Old IDESA and New IDESA-2: European Training Programs for Implementation of DSM CMOS ASICs

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Abstract—**IDESA is an EC funded European program for training in VLSI implementation in DSM CMOS technologies that started in 2008. In this paper the outcome of IDESA and lessons learned are discussed and the new IDESA-2 training program is announced.**

Keywords-CMOS; VLSI; deep submicron; training

I. INTRODUCTION

The semiconductor industry introduces a generation of CMOS manufacturing technology approximately every two to three years. The mainstream technologies now are 90 nm and 65 nm while 45 nm is already available in several fabs and 32 nm is expected to reach industrial maturity soon. Although deep submicron technologies down to 65 nm are accessible for EU universities, adoption of these technologies in research and training has been rather slow. The economical obstacles – high silicon prices – have been partially overcome by means of the Europractice Mini@sic model and EC subsidies for university designs in deep submicron technologies [1]. There is, however, another obstacle. Deep submicron (DSM) design flows and tools are much more complex than traditional ones and require new knowledge and skills. To facilitate transition to DSM technologies, the IDESA "train the trainers" training program was launched in 2008, with a series of 4 "hands-on" courses traveling across Europe and 22 advanced seminars recorded and available from the IDESA Web site in multimedia format. All course material and seminars can be freely reused at European universities. The satisfaction level of the participants in the IDESA courses is very high. To extend the impact of IDESA and update the courses with topics relevant to the most advanced state-of-the-art processes, the IDESA-2 project will start in September 2010. The purpose of this paper is to summarize the outcomes of IDESA, discuss the lessons learned and introduce IDESA-2.

II. IDESA AND ITS OUTCOMES

A. Facts and Numbers

IDESA involves 8 partners active for many years in VLSI design: imec, EPFL, TU Delft, RAL, Slovak TU, UT Warsaw, KU Leuven and CEA-LETI. The partners jointly developed 4 advanced courses: an analogue IC implementation course, a RF IC implementation course, a digital IC implementation course and a design for manufacturability (DfM) course. These courses were repeated 7 times each spread over 17 locations in Europe. Table I shows the number of courses and course locations in the 12 countries in which the courses were organized. The IDESA consortium tried to find course locations in the East, West, North and South of Europe in order to make the courses easily accessible for attendees from all EU member states and other European countries. The geographical coverage shown in Table I is quite good. One of the courses (DfM) was given in four locations only (in the UK, in Italy, in the Czech Rep. and four times in imec, Belgium) due to limited number of institutions interested in hosting this course. The reason behind this will be addressed later in this article.

TABLE I.

Country	No. of Locations	No. of Courses
Belgium	2	9
Czech Rep.	1	1
France	1	1
Greece	1	2
Italy	2	2
Poland	3	3
Slovakia	1	2
Spain	1	1
Sweden	1	1
Switzerland	1	1
The Netherlands	1	1
UK	2	4
Total	17	28

Due to generous EC support the participation costs could remain very low: 50 EUR per course day. The participation fee included attendance to all course sessions, extensive printed materials, refreshments and in many cases also free lunches. The participants had to cover their own travel and lodging costs.

As an addition to the courses, a series of tutorials addressing a broad range of specific advanced topics have been prepared by invited experts (most of them not from the project

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consortium). These seminars were presented in front of live audiences at imec and recorded. 22 of them are now available online from imec Microelectronics Training Center servers [2].

Development of the courses (including extensive course materials and logistics - software support for hosting institutions etc.) was a significant effort: more than 800 person-days.

The total number of attendees was 428 persons from 26 countries. These countries included 21 EU member states and Belarus, Russia, Serbia, Switzerland and Turkey. Six EU member states, among them the Baltic states, were not represented. The highest numbers of attendees (30 or more) were from Belgium, Spain, UK, Italy, Germany and Poland. Table II illustrates the geographical distribution of the course attendees.

TABLE II.

