IC Design Activities in the Microelectronics Students' Group

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Microelectronic courses lack to provide undergraduate students with a more industry-oriented skill set due to CAD tools complexity and time-consuming design-flows. This paper presents how this difficulty is mitigated with an extracurricular activity being carried at the University of Porto by the Microelectronics Students' Group.

This initiative started in 2008 with a small group of students that since then has evolved into a well-structured teamwork environment. With little supervision, the students created their own design framework similar to those found in industry, comprising properly organized CAD software, custom process design kits, and website hosting sharable information, all built on top of an advanced network infrastructure.

So far, the students have accomplished several tape-outs, hosted MSc thesis, produced scientific papers for international conferences, promoted seminars, won two design awards, and produced material that has been put to use by some MSc courses in the Faculty of Engineering — University of Porto. This reveals that given the opportunity and necessary conditions, students are capable of autonomously exploring a field of their interest while extending their career options with desirable professional skills.

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Introduction

Last decade has witnessed an intense effort to reform the curricula at European Higher Education Institutions driven by the Bologna Process. This led to the introduction of (learning) student-centered paradigms, stimulating the students to be active in the planning of their own learning and encouraging autonomous knowledge improvement. Nonetheless, some skills and knowledge consolidation are difficult to achieve during a course timespan. Regarding in particular the microelectronic subjects, it is very difficult to sorely follow time-consuming design-flows using professional CAD tools in efficient ways. Extracurricular projects, driven to fulfill a set of aptitudes expected at the end of a degree, can play an important role to overcome such difficulties, especially for those students that express interest in furthering a particular topic. When properly designed, such activities are capable of stimulating numerous features on a given professional profile. Moreover, individual achievements can be included in the Diploma Supplement, which is generally seen as evidence of added value proficiencies. This paper reports on the activities and results of such experience: the "Microelectronics Students' Group" (μSG) [1], an autonomous initiative where undergraduate students are committed to the design of CMOS integrated circuits.

Microelectronics Students' Group

During 2008, at the Electrical and Computer Engineering (ECE) department of the Faculty of Engineering – University of Porto (FEUP), Portugal – seven undergraduate students started a small set of microelectronic projects led by a PhD student. The ECE department provided a room with computers where students could develop their work activities. Soon the students recognized that an adequate structure was required to properly operate within a teamwork environment. Some efforts were addressed to find a solution for several common issues, such as: how to manage installation, configuration and updates of CAD software from an extended list of professional tools; to establish good design practices, essential to cooperate in team projects; integration of new students invited to take part in the development of IC projects… These aspects covered a great part of the group's initial activities.

Likewise, in any university lab where workstations must be shared among numerous users, there are several issues to be carefully considered when designing a networked-infrastructure with licensed software. Both software and project data has to be kept secure in a network and shared among group members. The µSG students provided a solution that has been running on a GbE network for almost a year, proven to be highly reliable [2]. As depicted in Fig. 1, the proposed infrastructure uses: Kerberos V and LDAP protocols to provide a single sign-on encrypted mechanism, storing user credentials and personal information, and an OpenAFS server for storage and volume management. This way, high amounts of data from IC projects, as well as CAD software, are centralized and accessible through any computer. Any given update or upgrade on CAD tools can be performed/tested independently without affecting on-going designs, and propagated on-demand throughout the network. The CAD software and foundry libraries are organized by vendors/process and versions with shared configuration scripts, which fit most project requirements in terms of design flow and selected process. Other network features include: flexible OS deployment, through the network, allowing computers to be formatted and configured remotely; SSH and NX allow users to securely access all the available services from outside FEUP network; HTTP server to host the website; MySQL databases to log physical access to the room and video surveillance. This organization involves four students permanently working as CAD manager, webmaster, and system administrator.

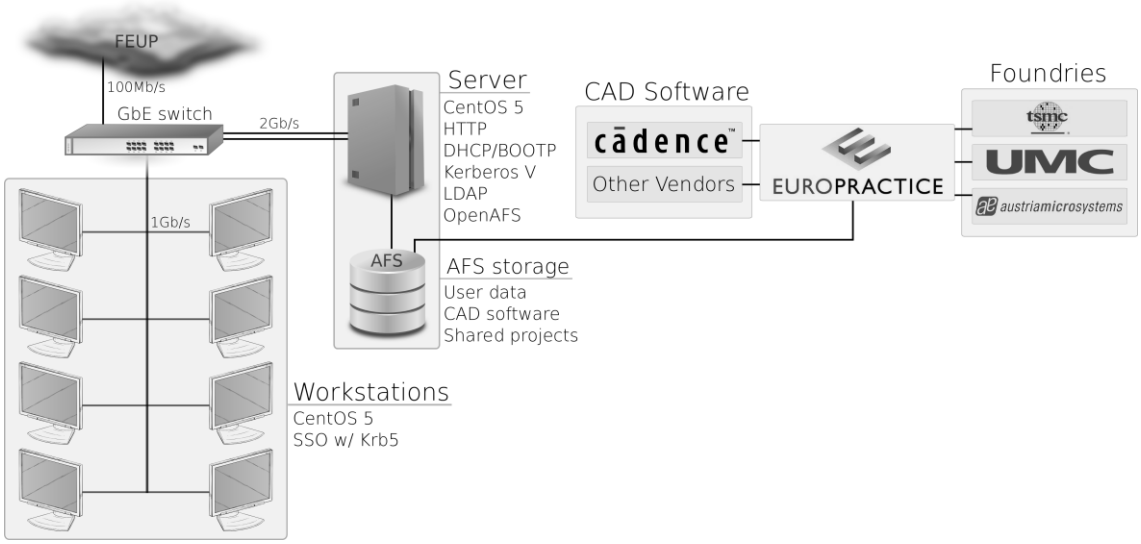


Figure 1: CAD network infrastructure for single sign-on and centralized storage.

