MicroSystems Education and a "Silicon Encyclopedia" Project

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Abstract

It is becoming harder to educate and train engineers to design Microelectronic Systems, both in the University and in industry. New technology (for example Field-Programmable Gate Arrays, and other programmable logic devices) and new software (logic synthesis and hardware description languages) for MicroSystem design is arriving at a rapid pace. Silicon technology and the design tools themselves are now quite advanced—after 20 years of research and development in silicon systems, unparalleled in history. The problem now is in applying this knowledge and finding a mechanism to tie the tools and techniques together. All too often a new ASIC works according to specification, and exactly as simulation predicted, but when the chip is plugged into the system the human specification is found to contain errors. In this paper we discuss how to use computer-based education and training material to help the hardware and system designers who are suffering from a bad case of information overload.

Introduction

Automation of digital VLSI design has received an enormous amount of attention in the past 10-20 years. Sophisticated commercial software is now available for MicroSystems design ranging from programmable logic to full-custom VLSI, and from layout to synthesis. However, a sophisticated tool with little or poor documentation or one that is difficult to use is useless in the hands of even a skilled engineer. The education and training of engineers to use these tools have largely been ignored.

Knowledgeware

With reductions in hardware and software costs, new advances in desktop publishing, communications, and authoring software there is an opportunity to explore new methods of teaching and sharing of information. In a recent survey the IEEE found that nearly 90% of its members have access to a PC of some type. Electronic courseware and multimedia can be rapidly created on a PC, shared and altered or "re-purposed" to meet individual needs. Such "knowledgeware" will play a large role in education and training in the 1990's. It is important that it be used to solve some of the problems of keeping pace with the rapidly moving technology involved in MicroSystems design.

We have been working to collate, condense, annotate, organise and index the material a MicroSystems engineer needs, such as manuals, data books, fact sheets, application notes, tutorials, photographs, video clips, and animations.

Our principal development platform is the Apple Macintosh because it is well-suited to handle large amounts of information from disparate sources. A large part of the project has been building all of the tools and techniques necessary to "re-purpose" all this data, difficult when it is in such a wide variety of formats.

Our project has been underway for about 6 months. Initially all the material that we assembled was created by stripping data books and scanning them. Our first efforts were the Actel and Xilinx data books. We used optical character recognition to convert text to ASCII, and the graphics were left as 300 dpi images (using PICT, the standard imaging file format on the Macintosh). The text and graphics were then imported to HyperCard. This procedure was very time consuming. Scanning each page was tiresome and the best OCR program we could find could only achieve about 98% recognition. Editing the remaining 2% of errors in the ASCII text files took several months.

We knew that most manufacturers used electronic publishing techniques (though it turned out there was a surprising variation in the sophistication of companies technical documentation methodologies), and that ultimately we needed to work on automated conversion. However, we also realised that companies would not give us their material in electronic format without knowing what we would do with it. We used the Actel and Xilinx electronic data books as examples.

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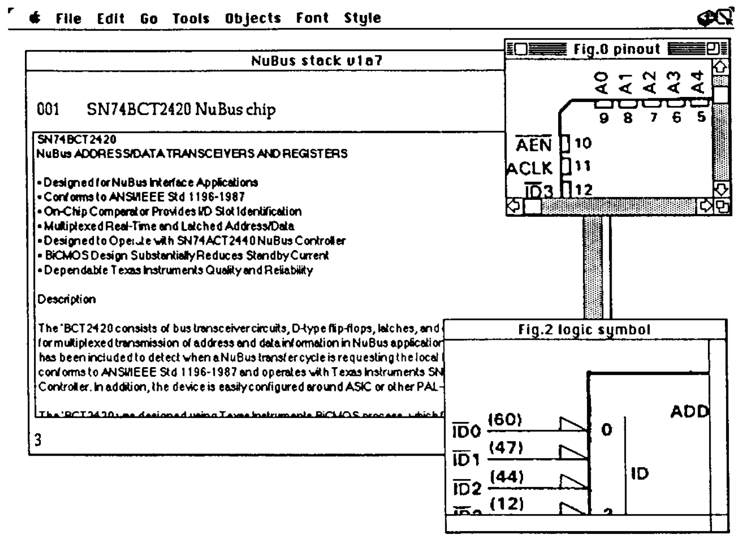

Figure 1. A screen image of a HyperCard stack produced from a Texas Instruments data book for an ASIC chip set for NuBus interfaces. The data book text was converted to electronic format by using a scanner and optical character recognition. The figures were scanned from the data book as 300 dpi (dots per inch) grayscale images. Since the Macintosh screen has a resolution of only 72 dpi, the images need to be enlarged to give the same resolution on the screen as in the data book.