Country	Number of course attendees				
	Total	*Analog*	*RF*	*Digital*	*DfM*
Austria	3	1	0	1	1
Belarus	1	0	0	1	0
Belgium	65	16	11	14	24
Bulgaria	2	2	0	0	0
Czech Rep.	16	6	0	5	5
Denmark	1	0	0	1	0
Finland	7	1	1	3	2
France	8	6	1	1	0
Germany	37	9	4	19	5
Greece	24	12	6	4	2
Hungary	1	0	0	1	0
Ireland	5	1	1	3	0
Italy	50	14	5	24	7
Norway	8	2	3	2	1
Poland	30	16	8	6	0
Portugal	2	0	2	0	0
Romania	1	1	0	0	0
Russia	4	0	3	1	0
Serbia	6	0	6	0	0
Slovakia	10	5	1	4	0
Spain	53	9	30	10	4
Sweden	21	3	14	4	0
Switzerland	9	5	0	4	0
The Netherlands	12	2	1	8	1
Turkey	1	0	0	1	0
UK	51	14	14	10	13
Total	428	125	111	127	65

Among the attendees there were 238 PhD students and teaching assistants, 88 academic teachers and 103 researchers and designers. They came from 132 institutions. This is about 20% of the estimated European academic teaching staff and PhD students potentially interested in the courses. IDESA-2 will be launched to expand the penetration.

The average number of course attendees was between 16 and 18 at the analog, digital and RF courses. This means that almost all these courses were fully booked. The average for the DfM course was at 60%.

B. Some Problems and Solutions

1) *Course Development and Delivery:* The courses have been prepared by international teams including academic teachers and researchers from partners' institutions: imec, EPFL, TU Delft, KU Leuven, UT Warsaw. Each course had its leader responsible for course development. Thanks to the very good understanding between the partners this turned out to be a relatively easy task. However, delivery of the courses, and in particular organization of the computer lab exercises, created initially serious technical and logistical problems. Each of the four IDESA courses consists of lectures and computer labs with "hands-on" demonstrations of design tools and techniques. Nearly half of the overall course time is allocated to these lab exercises. Each course participant has to carry out a set of particular design tasks him- or herself. Such "hands-on" courses are usually organized on the site of the course provider, where all the technical infrastructure is readily available. In IDESA this is not the case. Each course was given for the first time at the site of the IDESA partner responsible for it, but the subsequent courses were traveling across Europe, where every hosting site had somewhat different hardware, network infrastructure, operating system versions etc. Many hosting sites did not have all the software tools and/or sufficient number of software licenses. This problem has been solved by RAL together with software vendors by making the necessary software and temporary license files (valid until the end of each course) available. The hosting site made their servers available remotely for the authors of the lab exercises, allowing them to check the software installation and make sure that everything worked as expected before start of the course. In this way technical problems have been successfully overcome. In IDESA-2 the same course organization framework will be used.

2) Marketing the Courses: Another problem was to spread the information about IDESA and its offering as widely as possible. Despite numerous e-mail based info campaigns (e-mails sent to all EUROPRACTICE members), conference presentations, the IDESA Web site and links from other Web sites (e.g. [4]) the IDESA team members learned many times that many academic teachers and PhD students potentially interested in IDESA courses were not aware that such high quality and low cost courses existed. It is not easy to deliver the message to all interested people when mailboxes are full of all sorts of commercial advertisements and spam... This problem will also exist in IDESA-2 and more effort will be needed to spread the information about the project and its offering.

3) Registration: One more problem was how to organize the registration process. It was decided to arrange a single Web based registration site at RAL. This site (linked to the

main IDESA Web site [3]) provides detailed information about the scheduled courses, handles registration and payments. RAL is also the "IDESA interface" to the course hosting sites. Registration for IDESA-2 courses will be also handled via the same RAL-hosted Web site.

4) Access to Design Kits: The registration process included arrangement of individual non-disclosure agreements for the course participants. Imec has successfully negotiated with TSMC conditions of availability of PDK of their 90 nm mixed signal CMOS technology. Each course participant has to sign a personal NDA before the course and send a copy to imec. In this way it became possible to base all the exercises on a real industrial DSM process.