Initially, most of the IC designs were focused specifically on wireless communication circuits [3]. A single project included all the students with different knowledge levels, working from baseband to radio-frequency front-end circuits. The students were encouraged to develop specific design partitions and had the opportunity to freely explore numerous engineering solutions, from the early stages of an IC design, up to submission for tape-out. With little supervision, this group managed to establish a well-structured and responsible work environment, maintaining the essential motivation to achieve good results [4]–[6].

Through projects sponsored by the University and other financial means such as scholarships, several ICs have been prototyped under the Europractice *mini@asic* program (refer to Figs. 2 and 3). Some of these works even led to final MSc thesis, where a total of five have already been successfully accomplished. Various scientific papers were also presented at international conferences, denoting a strong innovation concerns within the group.

Besides IC design projects, the µSG also shows great interest in stimulating new areas of research and development, and to foster entrepreneurship in semiconductor technologies for the region. In this sense, the group promotes seminars with invited experts from semiconductor industry, covering topics from design issues to venture capital. Workshops and local exhibitions, directed to university and high-school communities, are other initiatives that aim to inspire new students into the area of semiconductors technology.

In order to share knowledge built by the group, the students have engaged in writing didactic (non-confidential) material posted at the group's webpage. This has been considered to be extremely useful in lectures for courses at FEUP, e.g. detailed information about tools usage in design of integrated circuit and tutorials. More recently, the µSG also became a contributor to the Cadence Academic Network.

As a result of such living activity, these initiatives have inspired other ECE undergraduate students to start their own groups in different areas.

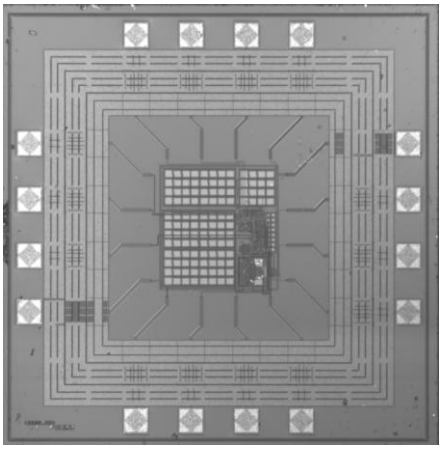
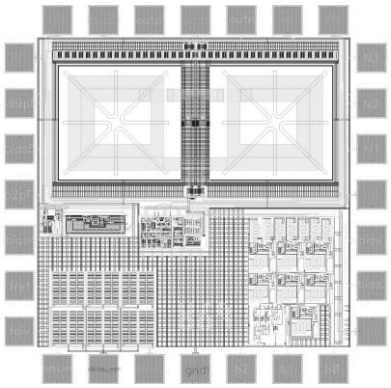


Figure 2: Chip micrograph of a MEMS readout circuit (charge-amplifier).



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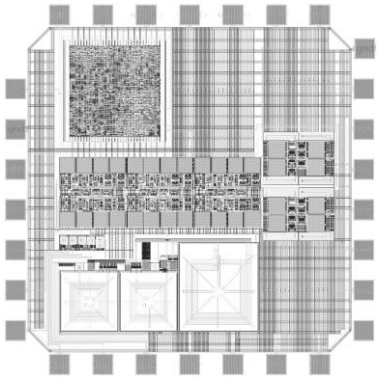

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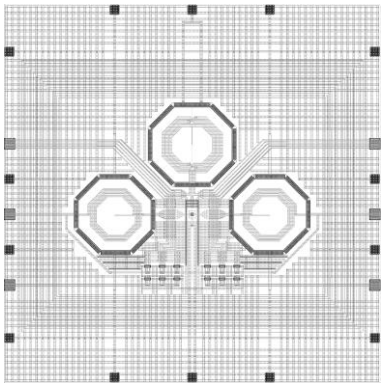

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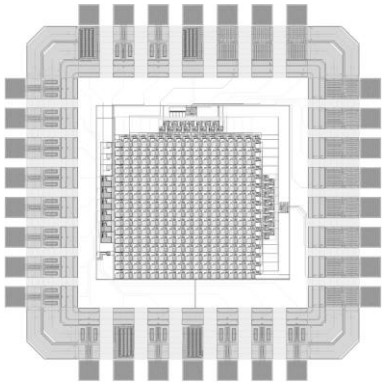

(d)

Figure 3: Layout examples of IC prototypes designed at the Microelectronic Students' Group in several CMOS processes and fabricated through Europractice – (a) N-fractional radio-frequency synthesizer, C35B3C3, 1730×1730-mm^2; (b) ISM-band front-end FSK wireless receiver, austriamicrosystems C35B3C3, 1730×1730-mm^2; (c) 2.45-GHz 20-dBm switching-mode power amplifier, TMSC 90-nm LP MS/RF, 1875×1875-mm^2; and, (d) 16x16 image sensor, austriamicrosystems C35OPTO, 1730×1730-mm^2.

Conclusion

We have presented an overview on the organization and main technical activities of the Microelectronics Students' Group – University of Porto, Portugal. This extracurricular initiative aims at providing the undergraduate students a design environment with close resemblance to professional scenarios in the areas of semiconductor technologies.

Along its three years of existence, this initiative has demonstrated to be particularly effective in motivating ECE students for developing knowledge and hands-on experience in integrated-circuit designs. As an extracurricular activity, it has shown to be an enthusiastic approach to improve skills of undergraduate students regarding the use of CAD software tools, optimizing practical procedures, providing turnarounds to solve common design issues, as well as providing an excellent complementary methodology to develop competences built within the microelectronic courses.

Acknowledgments

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