We have since persuaded other companies to share material with us, some directly in electronic format, including: Apple, VLSI Technology, LSI Logic, Actel, Xilinx, Altera, Plus Logic, Capilano, Cadence, ViewLogic, and other silicon chip manufacturers and computer-aided design tool vendors. Actel, Xilinx and Viewlogic have provided their technical documentation directly in electronic format. In addition we have culled information from journals, magazines, the IEEE literature, electronic bulletin boards and the US Patent Office. We have also developed our own material as we have evaluated and used commercial tools to design ASICs in the design lab at the University of Hawaii.

Figure 1 shows an example of an electronic data book. Our aim here is to allow the specifications, circuit diagram, ASIC pin out etc. to be stored electronically in such a way that they can be directly copied to the schematic entry program, simulator, etc.

Figure 2 shows an example from the Actel data book HyperCard stack. Here the advantage of the data book in electronic form is the ability to index and search (in this example through the large number of Actel logic macros detailed in the data book).

Figure 3 shows some pages from the Xilinx book. By the time that we had manually converted the Xilinx XC3000 data book, Xilinx had announced the XC4000 series. Since Xilinx uses the Macintosh to prepare technical documentation in-house, we are using the Xilinx material to investigate ways of transferring "linear" text (from PageMaker on the Mac) directly to "Hypertext", automating the production procedure.

Figure 4 shows a unique capability of multimedia. By taking a videocamera through the fabrication facilities at Stanford and VLSI Technology we produced a training stack covering material difficult to present in any other fashion.

Table 1 shows a sample of some of the materials that we have assembled to date. We initially concentrated on conversion to HyperCard. As we progressed we quickly discovered that not all material is suited for hypertext presentation, for some material a conventional linear text is still much more appropriate.

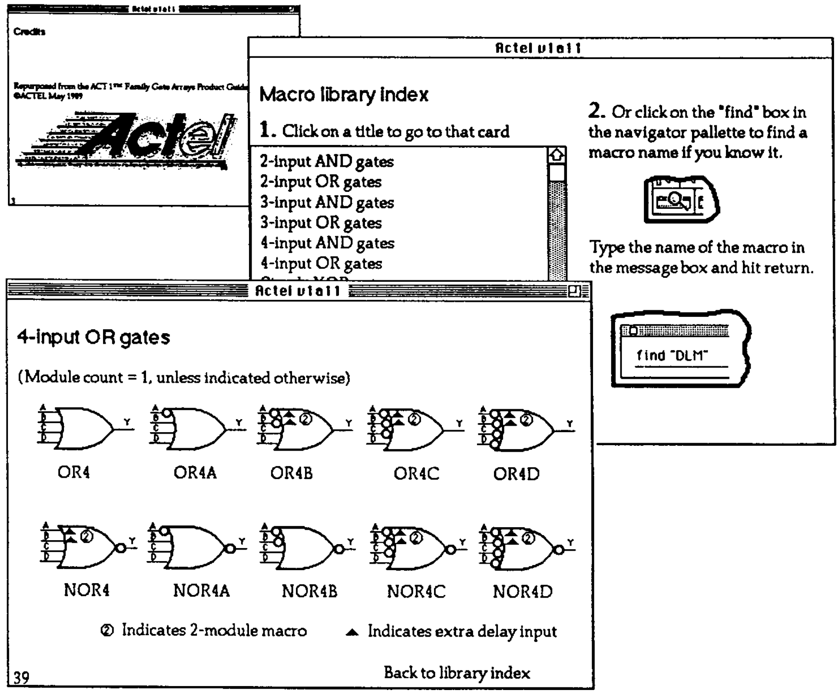

Figure 2. Screen images from a HyperCard stack produced by scanning the Actel data book. The logic macro cells are indexed allowing the database to be searched by name or function. Ideally the symbol and model would be stored in such a way that once found the macros could then be used by other CAD tools directly.

VIEWlogic from Ventura Publisher (IBM-PC), conversion using VP (Mac)
Xilinx from PageMaker (Mac)
Actel from Interleaf (UNIX) and scanned text
ASIC Technology and News **TI Data Books** **LSI Logic Data Books** **VLSI Technology** from scanned text using OCR
Stanford CIS **VLSI Fab** from Video Hi-8mm, RasterOps Framegrabber, QuickTime compression
US CMOS Patents Scanned text and figures

Table 1. A partial list of materials showing source, type and method of conversion.

