

EuroTraining

– Supporting University Programmes in Nanoelectronics

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Abstract—This paper describes how the EuroTraining project supports a timely introduction of new nanoelectronics university programmes in Europe. The provisions include training courses, training material and training roadmaps describing the structure and content of nanoelectronics curricula. In order to facilitate the European integration of the new curricula courses based on the ECTS system are offered and training material free of copyright and IPR is emphasized.

Keywords-training, nanoelectronics, curricula, courses

I. INTRODUCTION

The goal of the EuroTraining project is to enhance European industrial competitiveness by providing easy access to European training courses and by stimulating the development of new courses in the field of nanoelectronics. EuroTraining is concerned both with university educational programmes and with professional advancement training and maintains a web-service providing a comprehensive course directory and links to course material for university courses and for professional advancement courses.

Furthermore the project has recently provided a training roadmap describing the academic training requirements within nanoelectronics [1]. Technology roadmaps show that the development of microelectronics into deep submicron technologies (nanotechnologies) causes fundamental changes in the coming years as the scaling limits of the traditional CMOS processes are reached. These changes have impact both at the system design level, at the circuit and device design level, and at the manufacturing technology level. In order to cope with these changes, new curricula in engineering education are needed.

This paper describes how EuroTraining supports the implementation of new university programmes in nanoelectronics.

II. PROVISION OF TRAINING COURSES

The objective of the EuroTraining project is to provide a European Training Infrastructure facilitating the provision of

high calibre training across Europe. The structure supports professional advancement training as well as academic training. The training action enhances the development of the European knowledge-based society in the field of nanoelectronics.

The EuroTraining action offers access to a comprehensive range of advanced training courses, course material for European nanoelectronics university programmes and employee training support. Special attention is devoted to develop and make available courses supporting the CMOS technology targeting digital components and complex digital Systems on Chip ("*More Moore*"); to master diversification targeting non-digital applications, heterogeneous integration in Systems-on-Chip or Systems-in-a-Package ("*More than Moore*") and to prepare for the technology generation beyond the CMOS scaling limits ("*beyond CMOS*").

The courses offered are structured in three levels:

1. *ECTS accredited courses*: European Credit Transfer and Accumulation System (ECTS). For successfully completed studies, ECTS credits are awarded. The credits facilitate the transfer and progression throughout the Union. Currently the ECTS accredited courses are mainly utilized as part of the PhD programmes.
2. *Quality Labelled courses*: The quality labelling procedure has been initiated by EuroTraining with the objective of improving the high quality of delivery of courses given by European Course Providers. Quality Standards outlines key components of effective education and allows course providers to evaluate their efforts in relation to these criteria. This evaluation procedure has the ability to check that the Course Providers are delivering high quality courses to students, and provides feedback and advice so that the quality can be improved in future courses.
3. *Other courses*: This category includes all other kind of courses or events (e.g. conferences) offered on a European level.

Annually EuroTraining offers more than 500 courses. Nearly half of these courses are either ECTS courses or Quality Labelled courses.

Since the start in 1995 of the preceding EuroTraining project 5.400 courses have entered into the web service and more than 1.2 mio. training users have accessed the service in order to find the right training. The general rationale of the project is shown in the below figure:



Figure 1. Course delivery from suppliers to users

III. PROVISION OF TRAINING MATERIAL

Most universities have small numbers of PhD students in each subject area for which reason they cannot afford to entirely develop their own courses. At the same time the innovation circle is becoming faster and faster. Therefore the basic development of courses, text books and training material must be shared among the universities.

The development of training material is normally a process going from writing R&D reports and scientific papers which are converted to lab exercises and lecture notes which later become an entire course. Over the years more mature course material materializes into textbooks published by international publishers. This value chain for the development of course material is shown in figure 2.

While scientific papers and textbooks are disseminated globally, the course material developed is only disseminated locally. This means that other users (universities) may have to wait for textbooks to be published some years downstream of the actual course material. By making the course material available through EuroTraining it becomes available globally and consequently new nanoelectronics courses become available much quicker.

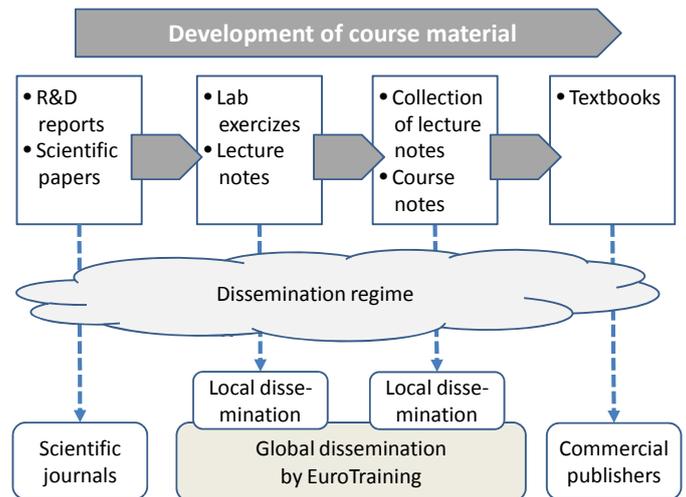


Figure 2. Development of course material

EuroTraining therefore offers a course materials brokerage facility. The course material is organized in categories supporting various technologies, e.g.:

