Experience in Using WWW Technologies in Education

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Abstract

This paper seeks to highlight the success of introducing WWW (World Wide Web) technologies in higher education. The computer assisted learning courses concerning CAD in engineering have been developed by joint effort of lecturers from the Department of Electronics, the Simulation Modelling Lab at the Technical University of Sofia and the EC ARTI project consortia. WWW-based learning materials has focused on VLSI Design and Simulation Modelling courses and aimed to promote student-centred active learning approach. The main efforts concentrate on introduction interactivity by using Java applets. The paper presents the structure and the layout of the learning materials. The techniques used in the design and implementation are discussed. Comments on the current experience with the Web materials and student's feedback are also given.

1. Introduction

Technical universities should produce engineers that meet the demands of the industry to keep their graduates competitive in the marketplace. Students seeking to enter the practice of engineering require education directly related to the techniques presently used in the industry. This education should provide students an understanding of the technology and experience in the design process and commercial CAD tools.

University courses generally emphasise both fundamental issues and technology-dependent skills. The fundamentals are basic concepts which are likely to be applicable for several years after graduation, whereas the technology-dependent skills may last only a few years. Therefore, it is prudent to teach state-of-the-art skills that enable graduates to contribute soon after employment begins.

Advanced technology has created new problems that are not being considered at the University level. Time to market requirements and increased products complexity place increased demands on risk of errors in the design process. The use of CAD tools in engineering design process is growing in importance by allowing the design team to bring new products to market faster. So providing students with exposure and experience with up-to-date CAD tools became significant goal of engineering education to reduce the "concept-to-system prototype" time, and to increase the probability of first pass design process.

For engineering education, students not only have to learn the basic theory but also be able to apply on unseen problem scenario. Indeed, it is the essence of engineering teaching. It is exactly why "Active learning" is important in engineering education that student have to be trained with extensive hands-on experiments/laboratory to reinforce further their understanding of the basic theory.

There are a several problems with the traditional methods of teaching, concerning CAD in engineering:

- CAD technology is a fast developing area and there are no up-to-date printed text-books;
- it is difficult to teach all aspects of design process in regular course. Because of time constraints several important aspects of design cannot be covered;
- often students are forced to learn different CAD tools in a short time without enough time to practice without teacher guidance;
- fixed class schedule are inconvenient for part-time working students to attend lectures and tutorial sessions;
- different students personal background and ability to learn normally prevent enthusiastic students of more knowledge obtaining in regular class.

To address above mentioned needs and problems we have introduced student centred active learning approach by means of modern information technologies.

The paper discusses the use of the World Wide Web (WWW) for teaching purposes and describes the development and implementation of new interactive software modules that are the results of co-authoring between lecturers from the Department of Electronics and the Simulation Modelling in Industry (SMI) Lab through the European Project ARTI (TEMPUS SJEP 09382).

The paper details how state-of-the-art technologies like hypermedia, computer modelling and simulation may be applied with the profit for education in electronics and simulation modelling. Section 2 begins by describing the course materials and lecture notes now available online at the SMI lab home page. Section 3 describes the interactive software modules that have been developed. Section 4 details how these interactive tools were implemented. The paper concludes by showing how the computational and network resources required to run this software have increased the quality of education by providing immediate guidance to the students and giving the teaching staff more time to interact with the students.

2. Non-interactive materials

Standard Hypertext Markup Language (HTML) documents are effective for distributing non-interactive course material to students. HTML materials have many advantages as teaching aids:

- present the information in an attractive and understandable fashion;
- permit flexible and free navigation;
- provide pre-determined guided tours;
- permit cross-referencing and linking;
- display video and sound coherently;
- allow users to browse at any level of content detail;
- are useable on existing PCs.

Starting in the Fall of 1996, new on-line content and interactive software modules were developed. Using standard WWW browser, students can now access the Web-based materials from any machine on the Internet.

Within the last year, all the lecture notes and course materials for CAM in Electronics have been made available to our students. The lecture notes contain sets of

HTML documents with dozens of figures and diagrams, representing 25 hours (half) of lecture material. Previously, students copied hand-written transparencies. Now, they obtain class notes directly from the SMI web server. On evaluation forms, students mentioned the following advantages of the on-line lecture notes:

- On-line notes are always up-to-date;
- On-line notes are readily available;
- On-line notes can be read from anywhere;
- On-line notes are free;
- Hotlinks speed finding information.

