EMBRYO - A Tools Package for Guided Integrated Circuits Design with Falcon Framework

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Abstract

A great demand of qualified Integrated Circuits (IC) designers has been observed around the world due to the increasing market of semiconductors, wireless communication and Internet. As a result, engineering schools need to ensure the education of a greater number of designers. To accomplish this, professional Computer-Aided Design (CAD) tools for microelectronics are preferred rather than academic CAD tools developed at universities, because they represent the actual environment in the industry and design houses. However, these tools are somewhat complex to learn and not very suitable to IC designers training. In this work, new didactic tools for IC designing are presented using the Mentor Graphics environment.

1. Introduction

Complexity of microelectronics projects progressively increases together with market growing needs for lower costs and larger benefits, involving both the selection of project techniques and researches. Due to demand, a shortage of specialized professionals results.

Among current design tools, CAD (Computer-Aided Design) frameworks such as Cadence, Mentor and Synopsys stand out, which are expensive and powerful solutions requiring large investments in qualified personnel's training. Moreover, those tools are not very intuitive, difficult to configure and somewhat complex. On the other hand, there are low-cost academic solutions, but they are not popular in the market, providing little support, poor documentation and low flexibility regarding final user.

The interest in preparing a professional tool for academic purposes arises so as to develop human resources. The intention is to use a professional design environment as a base, which extensive resources and flexibility are used to accomplish complex tasks. The addition of an intuitive interface and a simplification of actions required by an IC design flow leads to a more didactically design environment, helping learning process.

2. Context, Objectives and Interests

This work’s target was the professional and powerful Mentor Graphics Falcon Framework. This software consists of window graphic interface and package of tools for system design, and multi-level simulation. Users can easily modify graphic environment

through specific AMPLE language from Falcon Framework [AMP 98]. As required, user can add menus, remove useless menus, modify keyboard and mouse commands, etc.

AMPLE is a native language with syntax and functions similar to C language that, besides bearing compiling characteristics, can also be interpreted, allowing direct use of code during execution time. Compilation offers advantages such as less access time and code secrecy. AMPLE has a lot of extensions and functions that facilitate the programming of new modules; some of them collect information while others restore the features of work area.

Advanced functions were also simplified. User, besides easily accessing special modules such as the generation of IC blocks, and a simple-to-use 3D viewing, is not required to know the inner workings of modules. Another objective is to integrate basic academic learning. Different points of view from traditional 2D version of current CAD tools help students to intuitively perceive and understand the IC and its operation. When object of study is better explained, understanding and internalization of knowledge is extensive.

All work presented in this paper was done using the 0.6um cub process of AMS [AMS 98]. However, all code is being written to allow process migration. All parameters used are from either the process file (supplied from the foundry) or a few files written specifically for the modules (these are manually generated to reflect target process).

3. Modules for Mentor Graphics Environment

The modules presented in this paper were designed for IC Station, a tool of the Falcon Framework, Mentor Graphics' most important suite of IC design tools. They consist of several AMPLE files and may be classified this way:

a) **Regular block generators:** This module generates the layout of IC blocks for guided design. The basic structures are placed according to user specified parameters. The user, besides choosing which block will be generated, may choose a lot of options regarding the characteristics of the block. The flexibility of these options is only limited by the process rules.

Currently, the only block available is the gate array. User can choose number of CMOS pairs, width of the transistors and number of horizontal lines available for manual routing. These options are used to instantly generate the basic structures of these blocks (feeding lines, polysilicon pairs, and active areas). ROM and PLA blocks are being designed for a larger variety.

b) **Guided IC design:** This module gathers all changes made to the user environment in IC station. It was designed to accompany a generated block. After generating a block the characteristics of the user workspace concerning design are adapted to the chosen block.

The functions commonly used when designing over the block are configured for easy access and automatic parameters supply. The visualization of the layout is adapted for the current block. Some restrictions are imposed to prevent the violation of the process design rules, such as grid and path length definitions.

c) **Cell synthesis –** This module is currently under development. It automatically generates a small IC based on popular descriptions. User may supply a Spice description or a logic equation and a cell will be instantly generated. This module is being generated in several steps, which are defined to be as modular as possible.

The Spice or logic equation description is converted to an internal description. The code generation for the Spice conversion is direct, but the logic equation must be interpreted, so the signals may be extracted and the connections (point A to point B), defined.

After the internal description is generated, the symbolic routing takes place. An algorithm for detailed routing of small circuits (no bigger than a D flip-flop) is being designed without a layout block in mind. The objective is to route a matrix and then lay this information on any of the known blocks from this work.

Having routed the circuit symbolically, the information is transformed to a block chosen by the user. The result is a small cell performing the user's function, using any of the known blocks.

The most important part of this module is the symbolic routing, which is very challenging and, besides having seen extensive research, is still relatively uncovered. A few algorithms discuss this subject, such as Lee's Algorithm [LEE 61]. The algorithm developed will aim processes that forbid via over contact and allow two metals usage.

d) **IC visualization -** The last module consists of functions designed to allow alternative viewing of any circuit in IC Station. The viewing tools are designed to ease the understanding of the circuit and their fabrication methods.

A cross-section viewer has been developed in IC Station. User defines a cut line in the layout window, and a new IC Station window is opened automatically with the related cut view. Cut lines can be defined in any direction, with the possibility to change the direction of this one any times in the same cut. This module allows the on-line study of the layout representation and the illustration of electronic device structures.

