MICROELECTRONIC DESIGN COOPERATIVE EDUCATION PROGRAM

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Abstract
We describe our experiences in using microelectronic design projects as cooperative education experiences for electrical engineering majors. We discuss funding of the necessary VLSI design laboratory and describe our course offerings. We believe our “alternative co-op” program is of value to VLSI educators with limited resources who are looking for ways to provide students with an alternative to the traditional co-op experience.

1. Introduction

The Padnos School of Engineering (PSOE) is a small, industrially-oriented department which offers the BSE degree with electrical, mechanical and manufacturing emphasis areas. A major strength of this program is its industrial orientation, which is manifested in a mandatory 3 semester co-op requirement. Because of resource limitations, almost all of these assignments are local to the west Michigan region, where manufacturing (of office furniture and automotive parts) is the predominant enterprise, and VLSI design is rare. This presents a problem for those electrical engineering students who want a VLSI-oriented co-op experience. Our solution is what we call the “alternative co-op” program, which allows students a VLSI design-based co-op project “in-house”, with a faculty member in the Laboratory for VLSI Development (LVD), a microelectronic system research and teaching facility within the department.

This paper describes our experiences with this program. It has enjoyed success since its inception in 1992 with a single “hand picked” student. It is now a permanent opportunity for two (at most, due to a faculty shortage) students from each graduating class. We begin with a description of the LVD facilities and the courses we offer. Of particular importance here is our funding method in the face of a very restrictive budget. We then discuss our co-op program and the impact it has had on students, faculty and local industry.

2. The Laboratory for VLSI Development

The LVD was conceived in 1992 for the purpose of providing lab support for both a NASA research grant and courses ranging from introductory logic design to full custom analog IC design. It was built initially with $45K research grants from NASA and the State of Michigan Research Excellence Fund, and a $5000 grant from local industry. A follow-on NASA research grant of $20K, an $8K grant from the Michigan Space Grant Consortium, a $2.5K fellowship from the Michigan Space Grant Consortium and a $1500 university summer research stipend have led to the lab’s present configuration. It includes a Sparcstation 10/30 server running Solaris 2.3 and OpenWindows 3.3 with five Windows for Workgroups Pentium 90 Mhz PCs. The PCs are dual-bootable with Linux so as to run Magic/IRSIM 6.0 and Spice3f4. This is done to alleviate loading on the server during peak usage times. Other EDA tools include the Mentor Graphics Design Suite, Altera MaxPlusII v7.1 CPLD design environment, and MicroSim Design Center v7.1.

The lab was implemented despite the fact that the PSOE had no UNIX knowledge or support, and, in fact, was very reluctant, for cost reasons, to purchase any UNIX-related hardware or software. System administrative expertise had to be developed “in-house”. Another source of funding was unreimbursed (overload) teaching. Recurring funding needs for the lab include the Mentor Higher Education Program and Exceed maintenance fees. These are paid by research grant proposals and extra teaching assignments, such as the offering of an EIT (engineer-in-training) test preparation course to local industry. System administration tasks that require advanced skills are provided by local industrial consultation.

Three courses use the lab: Introduction to VLSI Digital System Design, Introduction to VLSI Digital Circuit Design, and Senior Project. The former introduces VHDL and emphasizes system design issues.
such as clock and power distribution, floorplanning, datapath, memory and control. The circuit design course focuses on manual layout details and the construction of standard cells. It treats such issues as processing technology, transistor theory, device sizing, Spice model usage and the power/speed tradeoff. The senior project course shares the same structure as its equivalent at other universities.

Both courses have once-weekly lab meetings where students use the Mentor Design Kit for MOSIS. This is a collection of userware and libraries intended for fabrication using the MOSIS brokerage service. The system design course employs the Mentor Graphics tools Design Manager, Design Architect, QuickHDL, Autologic II, Quicksim II, Accusim, IC Station and Quickpath. These tools provide management, entry, HDL simulation, synthesis, digital simulation, analog simulation, IC layout and critical path analysis, respectively. The circuit design course uses the same tools with the exception of QuickHDL and Autologic II. It also employs schematic driven layout (sdl) which expedites the process of taking transistor level schematics and laying them out in IC Station.

3. The Co-op Program

The co-op program consists of three semesters, with the third used for a “capstone” design project. Present and past projects have been:

- Delta-Sigma Demodulator Using the One-Hot RNS
- Low Delay-Power Product CMOS DSP [1]
- Resonant Tunneling Diode-based D/A Converter
- Processing Subsystem for an Earth Sensing Satellite
- FSM Coding Effects on FPGA Implementations

We have found that third semester students are capable of significant design contributions. All three semesters are planned early in the first so that the student is aware and can prepare. Typical first semester tasks involve lab exercise debugging for courses so that student coursework can reach a suitable level and required CAD tools (usually Mentor) can be learned. Second semester duties involve pre-project idea exploration. The student is asked to choose an interesting project from an instructor “hot list” of research topics. Subsequently, core papers are studied and remedial needs are identified. In many cases, one or both VLSI courses must be taken, usually by means of independent study. The project plan is then developed. The third semester is devoted entirely to the project work.

The program is competitive. Prospective students are interviewed in their second semester under conditions identical to those of other co-op companies. Our requirements include an excellent GPA, graduate school inclinations and, most importantly, a desire to explore new ideas and a sense of excitement from doing so. Funding for student salaries is provided by all of the sources mentioned in Section 2 and, in addition, departmental matching funds.

4. Discussion

Student feedback has been very gratifying. They are excited about the opportunity to do “high-tech” work as an alternative to many of the more mundane co-op positions available in local industry. They enjoy the less-restrictive atmosphere and the near-absence of office politics. Those who plan to go to graduate school welcome the research flavor and resume impact of their projects.

Faculty feedback has been interesting, with two major potential pitfalls failing to materialize. The first was a lack of local industrial respect for such a “non-real world” academic co-op experience. In fact, local industry has been exceptionally impressed with the quality of the program graduates, citing their ability to think and “learn without supervision”.

The second is the projects’ “grad school flavor” and lack of relevance to the needs of regional industry and the taxpayer. Admittedly, these projects are directly related to only a few local companies. However, they allow students to acquire skills that can be marketed anywhere in the world. The program widens student horizons and job opportunities and in that sense serves regional needs.

Respect for the PSOE has grown as a direct result of the program. The attractiveness of hi-tech topics, particularly integrated circuits, has powerful marketing potential. Our department is enjoying 10% yearly growth in enrollment at a time when that of other universities is stagnant.

In summary, we believe that our “in-house” cooperative education program is a compelling alternative to industry-based programs. It is ideal for those students who aspire to graduate school and desire a research-oriented co-op experience.

References