Using the WWW in Advanced Digital Design Courses

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Abstract

Modern digital design requires a knowledge of Programmable Logic Devices (PLDs). PLD technology is changing so fast it is difficult to keep up with new PLD architectures and devices. Companies are continually changing their products and buying other companies. It has been difficult to keep up-to-date data books for students to use in design. It is also important to be using PLDs that have not been discontinued. The World Wide Web (WWW) has helped solve the problem in the advanced digital system design course (ECE 487) at Utah State University.

Last Fall I noticed that some PLD companies had developed home pages on the WWW. I decided to use the WWW as the major resource for finding information about PLD companies and trends. Up to this point I personally kept current in the field of PLDs and had a large collection of data books. The WWW dramatically changed the class. Students were using it to find all of their information. This paper describes how the WWW was used in the digital design class and the results of how well it worked. It also suggests how it could be used for other courses.

Advanced Digital System Design Course

The advanced digital system design course (ECE 487) in the Department of Electrical and Computer Engineering at Utah State University is a senior-level capstone course in digital design. We have a similar capstone course in analog design (ECE 480). Prior to taking this course students have completed courses in combinational logic design, sequential logic design, and microprocessor systems. This course was created to provide students with experiences needed to further develop design skills required by industry. In previous courses students have learned the engineering principles needed for design and have experienced small digital designs. They have even been introduced to small system designs which requires a top-down approach. They do not, however, have enough design experience to feel competent. Since the early digital design courses are some of the first engineering courses our students take, there is often a two to three year gap between the fundamental courses and the advanced digital system design course.

The first two weeks in the advanced digital system design course is spent in reviewing combinational, sequential, and system design. By actually concentrating on the design aspects of digital circuits rather than repeating massive information taught in previous courses the students are quickly up-to-speed in digital design. During the quarter they have the opportunity to do several advanced designs, including computer simulation and actual implementation in the lab. This builds their confidence in design so that they feel at ease in tackling any level of digital design by the time they complete the course.

Using Programmable Logic Devices (PLDs)

One of the strong features of the advanced digital system design course is working with Programmable Logic Devices (PLDs). PLDs are general-purpose integrated circuits used to implement digital designs. The designer enters the design on a computer then downloads the design onto the PLD. This replaces physically connecting a lot of individual gates. To be able to be proficient in digital design a student needs to know how to use PLDs in design. Many texts introduce simple PLDs. Advanced digital system design requires the use of Complex PLDs (CPLDs) and Field Programmable Gate Arrays (FPGAs) as well. One of the objectives of the course is to introduce the students to the various PLDs, CPLDs, and FPGAs available so they can make an educated decision on which device to use for their specific application.

It is difficult to keep up on the trends of PLDs since the market is very active. Companies come and go as well as new devices. Every year the situation changes so that devices that were important last year have been discontinued this year. New companies show up each year with exciting products. Old companies that were major dealers last year have been acquired by other companies this year.

Beyond the volatility of the market is the massive amount of information needed to follow the PLD trend. Textbooks are sparse that teach the internal architecture of various PLD families. Each company has a set of data books describing their products, but it is difficult to package this information in an acceptable format for
students. The databooks alone take up a full shelf in my library as well as several filing drawers of other information. It is difficult to provide enough copies of databooks for students while we discuss certain architectures.

For the last several years there has been a special PLD conference held in San Jose to teach engineers in industry about designing with PLDs. I have been able to keep current in this area by attending the conference each year. Representatives from each of the major companies are present. It is a chance to talk to each of them, collect new databooks and find out where each company is headed. The problem is in transferring the information to the students. One year we had the whole class go to the conference as a field trip. The vendors were surprised about the knowledge of students, who knew more about using PLDs than many of the engineers attending. It was a great way to transfer a lot of information, but is not feasible each year.

Multimedia Approach

With the difficulty in passing available information along to the students, I came to the conclusion I needed to write a multimedia textbook for the course. Having the textbook in a multimedia format would allow students to search the world of PLDs from different angles: historical, by family, or by company. A summer of preparation left me far short of my goal. During the development of the multimedia textbook it was determined that it should include a link to the Internet so students could find information from the companies themselves. The link was developed and added to my course page on the World Wide Web (WWW) so it could be used fall quarter, 1995.

The WWW Link

In searching the WWW we found that most of the major PLD manufacturers had web sites. Others added web sites during the quarter. We set up an index page linking to these sites. It included an alphabetical list by company name. It also had a list by PLD families and architectures, such as simple PLDs, CPLDs, and FPGAs. Since PLDs are programmed using special design tools there was also a link to the design tools available. These WWW sites represented what each company wanted the world to know about them. They included information about the company, employment possibilities, and details about their products. In effect it was a databook on the web.

