The VLSI Circuits and Systems Educational Program in Taiwan

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Abstract *— Different from the 1st-phase VLSI Circuits and Systems Educational Program that aimed at establishing the fundamental infrastructure for improving the teaching environment of VLSI circuits and systems design in Taiwan, the 2nd-phase educational program intends to integrate existing teaching materials and laboratories and focus on more advanced technology as well as broader scopes. The main goal is to cultivate a sufficiently large number of high-quality human resources in IC design. The 2nd-phase program adopts the top-down approach by running the program based on six technology-oriented, inter-collegiate consortia: the Advanced Technology (ADV) Consortium, the Digital Intellectual Property (DIP) Consortium, the Electronic Design Automation (EDA) Consortium, the Mixed Signal Design (MSD) Consortium, the Prototyping and Layout (P&L) Consortium, and the System-on-Chip (SOC) Consortium, among which the ADV Consortium acts as the coordinator as well as the monitor of the whole educational program. The tasks of each consortium consist of two major parts: (1) consortium administration (e.g., arranges regular meetings, evaluates and promotes on-going educational projects, etc), and (2) project execution (e.g., improves and promotes teaching materials, cultivates seed teachers, initiates academia-industry and international cooperation programs, etc). The new infrastructure has significantly enhanced the VLSI circuits and systems educational environment in Taiwan.*

Index Terms *— VLSI, Intellectual Property, Electronic Design Automation, Mixed Signal Design, Layout, Prototyping, System-on-Chip.*

INTRODUCTION

Integrated circuit (IC) design has become one of the fastest growing and captial intensive industry in Taiwan. According to a recent survey conducted by ITRI, Taiwan's world-wide market share in IC design was 28.4% (25.9%) in 2002 (2001), which makes Taiwan rank #2 world-wide in IC design industry [1]. In order to keep pace with the technology advancement of nanometer semiconductor manufacturing, the IC design and system-on-chip (SOC) techniques are evolving, leading to a strong demand from the industry for a large number of well-educated IC design engineers as well as supporting human resources in business, the humanities, and law.

To meet the strong demand, the Advisory Office of the Ministry of Education (MOE-AO) of Taiwan ROC has been running a VLSI circuits and systems educational program since 1996. The goal of the 1st-phase program, 1996--2001, lies mainly in establishing the fundamental IC design environments at the universities in Taiwan. Major tasks in this phase include setting up/upgrading IC design laboratories, improving IC design teaching materials, holding workshops for teaching experience exchange, and so on [2].

Different from the 1st-phase VLSI circuits and systems education program that aimed at establishing the fundamental infrastructure for improving the teaching environment of VLSI circuits and systems in Taiwan, the 2nd-phase educational program (2002—2005) intends to integrate existing teaching materials and laboratories and focus on more advanced technology as well as broader scopes [2, 3]. The main goal is to cultivate a sufficiently large number of high-quality human resources in IC design. Under the guidance of MOE-AO, the 2nd-phase program adopts the top-down approach by running the program based on six technology-oriented, inter-collegiate consortia: the Advanced Technology (ADV) Consortium, the Digital Intellectual Property (DIP) Consortium, the Electronic Design Automation (EDA) Consortium, the Mixed Signal Design (MSD) Consortium, the Prototyping and Layout (P&L) Consortium, and the System-on-Chip (SOC) Consortium, among which the ADV Consortium acts as the coordinator as well as the monitor of the whole educational program. (See

Figure 1 for the consortia.) The tasks of each consortium consist of two major parts: (1) consortium administration (e.g., arranges regular meetings, evaluates and promotes on-going educational projects, etc), and (2) project planning and monitoring (e.g., improves and promotes teaching materials, cultivates seed teachers, initiates academia-industry and international cooperation programs, etc).

The new infrastructure has significantly enhanced the VLSI circuits and systems educational environment in Taiwan. Through this program, we have established IC deisgn laboratories on more advanced technologies (such as system-on-chip [SOC] laboratories, radio-frequency IC design laboratories, communication IC design laboratories) in major universities, designed teaching materials on advanced IC design challenges (such as SOC design/testing, mixed-signal IC design/testing, physical design for nanometer ICs, embedded real-time systems), held conferences/workshops on technical training and experience exchange, run domestic and international contests on IC/IP design and EDA tool development, initiated the mechanism for the cooperation between academia and industry, promoted the activities for international exchange on VLSI design technology, and so on.

The remainder of this article is organized as follows. Section 2 describes the organization for executing the educational program and details the functionality and tasks of the six consortia. Section 3 reports the progress of this educational program, including the past, the present, and the future roadmap. Finally, concluding remarks are given in Section 4.

