INTRODUCING MULTIMEDIA IN TEACHING OF DIGITAL SYSTEM DESIGN

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ABSTRACT
In this paper we will present a project which started as VDHL Online and is now developing into an integrated teaching system for high level design of digital systems. The VHDL Interactive Learning project is based on the Internet as information storage system. Using the Internet offers a wide range of abilities: static information like foils and explaining text, links which cannot be realized in a book, direct inclusion of commercial tools for getting online experience and interaction between teacher and students via e-mail and Internet relay chat. This concept of having the information available on the net is now used in courses on high level design in a growing number of universities in Germany. Due to the high quality and completeness of the information it is possible for the students to prepare themselves at home and even do the basic training at home using an Internet access.

1. INTRODUCTION
Lectures on high level design of integrated digital systems are a must for all students who intend to work on the area of the design of digital systems. Systems are getting so complex that now even for smaller applications PLDs and FPGAs have to be used. These components require a formal system description and explicit simulation before they can be programmed and used. The system description has been done previously often as a schematic, but hardware description languages (HDLs) like Verilog and VHDL become more popular. For larger systems HDLs are the only way to cope with the complexity.

This development is reflected in the course contents. In addition, the way of teaching is now changing rapidly, in particular by using the features offered by the Internet and the tools which allow to access the information. We have made extensive use of the new technology: providing online information, using interactive access to the tools through the Internet, checking of understanding via multiple choice test, offer communication via e-mails and Internet relay chats (irc) and finally introducing animated sequences where it is appropriate for illustrating. These new techniques used in the course are the focus of this paper.

2. COURSE STRUCTURE AND REQUIREMENTS
The EIS course at Universität Siegen 1 lasts one year. In the first semester, the focus is set on standard cells: designing a single standard cell as well as designing a small digital circuit with standard cells. In the lecture part the students learn about the levels of design abstractions as illustrated by Gajski in his Y-diagram. Simulation techniques on various levels as well as test and testability aspects are covered, too. The practical work consists of designing the standard cell based on the ES2 library and simulating the design using HSPICE. Usually the students start a competition which group gets the fastest cell. This part of the course is well established.

In the second semester the system design becomes the hub. Three aspects have to be respected: first, the various ways of describing a system. Second, the tools must be provided, which is the HDL and its possibilities. Third, the students have to learn how to handle the tools to illustrate the difference between what can be specified and what can be synthesized. Teaching all this in one semester is pretty much. This leads to the following points:

- The possibilities of VDHL are so wide that not every detail can be explained in the lecture
- The lecturer has to pick out the most relevant parts, leaving gaps of knowledge with the student
- It should be possible to trace back the level of knowledge of the students
- Practical training has to be part of the course

Using a web based training system helps to cope with these problems. But it is not sufficient to simply transfer the slides to a set of linked web pages. It is necessary to rearrange and extend the material so that the students can...
get the information for preparation before the lecture as well for learning after the lecture. In addition, computer specific aspects have to be kept in mind e.g. the limited size of the screen and the bad resolution (72 dpi) compared to a laser printer (600 dpi).

3. THE CURRENT SYSTEM: VHDL ONLINE

The centre of the system is VHDL Online tutorial. It provides a set of more than 200 foils which explain the syntax and the capabilities of VHDL. This is what you need for giving a lecture. The foils are linked sequentially, so that you can browse forward and backward as well as hierarchically, which means that you can go to the table of contents and select the topic you are interested in. The lecturer can select which foils are relevant for his lecture and leave it up to the students if they want to see more details or not. This is a standard procedure, because not all courses are structured in the same way. The tutorial itself is accompanied by an VHDL reference, which allows to select keywords by topic and/or name and gives the definition as well as a short example illustrating the usage. This online reference is much more effective than the original publication.

Giving the students the freedom to use the tutorial on their own requires some control how far they got with learning. This is traced via the multiple choice questions. After having marked the answers the students can look at the results. The program gives, according to the marks, either an ok. or a hint where to obtain more information to find the correct answer. If wanted, the answers can be traced so that the lecturer gets a feeling how many answers were correct on the first try. A real test is not intended, because the answers are evaluated automatically.

Now the students know theoretically what to do. Lets move to the practical part. As test vehicle we have prepared the control of a simple camera. It is sufficiently complex to require a hierarchical design but still easy to understand. The task of the students is to enter into the schematic editor (SGE) of Synopsys for defining the top level hierarchy, then use a text editor to fill in the VHDL code and then simulate the behaviour of the control.

All this is done using the web browser. After having entered the IP address and directed the output of the server to the screen of your local computer you can activate the tools. They are started using cgi scripts and can be used like any other tool. This feature allows access to the tools from all machines which are capable of handling an internet connection as well as are running an X client. A screen shot can be seen in the figure.

4. EXTENSIONS TO THE SYSTEM

The VHDL Online system covers of course not all what is required. Looking towards technology we have integrated a tutorial on Xilinx FPGAs. The tutorial first consists of text with embedded pictures. Due to the limited resolution of the screen these pictures are reduced in size so that only the structure can be seen. For a detailed view you have to click on the figures and you get them in full size with all details. Links are provided to the slides which are used in the presentation. This leads to a ladderlike structure as shown in the figure, which allows to go quickly through the slides or carefully work on the text. This structure comes in quite handy.

The second extension is towards high level design, where the specification of a system on a more abstract level is taught. According to the topic an appropriate tool is introduced, which allows to describe a design in terms of a structure like all schematic entry tools, hierarchical state diagrams, state tables and VHDL text.

5. EXPERIENCES AND OUTLOOK

The experiences with the system are simply good. The general quality of the presentations have improved and changes of or extensions to the contents of the lecture can easily be included. The VHDL Online does not limit the presenter in any way. But still there is much to improve, e.g. the integration of the various parts and the optimization of the didactical aspects. We will make use of animated sequences, include more tools and of course, will support English in the near future.

REFERENCES