5) Academic Perception of Design-for-Manufacturability: Few universities volunteered to host one of the DfM course sessions. At the same time, the level of subscription for the DfM sessions was 40% below the average for the analog, RF and digital implementation courses. Manufacturability issues, however, do have a significant impact upon the IC implementation flows for 65nm and beyond. Analog, mixed RF and purely digital circuits are all affected. Increased marketing and PR actions for the DfM topic have failed to raise the interest to the level we have seen for the other courses.

C. Outcomes and Lessons Learned

All courses were evaluated by the attendees. The evaluation forms were extensive, included detailed evaluations of the contents of the courses, quality of teaching (overall and for individual trainers) and organizational aspects. Suggestions how to improve the courses were welcome. These suggestions will help to make the IDESA-2 courses even better.

In general, the course attendees were very satisfied with the course contents, the style and quality of training and the materials provided. Most attendees declared that the courses they attended were very relevant to their current and/or future work. Many also declared their intention to reuse the course material in their training activities. Among those who didn't some attendees considered the course material too advanced for their teaching. Another obstacle indicated was lack of access to the software used in the courses, in particular the ADS toolset from Agilent for RF design, which is not available via EUROPRACTICE. Most of the attendees also declared an intention to submit deep submicron designs for fabrication in the future, but not in 2008 or 2009.

The lab "hands-on" sessions were indicated as the most valuable component of the courses. It seems that the level of theoretical knowledge among the course attendees was quite high (although not equally high in all courses and on all topics), but what was missing were practical design skills. Indeed, design and verification of complex designs in deep submicron technologies involves a number of new tools or steps not easy to master, with lots of new functionalities and options. This is the reason why many attendees suggested longer lab sessions, asked for reference material related to the tools used and for more design examples.

The numbers presented in Table II indicate that while the analog, RF and digital design courses were very popular, the DfM course turned out to be of somewhat lower interest. However, in post-course feedback most DfM course participants agreed that the lecture material was of essential importance to their design activities. In hindsight, the students regretted any initial hesitation to attend. Quote:"I was in the DFM course and it was very good. I would like to send 2 more staff as soon as possible. Do you have dates for the next DFM sessions in 2010?"

The main outcomes of IDESA can be summarized as follows:

- the vast majority of the participants rated the courses as very good,
- practical lab sessions were considered as especially valuable component of the courses,
- many attendees declared that after the courses they would design their first chips in deep submicron technologies,
- most attendees from universities declared that they would reuse the course materials in their teaching,
- while the analog, RF and digital design courses were very popular, the DfM course turned out to be of somewhat lower interest. Additional work needs to be done to convince academia that a focus upon DfM is essential to implement functional and reliable circuits. Manufacturability is not about technology, manufacturability is about design.

The overall outcome is definitely positive. It is worth noting that in the first half of 2009 the number of 90 nm designs submitted to EUROPRACTICE for prototyping was higher than in the whole 2007 and 2008 despite economic difficulties. In order to stimulate the application of the knowledge acquired in the IDESA courses, Europractice again organizes design contests in 2010. Applicants can win free prototyping on a 90nm mini@sic run. [5]

The economic crisis clearly had some adverse effects on IDESA. High travel costs forced many potential participants from such non-EU countries as Belarus and Ukraine to cancel their course registrations despite travel grants of 300 EUR per person offered to them.

III. IDESA-2: Similar, But Not Exactly The Same

The IDESA-2 project, which starts in September 2010, will continue the main activities of IDESA. The course contents will be updated where necessary, taking feedback from IDESA courses into account. However, the overall scheme of the courses will remain the same. Again, each course will be repeated seven times in various places in Europe. The portfolio of advanced seminars will be extended with new topics. The proposals are being collected now.

It is planned to open the courses to design engineers from European SMEs. However, to avoid unfair competition with commercial course providers, the non-academic course

attendees will have to pay a participation fee in line with market prices for commercial courses.

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