Using the Web information

Once the links to the web sites were set up I had to determine how to use the information in the class. One of the requirements of the class was to read a technical article about PLDs each week and write a one-page summary. This was to give them practice in going to the literature for information. Even though we had resources available at the university for this assignment, many of the students found their articles on the web.

In the segment of the course where we discuss the various PLD families I had students prepare by searching the web for information about each family. We then discussed what they found and tried to put it in perspective with the industry overall. They were able to print out the information for their own records. I developed a take-home test with questions about each of the PLD families and companies. Rather than presenting the information in class they would look up the information on the web.

Results of Using the Web

Prior to using the WWW for finding information about available PLDs, I had extracted many visuals from databooks for overheads to be used in the class. I would go over each family in detail explaining their architectures and application in design. The students had copies of the overheads, but were overwhelmed by the mass of data presented. They would not be able to find all of the databooks to get additional clarification outside of class. They had a lot of information, but did not feel conversant in the subject. The classroom is not the best place for information transfer, but without a textbook there was no alternative.

By using the web and letting students know what to look for, students came to class prepared for a discussion. Several times I found out my information was out of date. Some families had been discontinued and others added. They were excited when they found a piece of information I didn't know. Roles changed. I was no longer the source of all information, the web was. My role was one of bringing perspective and meaning to the information.

The experience of using the WWW as a distributed databook taught me that I didn't understand the full power of the web. Students not only used my links to PLD companies for information, but they started searching the web for as much information as they could find. In this way they found new companies developing PLDs. For example, there was a new company which released a new architecture of FPGAs. Up to this time all FPGAs were either SRAM-based or Antifuse technology. Some students found information on this new FPGA and asked about it in class. We were able to get more information about the FPGA and about the company and determine how
the new "find" would fit in designing FPGAs.

The major impact in using the WWW for the advanced digital design course was in student interest. Students became active participants in their education. They were learning as engineers would learn in industry. They came prepared with knowledge, ready to discuss issues. They knew that they didn't have to be afraid of a new field and massive amount of information. It was all there available for them, without even the cost of a textbook.

The Portfolio

The final exam for the course was a portfolio. The purpose of the portfolio was to compile all of their best digital design experience in a format that could be shown to an employer. This included some designs from other courses, the system designs completed in ECE 487, and information gathered from the web. Each student set up an appointment during finals week for an employment interview. They would bring their portfolio and be ready to answer any questions about it. By the time they came in for the interview they felt confident about what they had accomplished in digital design. They could show their design approach and talk about all the details. They could also talk intelligently about how design is carried out in industry and the devices available for implementing designs.

The Frosting on the Cake

I often wonder if my experiments in teaching are really of much value to the students or whether they just create more work for the students and for me. Two events occurred from this experiment that gave me encouragement to try it again. Two of the students in the class liked using the web so much they decided to create their own homepage. Rather than turning in their portfolios in on paper they turned it in on the web. They included labs and designs that I could list under "student projects" on my ECE 487 page. It had pictures of the hardware as well as their design documentation. One of the students entered in the designs using schematic capture on the computer. The other student scanned in parts of his lab book.

A portfolio is a necessity in art and other fields in which you must show your abilities. Having students pull together their work into a portfolio gives them something to show for all the time and effort they have expended on coursework. One of the students in the advanced digital system design course took his portfolio to an on-site interview. When an interviewer asked what experience he had the student pulled out the portfolio and showed him some of his designs. The interviewer was so impressed with the level and quality of his work he offered him a job on the spot.

Conclusions

The World Wide Web has opened a new medium for teaching. In courses where information changes daily, textbooks are inadequate for teaching. Even instructors cannot keep up with the changes. The WWW allows students to find current and important information. No longer does the instructor need to compile the information. Companies themselves are eager to keep their information current and publish it before the world. No longer is it necessary to keep bookshelves full of data books that are often out of date as soon as they are published. The WWW is a resource that should be used in engineering education.

The benefit of using the WWW for the advanced digital systems design course was in finding information not otherwise available. It can also be used for any course as a means of communication with the student. Following my experience last fall, I started to set up each of my courses on the web. Students can find out about any of the courses I teach by looking at my homepage. Course information includes the syllabus, assignments, labs, announcements, and a way to reach me by e-mail. I no longer have to hand out a lot of information at the beginning of the quarter. I just tell the students to get it off the web. One difficulty in using the web for communications is that you always have to keep it updated. Links tend to change often.

The World Wide Web has changed the way I present information in my classes. It is not the answer to all problems, but it has been very helpful in updating my courses.

Link to COMPANY.HTM