AC 2004-757: AN ONLINE COURSE MANAGEMENT TOOL TO DEVELOP AND DELIVER THE MICROELECTRONICS LABORATORY CURRICULUM

Lakshmi Munukutla, Arizona State University

Microelectronics Laboratory Curriculum Development and Delivery Via Online Tool

Lakshmi V. Munukutla, Richard Newman,
Harry Koehnemann, and John Robertson
Arizona State University East
College of Technology and Applied Sciences and
Department of Electronics and Computer Engineering Technology

Abstract

The Microelectronics Laboratory Curriculum development, for both associate and bachelor degrees, is a project between Arizona State University East (ASU East), three community colleges in the Maricopa Community College District, and Maricopa Advanced Technology Education Center (MATEC) and is funded by the National Science Foundation. This paper describes a model curriculum development strategy to create user-friendly material for students and the instructor. The development team consists of faculty from community colleges, ASU East and industry subject matter experts (SMEs). To maximize the efficiency of the development team an *Online Authoring Tool* is developed to generate the curriculum materials.

This modular curriculum is competency based and industry validated with the goal of producing work-ready graduates. The online tool structure allows all potential authors to upload their material into the system. Based on their development role, it provides access to all (authors, editor and publisher) to review and revise the material.

The tool also has the capability of automatically saving each version of the material for logging the changes. When the author uploads the final version of the material the editor makes the final changes and informs the publisher to publish the material to the site. The instructor material covers the information to prepare for the laboratory. The student material covers the details of each laboratory exercise with several learning objectives.

Microelectronics Teaching Factory: Background, Rationale, and Benefits

Arizona continues to rank as one of the leading states in the number of workers employed in the semiconductor manufacturing industry. To meet these demands, semiconductor companies (both nationally and locally) have launched an aggressive campaign to attract students into programs that prepare them for the future workforce. As a result, local semiconductor companies have sought to collaborate with neighboring higher education institutions to implement this workforce initiative. The College of Technology and Applied Sciences (CTAS) at ASU East is leading the way by developing a state-of-the-art teaching factory in response to this local and national high technology workforce need. A one-of-a-kind Microelectronics Teaching Factory (MTF) has been developed in partnership with Intel, Motorola and other local partners in the semiconductor industry.

This facility provides a unique learning environment for the students from ASU and community colleges statewide who represent the future semiconductor workforce [1]. By collaborating via the Teaching Factory, the partners in this project can begin to transform SMT education in Arizona into a truly integrated regional enterprise providing a seamless curriculum, one that takes advantage of the unique resources of each partnering institution [2].

Curriculum Development Goals

The MTF at ASU East is a key element in the joint effort to develop a comprehensive and robust laboratory curriculum for both the community colleges and university. The curriculum being developed uses a hybrid model. This model consists of materials and resources e-delivered via the web and follows with a practical application requirement at the MTF. This model provides the optimum flexibility for the working student's schedule.

Six laboratory modules and their corresponding laboratory workbooks (LabEx) are being developed during the duration of the multi-year project funded by NSF. Four modules relating to the cleanroom operations, environmental health and safety and selected processes have been developed to date. The laboratory modules are currently being beta tested and evaluated in community college and ASUE courses during the 2003-2004 academic year.

Each module focuses on a selected process area within the Teaching Factory and corresponds to community college or ASU East courses. The electronic workbooks contain lab preparation materials, learner oriented lab manuals, laboratory exercises, and assessment instruments for both degree levels [3]. Electronic versions of the workbooks are available to the community college and university faculty and students via the web as downloadable files housed on the ASUE web site. Each development team produces the LabEx manuals utilizing an on-line authoring system located on the ASUE Microelectronics Teaching Factory web site.

Curriculum Development Web Application

This section discusses the web application created to support the distributed curriculum development. The application provides access to several types of constituents: students, curriculum developers, and the general public. Students access the site to download published versions of curriculum and laboratory exercises. Curriculum developers use the site to upload, download, and review curriculum. Finally, the web site provides information and contact information for the general public regarding the Teaching Factory and the NFS-sponsored curriculum development effort.

