Computer-Aided Instruction For VLSI Design Using The NeXT Workstation - Phase II

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ABSTRACT

In response to the need for interactive Computer-Aided Instruction (CAI) tools for higher education, a prototype was developed for a VLSI tutorial using the NeXT Workstation. Since VLSI is a strategic area for the national growth CAI tools are vitally important in providing good fundamental understanding of the subject area. After successful completion of a single chapter from the "Mead and Conway" VLSI design text, the tutorial was extended to cover an entire course.

North Carolina A&T State University has been implementing the CAI VLSI NeXT tool over the past 2 years to support its VLSI course sequence. The research discussed in this paper presents recent additions made to the CAI VLSI NeXT-based tutorial along with other structural enhancements. The NeXT workstation was used as the workstation platform due to its ease in integrating text, graphics, images and sound to provide an interactive environment. The resulting system is a Hypercard-like video/audio system which teaches the fundamentals of VLSI design. A generic tutorial system has been created requiring the developer to input images and audio to a shell.

The effectiveness of the tutorial on professors and students has been studied. Students with varying degrees of knowledge in VLSI design were questioned for their opinions on the system. The student interacted with the NeXT machine on a self-paced regiment. Topic areas were prompted with the option of going in more detail. All sessions were designed to be interactive and provided the student with audio and visual interaction.

The complete NeXT CAI VLSI system is demonstrated. Opinions of students and professors are discussed along with the possibility for future tutorials in other subjects.

BACKGROUND

North Carolina A&T State University has offered the course entitled "EE 629/630 - An Introduction to VLSI Design" as an advanced undergraduate/master's level graduate course since 1983. The course was originally focussed towards nMOS technology. Present offerings stress CMOS technology.

The primary aim of the VLSI course at NC A&T is to provide students with the circuit/system background and CAD tools necessary to design VLSI chips using the Mead and Conway approach[1]. Other texts have been adopted since the early years [2-3]. However, the goal of creating a "tall-thin" man has remained the same, i.e., a student possessing a myriad of skills in the areas of: circuit theory, materials, layers of abstraction, basic gates used as building blocks, power/delay issues, layout, clocking and system design. The course strives to balance lecture time, where students gain the analytical skills, with laboratory time, where students receive one-on-one interaction with engineering workstations. A student project due at the semester's end is used as a primary indicator of the student's acquired competence and is weighed heavily in the grading scheme.

The laboratory environment is a key component for successful operation of the course. It is no coincidence that the first computer workstations appeared around the time of peaking interest in VLSI. The MIPS/dollar performance and unprecedented interactive graphics makes the engineering workstation a necessity for effective teaching of VLSI. Historically, NC A&T has provided a DEC/Ultrix workstation environment. However, today's CAD laboratories are a mix between DEC and Sun workstations. Current levels provide nearly 50 workstations including Apollo, DEC, Sun and IBM platforms.

NC A&T has greatly benefited from being a member of the Microelectronics Center of North Carolina (MCNC) affiliate universities. MCNC has supplied public domain and 3rd party VLSI CAD software. Because of this support and other linkages, the VLSI CAD environment at NC A&T...
supports the following tools: Magic (Berkeley), Mulga (MCNC), OASIS (MCNC), Logic III (MCNC), HiLo (MCNC), VPFR (MCNC), Advice (AT&T BTL) and Schema (AT&T BTL).

Even with the fruitful laboratory facilities, there is still no replacement for quality instruction. Because of the popularity of the VLSI course at NC A&T, care was taken to insure that only top instructors were given the responsibility of teaching the course. However, as time passes, this attention cannot be guaranteed. Therefore, alternative methods must be evaluated for effective transfer of knowledge. The quest for effective support materials is what prompted the development of a Computer-Aided Instruction (CAI) tool for the VLSI course.

**THE NeXT WORKSTATION**

Since its auspicious announcement Fall of 1988, the user community has been awaiting the coming of the “next generation” computer. Many articles have appeared describing the technical capability of the NeXT workstation [4,5]. Depending upon application the Next computer delivers an effective speed of 3-7 MIPS.

The desirable CAI qualities of Steve Job’s new machine were not speed or graphics but rather two other items: i) voice integration and ii) ease of tool development applications. As will be shown in the tutorial, both voice and human interface design were key to the success of the CAI environment.

The NeXT machine comes with built in audio recording and listening capability. With small modifications of existing demonstration programs, speech signals can be linked to graphics to give an audiovisual effect [6,7].

**CAI VLSI TOOL**

The basic operation of the CAI program is described elsewhere in the literature [8]. The major enhancements over the past 12 months were the addition of more tutorial frames and a student test score interface of which the professor can monitor student progress. A chapter exam is added to each chapter where a pass/no-pass threshold can be set for progressing to future chapters. A modest amount of random questioning was added to provide a small amount of academic security.

Figure 1 shows the CAI Login interface which acts like a shell on top of the NeXT UNIX system. Figure 2 shows several of the tutorial frames. Figure 3 shows a chapter exam used for the CMOS logic section.

**CURRICULUM DEVELOPMENT**

The Spring 1990 effort entailed the introduction of the CAI tools to the VLSI course. A single chapter was evaluated, with feedback from the students used to enhance the interface. Over the Summer Fall 1990 time period the CAI tool has been expanded to include the entire course.
Therefore, the CAI tool will be used as a course supplement for the entire Spring 1991 course. Comparisons will be made between a group using the tutorial and a control group. Of the CAI group each student will be required to go through the tutorials as a laboratory exercise. After completing the tutorials, a questionnaire is completed by the students with the results analyzed.

FUTURE WORK
After the 1990-91 results have been analyzed a decision will be made towards a decision for integrating CAI tutorials into all electrical engineering undergraduate courses. Using a staff of 2 programmers and 3 graduate students a proposal has been submitted to the National Science Foundation proposing the CAI project as a primary initiative at NC A&T.

REFERENCES