We have tried to standardise on formats which are the lowest common denominator – in the sense that the material can then be transferred between platforms and re-organised or "re-purposed". However, we also need to find standards with more functionality than ASCII text and raw graphics. At present we have "standardised" on HyperCard and MS Word. Both of these formats allow transfer to other platforms (although there is currently no widely used hypertext tool on UNIX platforms).

Conclusion

We have shown some examples of the development and use of computer based education and training material. The largest barriers to wider use of these techniques is the conversion of existing material, the lack of standard formats and the lack of appropriate software on UNIX based platforms.

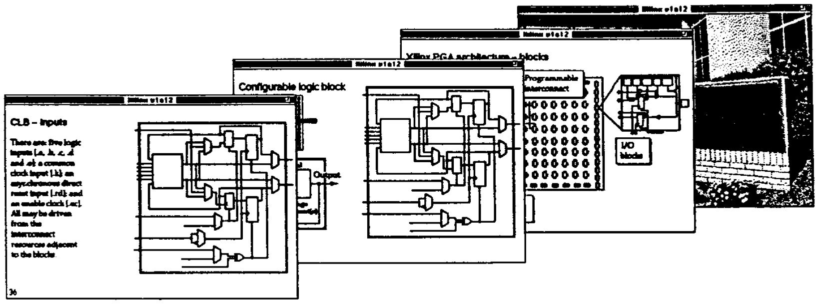

Figure 3. A stack converted from the Xilinx data book. Much of the material was originally created using PageMaker on the Macintosh.

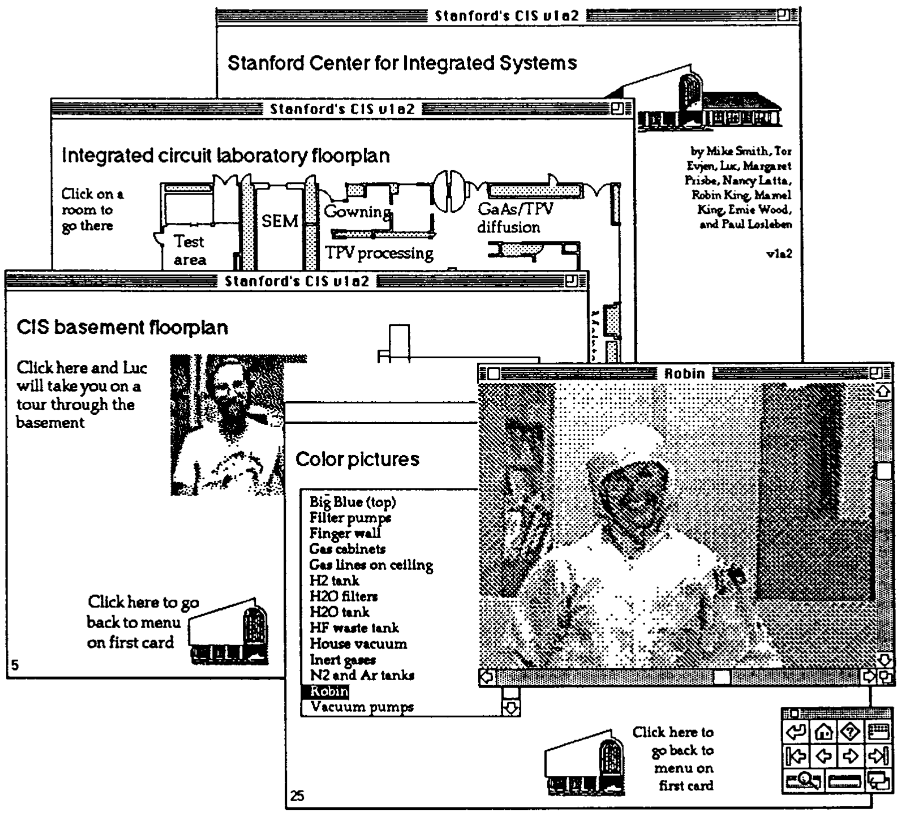

Figure 4. This HyperCard stack illustrates the use of multimedia. It includes pictures and compressed video to present material on a silicon fabrication laboratory which would be difficult to do in any other way.

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