The site is also partitioned into a public side and a password protected side. The public side contains the general information, contact information, and all published curriculum which is accessible by students and the general public. There are several reasons behind

this decision. First, the NSF has funded the content creation so there are no intellectual property issues regarding its protection. Second and perhaps most important, managing and supporting student accounts for courses provided at a variety of different educational institutions would be problematic. Therefore, the site supports protected logins only for curriculum developers and one or more administrators. Figure 1 below shows a site map and the public and protected portions of the web site.

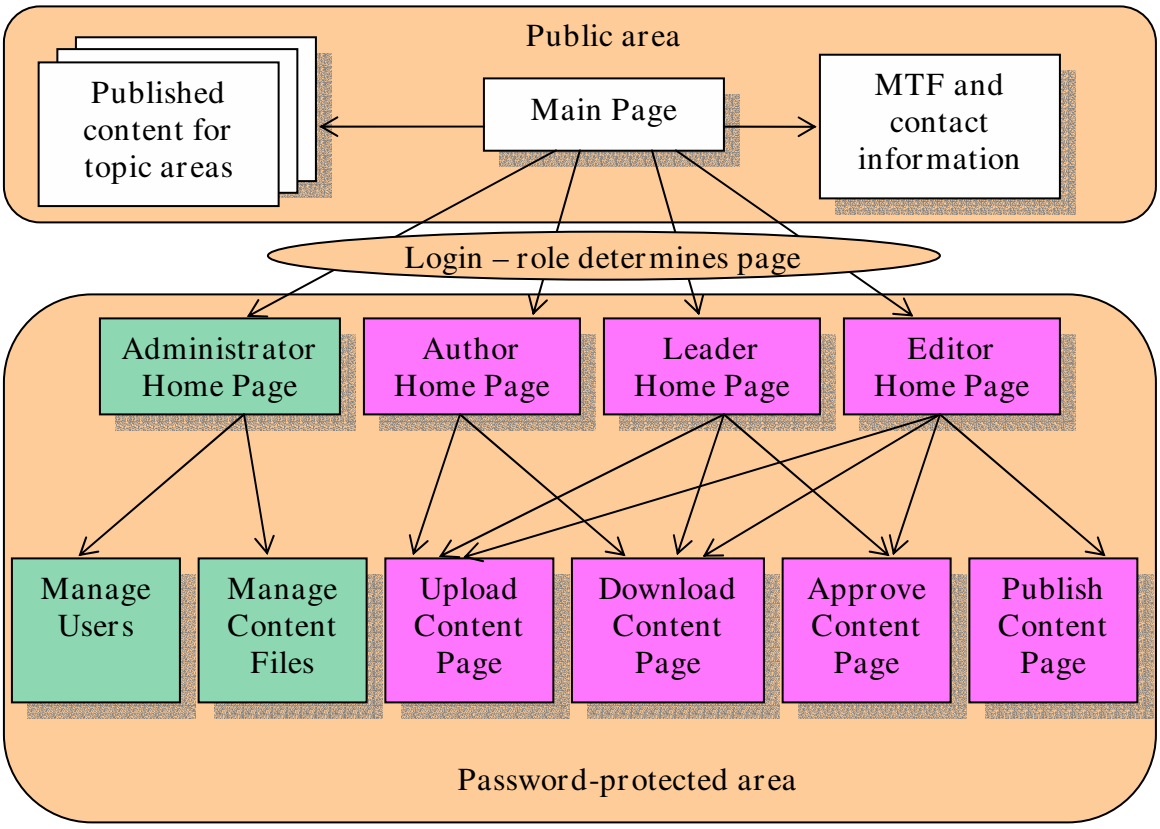

Figure 1: Application Site Map

Curriculum developers are partitioned into several roles with associated capabilities as shown in the figure above. The interaction between these roles to create the curriculum development workflow is discussed in the next section.