2.1 Use of the WWW resources

Web pages for the course of Computer Aided Technologies in mechanical engineering are organised under an umbrella home page which can be accessed at SMI Lab network. Links were placed in the first section to class and laboratory schedules and to a copy of the course outline and lecture schedule. Although the course had a reference textbook [1], and several assigned readings from text on reserve in the library many reading assignments ended up on the web page. Problem definition, specification, and follow-on tutorial and help information were provided to the class. Some links were placed on this page prior to class lectures, and were assigned as advance reading. Additional links provided copies of lecture materials, slides and other graphics for student review outside class. Some materials were obtained from outside sources for instructional use on campus. Also links was provided directly to commercial companies pages so that students could get tool information directly from manufacturer. Finally, a "relevant links" page was created to point to other WWW sources. The tools, thus provide a highly expressive and modular system for navigating..

Most of the developed teaching materials contain a lot of sensitive map illustrations, permitting hierarchically navigation through the figures, circuits, simulation results etc. They decrease complexity of the pictures without lousing important details allowing in the same time to enter deep inside considered problem.

Initially the professor and assistant identified academic and, commercial web site links which provided content, relevant to the course. Tutorial information pages were created and updated as the lectures progressed. The evolution of this page, and positive experiences students had using WWW resources to get help with class material, was an unplanned positive outcome of the class.

3. Interactive on-line modules

While HTML documents are well suited for the presentation of lecture martial, they cannot be used alone to present material that changes dynamically. Interactive modules have been developed that implement Java language for promoting animation, on-line simulation and dynamic visualisation the logic levels through the circuits. The interactive tools described in this paper are currently used for the VLSI design course at the Department of Electronics – Technical University of Sofia. The functionality of these modules is described below.

Better understanding of physical phenomena in the electronic circuits could be obtained by animation of the processes during transition. Figure 1 illustrates an Java applet example explaining charging and discharging paths in CMOS inverter. Java cup indicates that the picture permits interaction.

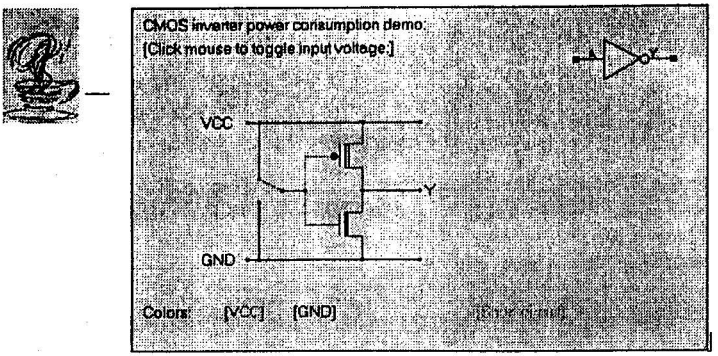

Figure 1. Java-based animation example

Figure 2 shows logic states in CMOS NAND gate and their dynamical modification according truth table.

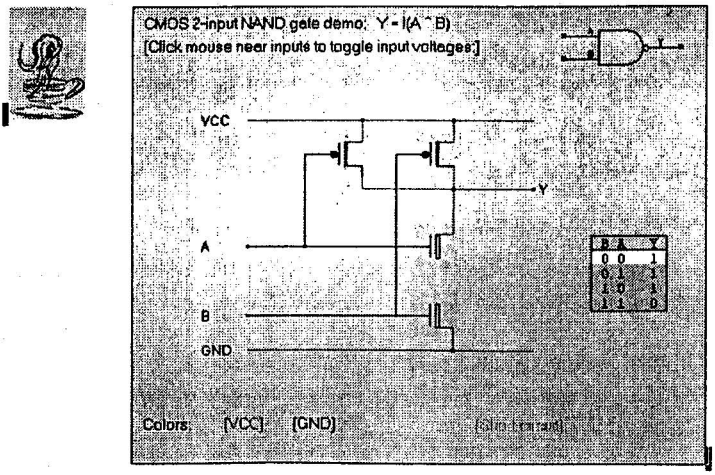

Figure 2. Java-based dynamic visualisation of the gate logic levels

Conventional textbooks often present concepts in a very complicated, abstract manner when, in fact, the idea could be understood easily by observing the effect of, say, changing a parameter in an equation. Simple Java-based simulation is used to facilitate students understanding and to provide interaction. Java applets help the student to experiment with a numerical parameters and to observe the result.

