time span, and the next school semester will prove their success. A CD-ROM will be used for outreach to other universities interested in new curricula and education reform.

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[2] Lamancusa, J. S., M. Torres, V. Kumar, J. Jorgensen, "Learning Engineering by Product Dissection", 1996 ASEE Conference Proceedings, June 23-26, 1996, Washington, DC.

[3] The MEEP Learning Factory Website- http://lfserver.lf.psu.edu/

[4] To learn more about MEEP assessment, see Morrel, L., J. Zayas, J. S. Lamancusa, J. E. Jorgensen, "Making a Partnership Work: Outcomes Assessment of a Multi-Institutional, Multi-Task Project", Technology Reinvestment Project Manufacturing Education and Training Program, 1997 Grantees Conference Proceedings, see URL: http://mayaweb.upr.clu.edu/paper/techno.html.