- Materials
- Nanotechnology
- IC (Analogue and Digital)/ASICs
- Nanoelectronics
- Micro/nano systems
- RF devices
- Design Tools and CAD

The training material is structured as either a set of links to course material providers or direct access to a database containing training material that is free of copyright or IPR. In order to maintain the links EuroTraining runs a regular check of the consistency which leads to a quality label called QBIL (Quality Bank of Internet Links).

IV. UNIVERSITY CURRICULA DEVELOPMENT

Nanotechnology is having increasing impact on university curricula in electrical engineering and physics. The advent of nanotechnology brings about new possibilities in nanoelectronics, including increasingly complex systems on chip, sophisticated technology fusion between electronic devices and non-electronic devices (such as bio-devices or chemical devices), and possibilities for developing fundamentally new nanoscale electronic devices. New engineering curricula in nanoelectronics must take these developments into account.

Therefore EuroTraining has developed a training roadmap describing the requirements with respect to developing new nanoelectronics curricula. Major influencers in the development of new curricula have been defined and

discussed and a model for the development of new curricula has been presented [1].

University curricula in nanoelectronics are still in their infancy but good examples of programmes already exist. The roadmap describes some representative examples of state-of-the-art curricula from major European universities.

In the development of new curricula, important issues are:

- versatility and flexibility to bridge gaps between computer engineering, electrical engineering and physics.
- internationalization to utilize peak competences in different locations.
- Matching of the competences of newly educated engineers to the local needs of industry and society.
- teaching resources available in the form of competent teachers and teaching material.

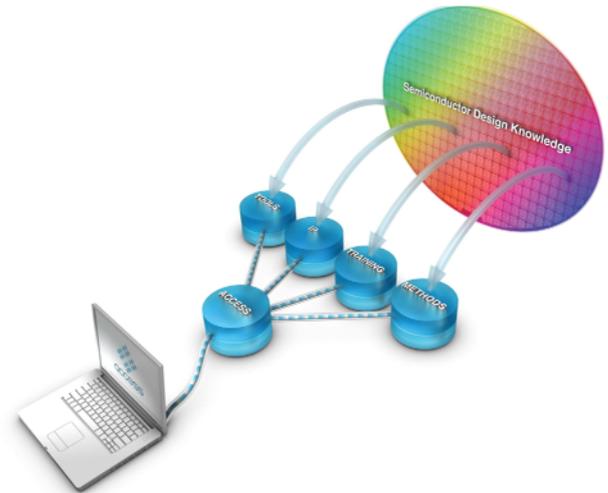


Figure 3. Integration of R&D knowledge on IP, Tools, Training and methodologies.

V. FURTHER INTEGRATION OF KNOWLEDGE

Recently EuroTraining has taken the initiative to further integrate the resources made available by the huge amount of FP7 projects working on semiconductor design. This initiative is organized in a project called “R&D Access” with the aim of identifying R&D results on semiconductor design from FP7 projects and to provide these results to partners from outside the consortia. The R&D results are divided into four categories:

1. Training and Education
2. Intellectual Properties
3. Design Tools
4. Design Methodologies

The dissemination platform facilitates the access to project results generated in huge numbers of Integrated Projects (IP), Network of Excellence (NoE), Specific Targeted Research Projects (STREP) and Coordination and Support Actions (CSA) from the FP7 programme. When the platform is implemented and routines for best practice have been established also relevant project results originating from e.g. FP6, ENIAC, ARTEMIS and national programmes will be invited to join the ACCESS platform.

The ACCESS platform is based on a web system developed as an extension to already existing European services like EuroTraining, IP Design-Reuse [2] and EDA network [3]. Since these services will be improved and already have nearly 40.000 subscribers the new combined ACCESS platform will be born with a tremendous user community.

The new site will become available at www.rd-access.eu

VI. CONCLUSIONS

Developing new university programmes in nanoelectronics require extensive resources and knowledge. Many universities cannot afford to develop entirely new programmes for which reason the work must be shared with other universities. EuroTraining supports this trend by offering access to advanced ECTS accredited training courses, training material and training roadmaps describing the requirements with respect to developing new nanoelectronics curricula.

All services offered are gathered in the European Training web site, promoting the training services and attracting participants: www.eurotraining.net.

ACKNOWLEDGMENT

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