Another additional viewing tool is used to show a three-dimensional (3D) layout representation. As IC Station does not allow a 3D graphic illustration, auxiliary tools have been used for this: VRML, Geomview, X3d and ANSYS [KAR 97][REI 98]. The user defines the layout area in the layout window to be illustrated in 3D. An output text description is generated in the desired format to be then visualized using appropriate 3D tool. This tool also provides great portability, as the generated files can be viewed in any appropriate 3D tool. It is not necessary the Falcon Framework to view these files.

4. Conclusions

The CAD tools presented herein are easy to use and provide powerful and flexible solutions to integrated circuit design in layout level. Its didactic characteristics are evident: simple and intuitive interface stimulates usage and understanding. Besides design tools, viewing tools also help learning process by providing a clear illustration of integrated circuit from many angles in an effort to emphasize circuit construction and layer arrangement.

Professional microelectronics CAD tools are used in IC design education in order to prepare students towards a realistic work environment. EMBRYO project is a set of academic tools designed to accomplish this goal. An overview of the package is shown in figure 1. It's an "OR" gate manually routed and them viewed in a VRML capable browser.

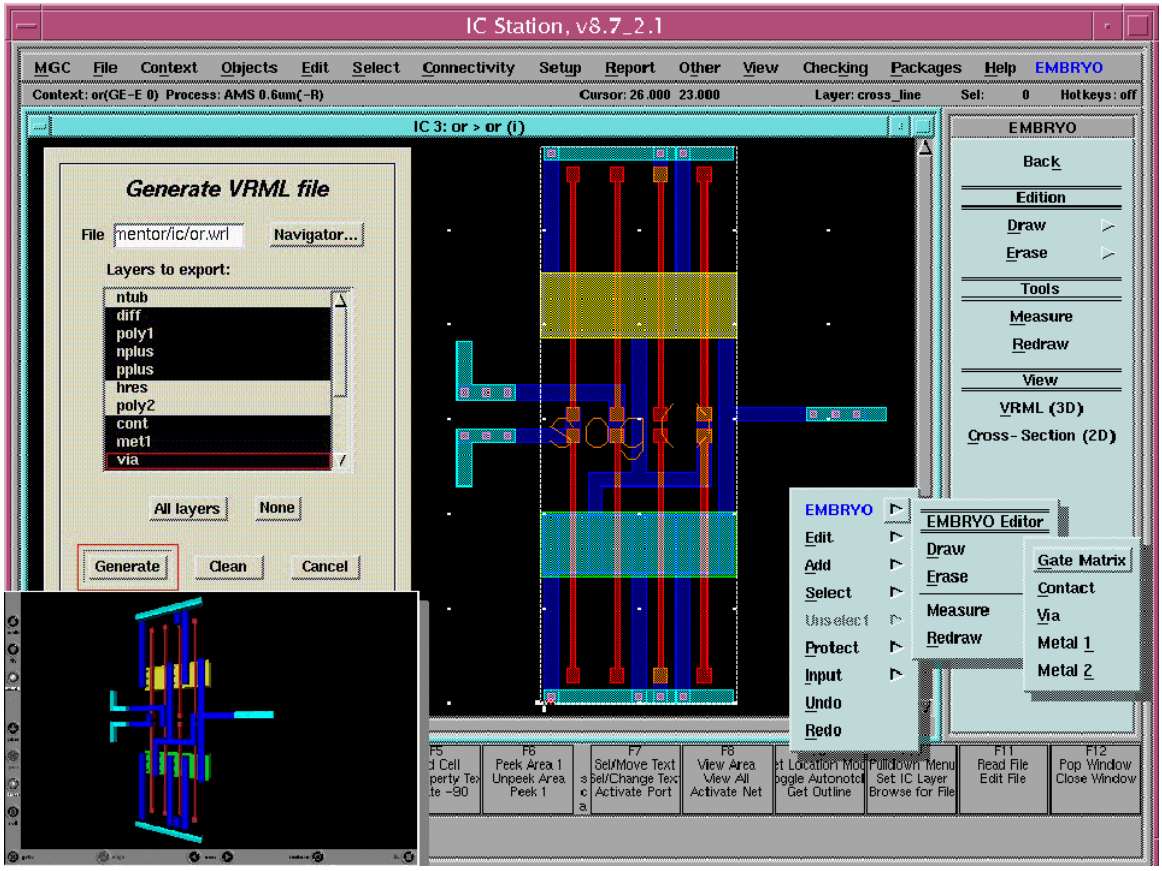

Figure 1 - The adapted IC Station.

Acknowledgments

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References

[AMP 98] Mentor Graphics Documentation - Falcon Framework Bookcase: *AMPLE User's Manual*, Software Release C.2 August 1998.

[AMS 98] *AMS 0.6 µm CMOS Design Rules*, Document #: 9931025, Revision D, November 1998.

[KAR 97] Karam, J. M.; Courtois, B. & Boutamine, H. CAD tools for bridging microsystems and foundrie. *IEEE Design & Test of Computers*, Apr.-June 1997, pp. 34-39.

[LEE 61] Lee,C., *An algorithm for Path Connections and it's Applications*. IEEE Transactions on Electronic Computers, September 1961

[REI 98] Reis, R. and Indrusiak, L. *Microelectronics Education Using WWW and CAD Tools*. XI Brazilian Symposium on Integrated Circuits Design Proceedings, Buzios, 1998