Fundamentals and Standards
in Hardware Description Languages

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Fundamentals and Standards in Hardware Description Languages

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Preface

The second half of this century will remain as the era of proliferation of electronic computers. They did exist before, but they were mechanical.
During next century they may perform other mutations to become optical or molecular or even biological. Actually, all these aspects are only fancy dresses put on **mathematical machines.** This was always recognized to be true in the domain of software, where "machine" or "high level" languages are more or less rigourous, but immaterial, variations of the universaly accepted mathematical language aimed at specifying elementary operations, functions, algorithms and processes.
But even a mathematical machine needs a physical support, and this is what hardware is all about. The invention of **hardware description languages** (HDL's) in the early 60's, was an attempt to stay longer at an abstract level in the design process and to push the stage of physical implementation up to the moment when no more technology independant decisions can be taken.
It was also an answer to the continuous, exponential growth of complexity of systems to be designed. This problem is common to hardware and software and may explain why the syntax of hardware description languages has followed, with a reasonable delay of ten years, the evolution of the programming languages : at the end of the 60's they were "Algol like", a decade later "Pascal like" and now they are "C or ADA-like". They have also integrated the new concepts of advanced software specification languages.
Although HDL's can describe some of the constraints associated to a given technology (timing, resolution functions, topology ...), these data can be considered as "outside world" parameters. The domain of HDL's contains abstract objects, which in theory could be mapped onto any technology, if convenient CAD tools were provided. This results into a new situation.
On the one hand side, due to their complexity, which was made them unmanageable even by large human teams since a few years, systems to be designed depend upon available CAD tools. We shall certainly continue to develop CAD tools able to implement more complex systems, but we shall design more and more implement systems that existing CAD tools are able to implement.
On the other hand side, HDL descriptions will remain "implementation free", although increasingly precise and complete, making possible several successive implementations of the same system over several technological generations.
It is interesting enough to know that this property was one of the biggest incentive (together with design documentation maintenance) for the DoD to launch the call for proposals for a VHDL (Very High Speed Intagrated Circuits HDL) because military systems have multi-decade lifespans and then imply reprocurement of obsolete part.
It is always fruitful to have regularly a look back to the technological progress, in order to confront its evolution to the fundamental concepts. This is the first aim of this book, and it has been achieved by scientists able to make a synthesis over several decades.
The first part deals with mathematics, high level language concepts and system level methodology. It will help to assimilate the theoretical background for advanced application domains of HDL's :

- Formal proof of designs
- High level synthesis
- Multilevel mixed - mode simulation
- Hierarchical test generation

These topics constitute the second part of the book.
But a sample of the most recently fully implemented HDL's will be also provided in the third part of the book. They demonstrate at the same time how new concepts can become reality, how long it takes and how long it will again take to complete HDL up to the level of knowledge of to day and, what is more, to have them easily used by system engineers and designers. Drawing the lessons of thirty years of Hardware Description Languages, this book is also an incitement to stay modest : new technologies, whether "high" or "ordinary" require a human generation to become widely accepted.

Acknowledgements

My gratitude is large to the NATO scientific committee who has accepted to support generously my proposal of Advanced Study Institute entitled like this book. I hope that they will find enough justification of their choice in the quality of the event and of the resulting book.
I must thank also the Commission of European Communities who has allowed to support, indirectly but significantly, the organisation of this ASI through the ESPRIT/ECIP2 contract and has permitted to charge on ESPRIT projects travel and living expenses of some members of these projects.
The support from companies was impressive with, in first rank, SUN Microsystems France and SUN Microsystems Italy, having provided ten workstations with technical assistance and also IBM, Mentor-Graphics and VANTAGE (A VIEWLOGIC Company) having made available one station each with their most advanced application software.
I shall not forget the remarquable contribution of small EDA companies such as Model Technology, ANACAD, FINTRONIC-USA, CLSI, and LEDA whose software and courseware have brought an irreplaceable technology for the hands-on laboratories.
But obviously this book belongs to its authors. I want to thank them warmly for having accepted to publish the best of their outstanding works and for having spent a lot of precious time to do this within severe constraints of size and presentation.
Wojciech Sakowski did the coordination of this collective work defining a unified presentation, collecting, reformating, cutting and pasting : he deserves a special acknowledgement.
Claire Bryars brought a professional check of the conformance of the text with the syntax of English.

Grenoble, June 10th,1993

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