Figure 3 presents an on-line simulation tool, which permits student to investigate delay dependence on capacitance load and transistor sizes. The knowledge obtained should allow students to address the problem of transistor sizing for a given delay. This proved a simple yet powerful way to give the student opportunity to investigate concepts, which had previously seemed difficult to them.

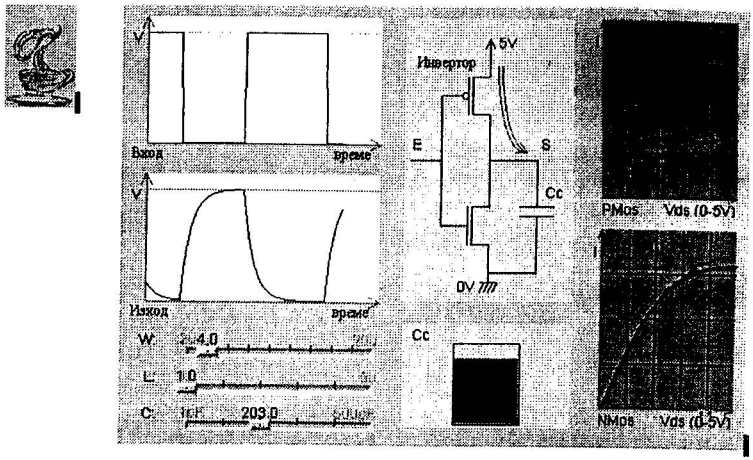

Figure 3. Java-based on-line simulation tool

With the advance in Computer Aided Design technology, digital design in the scale of VLSI has moved from bottom-up design approach to top-down design methodology with the aid of advanced Electronic Design Automation tool. The most common design platform is the tools that make use of VHDL (Very High Speed Integrated Circuit Hardware Description Language) as design media. It has become the standard approach of designing digital circuits. However, mastering VHDL for design is not as simple as it seems even for experienced designer.

An interactive learning tool with the capability of conducting experiments concurrently is proposed to enhance the teaching quality and provide training for students in learning VHDL. After introducing the basic concept of particular VHDL syntax, structure, or feature, design examples are used to illustrate the utilisation of the VHDL code. It also has the capability to illustrate the circuit functionality through logic simulation. Hands-on experiments could be obtained working at a distance with the Vsystem VHDL simulator. Remote user can interact with the Vsystem simulator through Java-based client server, which can exploit data flow in both direction ensuring virtual CAD laboratory facilities.

The Computer Assisted Learning system is developed with Active Learning philosophy using interactive learning methodology under hyper-media environment. It is used as teaching material, self-learning guide, tutorial, workbook or laboratory. The proposed system is an useful learning tool in the area of digital design using VHDL, but could be used for every batch-mode simulator.

4. Implementation and computational resources

The Web contents development tools used in the present application includes Microsoft Word 97, Microsoft Front Page [2], Netscape Navigator Gold 3.01 and Netscape Communicator 4. The graphical material is created with Corel Draw and Adobe Photo Shop. The technology used for the preparation of a typical web page is discussed in [3]. Microsoft Visual J++, Sun Java SDK 1.1 and Perl 5 were used in Virtual VHDL Lab development.

The students access the Web-based courses via the University Network using PC or Unix computing facilities. Netscape Navigator with appropriate AVI and PDF plug-ins is used as a browser.

The on-line educational materials are distributed amongst two Web servers - one Intel and one Sun Sparc based. Two different architectures are required since some of the external programs (e.g. simulators, synthesisers) are available only for Sparc and others - only for Intel. The servers are configured as follows:

Intel
- Intel Pentium Pro based PC
- Windows NT Server
- Microsoft Internet Information Server
- Perl 5 for WIN32 [4]
- CGI programs
- external programs.

Sparc
- Sun Sparcstation 20
- Solaris 2.5 OS
- Apache 1.2 Web server
- Perl 5
- CGI programs
- external programs.

6. Summary

Experiences with the World Wide Web both for distributed learning and for interactive learning materials has proved to be very favourable. Students strongly approve (and almost enjoy) the on-line learning environment and noted that they appreciate the improved presentation of dynamic processes provided by the interactive modules.

Students feedback from the teaching evaluation forms was generally positive while being both critical and constructive. Some areas needing improvement were identified. Course materials have been significantly improved as a result of students feedback. Students responded positively to the "hands on" nature of the course, and to the fact that they were allowed to operate in an "engineer-on-the-job" environment.

As a result we believe that our students are able to graduate with not only a good theoretical background but that they are also familiar with the types of tools being used by industry today.

References

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