Curriculum Development Workflow

Curriculum uploaded into the site is associated with a topic area. Topic areas typically map directly to courses but can be any area of interest for which content is being created. For example, the current web site contains content for teaching users how to use the web site, advice for prospective students, and documents for the MTF Industrial Advisory Board. Authors can create and load content associated with these topic areas just as they develop content for courses. Authors must be aware that any documents placed in these areas are public.

A curriculum development team (consisting of fifteen community college and university faculty) utilizes a standardized instructional development process template to produce the LabEx workbooks. The instructional design template is available to the developers, editors and subject matter experts (SMEs) via the online authoring system. The template and its availability online provide a virtual authoring and development space that is convenient and consistent for each development phase [3].

Each module development team member is assigned a role and set of tasks based on their knowledge, interest and experience by the project manager. Each module team consists of three to five faculty members and one to two industry subject matter experts. Each individual team member downloads the template and completes their assigned components based on the timelines associated with each module completion and online delivery due date. A team leader is assigned to each team; the leader receives and monitors work progress from the developers and SMEs by uploading their material to the Online Authoring System. The leader edits the material by downloading and posting the developers' materials to the system for the editor's review. The editor is responsible for all edits, changes and final proofing. Changes and edits are sent back to the developers for their review and sign off. The publisher downloads the editor's files in Microsoft Word and converts them to a PDF format for delivery via the online delivery system. The online authoring administrator retrieves the word files, by downloading the editor's final version and uploads them as PDFs to the online delivery. The administrator also is responsible for the performance and integrity of the system, including the assignment of passwords and login, debugging, and overall system improvement.

Figure 2 shows the MTF web application home page. The topic area links are located in the lower left corner and are accessible by anyone. The contact link provides information about the Microelectronics Teaching Factory and various contacts. The right column contains recent news that can be added by an administrator. The application displays the news directly from a file and does not manage news items internally in the database.

Finally, the home page contains a login for the curriculum developer. All curriculum development occurs in the protected side of the web application. When his or her account is created, each curriculum developer is assigned a role as one of Author, Leader, or Editor. Based on the type of user logging in, the web application displays an appropriate main page providing the appropriate functionality.

Authors create curriculum content as files in any application of their choosing, for example Word, PowerPoint, etc. The web site supports any type of file. Authors have a link to upload files to a particular topic area and to view the files, including all uploaded versions of a file.

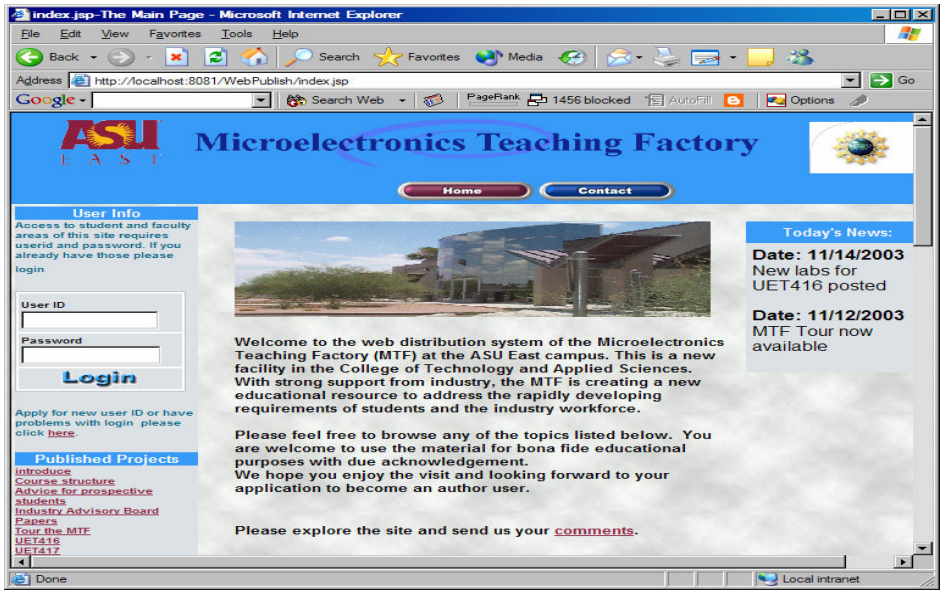

Figure 2 : MTF Web Application Main Page

Once the files are uploaded, the web application makes them available for review to the Leader for that topic area. The Leader may approve the document or provide textual feedback to the Author requesting changes. If the Leader provides feedback, the Author makes appropriate changes, uploads a new version of the content to be again reviewed by the Leader. In the system, Leaders are also considered Authors and therefore have the ability to upload content to and view content in topic areas. Once approved, the document is made available on the Editor to publish to the public side of the web site. Editors are considered Leaders (and therefore Authors) so they also have the ability to provide feedback instead of publishing the content.

Design Improvements and Adjustments

Future enhancements for the web site are the ongoing maintenance of bugs, cleaning up any poor code created by students, and generalizing the product for use outside the Microelectronics Teaching Factory. Others have expressed interest in using the web application; therefore, the code needs to be modified to make the application more general, removing application-specific logic and rules.

Conclusions

As with any software project, the software must be enhanced while in operation. The initial development and deployment was performed by team class projects. Using student projects for development presents several challenges. The first is getting students out of the "throw away" mentality they have with most academic assignments. Once finished, the result can be discarded. The difference between this project and typical class projects is that it will be put into use for several years, requiring a higher degree of quality, testing, and maintenance. Another issue is the 100% turnover in team membership every

semester. Finally, perhaps the largest issue is project management, both organizationally and technically. Students are learning how to be project managers and they sometimes do not see the necessity to devote their scarce time resource to plan, track, and review all the project's activities.

To solve some of the problems, team members are offered independent study credit for working on the project in the "off season" (such as summers) when the project class is not offered. However, project management remains an ongoing issue. Students in the project class are taught requirements management and project management skills, but this is their first effort to generate a workable application. Students present their plans and status in class and the instructor provides input, but most students are more worried about their grade than the project success and don't bring up real issues in those status reports. These problems parallel real software development and the project experience is good preparation for their future careers

Bibliography

1. Lakshmi V. Munukutla and Albert L. McHenry, "Innovative Educational Partnership for the New Century," ASEE Annual Conference Proceedings, Seattle, Washington, June 28- July 1, 1998.

2. Richard Newman, Lakshmi V. Munukutla and John Robertson, "Building Bridges with Community Colleges *Partnering for Educational Success*", ASEE Annual Conference Proceedings, Montreal, Canada, June 16-19, 2002.

3. Joseph S. Mattoon, "Metrics for Assessing Return on Investment from Information Technology", Proceedings of the 14th Triennial Congress of the International Ergonomics Association and the 44th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, 2000.

Biographical Sketch

Lakshmi Munukutla received her Ph.D. degree in Solid State Physics from Ohio University, Athens, Ohio and M.Sc and B.Sc degrees from Andhra University, India. L.V. Munukutla developed an interest in semiconductor device processing technology and characterization while she was working at Motorola Inc. She has been active in research and published several journal articles. She holds an Associate Dean position in the College of Technology and Applied Sciences at Arizona State University East.

Richard L. Newman joined Arizona State University East (ASUE) in August of 2001 and currently serves as Director of Training Operations for the Microelectronics Teaching Factory. Before joining ASU, he was Associate Director at MATEC. Mr. Newman has been actively involved in curriculum and program development for Technology and Applied science programs since 1980.

Harry Koehnemann is an Assistant Professor in the Division of Computing Studies at Arizona State University East. He completed his Ph.D. from Arizona State in 1994. His research interests include distributed web-based software systems, software process, and network-enabled embedded devices. Please see his home page at http://latitude.east.asu.edu for more information.

John Robertson is a professor in the Department of Electronic and Computer Technology at ASU's East campus in Mesa, Arizona. His activities involve substantial curriculum development as well as research on semiconductor devices. From 1994 to 2001, he was Director in Motorola's Semiconductor Products Sector and before that, Professor of Microelectronics in Edinburgh University, UK.