THE ORGANIZATION AND ITS TASKS

The organization for running the educational program consists of four levels; from top to bottom, they are MOE-AO, the ADV consortium, the other five consortia, and partner universities. MOE-AO defines the goal of the program and provides the funding for executing the program, the ADV consortium coordinates and monitors all consortia for the program execution, the other five consortia as well as the ADV consortium define the projects for the corresponding technical areas and monitor the partner universites for project execution, and the partner universities execute the projects assigned by the specific consortium. See Figure 2 for the organization for the educational program.

Among the four levels, the six consortia play the pivotal role in running the whole educational program. Therefore, there is also an independent Planning and Advisory Committee (PAC) for each consortium to define and guide the direction of the consortium and evaluate the progress of the projects. Each consortium is in charge of two major tasks: consortium administration and project planning/evaluation.

For consortium administration, the tasks for each consortium include the following:

- Establish the consortium office and its execution mechanism.
- Construct a web site to promote the educational program. For example, see http://www.ee.ntu.edu.tw/~vlsi for the whole educational program.
- Call quarterly working meetings to establish a channel for the experience exchange among partner universities and also evaluate/monitor the project execution.
- Call a PAC meeting every six months to plan the direction of the consortium and evaluate the related project progress.
- Compile monthly newletters.

Being a monitoring consortium, the ADV consortium has an additional task of calling quarterly joint consortia working meeting to coordinate all consortia to smooth project execution.

For project planning/evaluation, each consortium plans projects of the following aspects and assigns them to partner universities for execution:

- Design advanced course contents.
- Cultivate seed teachers.
- Hold VLSI design related workshops and forums.
- Plan short courses and talks.

The ADV consortium additionally has the following tasks:

- Design the VLSI design program for university stduents not majoring in electrical engineering or computer science.
- Design the VLSI related inter-disciplinary courses such as high-tech laws, science, technology and the humanities, and so on.
- Hold the inter-collegiate IC design related contests such as IC design contest, silicon IP design contest, and IC computer-aided design (CAD) contest.
- Hold the annual VLSI Design/CAD Symposium and related international conferences.
- Establish the mechanism for the cooperation between academia and industry.
- Promote the international academic exchange in VLSI design.

- Construct and maintain databases for VLSI courses and the human resources in academia.
- Hold an annual workshop on the execution of the educational program.

THE PROGRESS

The Past Year

In 2002, the Taiwan government allocated about 2.4 million US dollars for 66 projects of the VLSI Circuits and Systems Educational Program. There were about 60 professors from 30 universities involved in the program. The completed projects are summarized as follows:

- VLSI design program: Completed the IC design minor program for university students not majoring in electrical engineering or computer science.
- Course planning: Designed 19 new advanced courses on VLSI design (including VLSI related courses on the humanities) and four course modules (EDA testing, EDA verification, introduction to digital IP design, and special topics on DIP design).
- Conferences/workshops: Held 34 domestic conferences, forums, workshops, or short courses, and held the 2002 IEEE Asia-Pacific ASIC Conference. There were about five thousand attendees for these activities.
- Contests: Held the annual inter-collegiate IC design contest, silicon IP design contest, and IC/CAD contest. There were more than five hundred teams in total from more than 30 universities involving in these activities. In particular, the IC design contest included a division for international competitions (e.g., teams from Japan and Korea).
- Summer schools: Held an IC design summer school for graduate stduents and an EDA summer camp for undergraduate students. There were 60 students participating in these activities.
- Industry-academia cooperation: Established a mechanism for industry-academia cooperation, including joint projects between companies and professors, and students' summer intern programs. There were 15 professors and students involved.
- Technology forums: Held the testing forum, the EDA forum, and the IP forum. There were 119 professors attending the forums.
- International academic exchange: Invited renowed international scholars to deliver short courses/talks in Taiwan and held ACM and IEEE distinguished lectures. There were about 15 hundred attendees in total.

The Present Year

In this year, the government allocated about 3.7 million US dollars for this educational program. We have planned to allocate the funding for the three major categories: (1) 1.6 million US dollars for promoting designed courses, (2) 1.8 million US dollars for executing regular projects, and (3) 0.3 million US dollars for designing undergraduate-level courses on analog IC design.

In 2002, we completed the design of many advanced IC design courses and compiled the teaching materials for these courses. To promote these courses to other universities, we selected 12 core courses and called for offering at universities. Among the 99 applications, we approved 60 proposals for teaching these courses at more than 20 universities.

In addition to the 2002 projects, we add the following additional tasks in this year:

- VLSI design program: Add the VLSI minor program for university stduents majoring in management, law, business, and the humanities to cultivate the VLSI supporting human resources.
- Course design: Add courses on nanometer IC technology, embedded systems, etc. to keep pace with the technology advancement and promote SOC design.
- Contests: Add the annual inter-collegiate embedded software contest and expand the international IC design contest to invite more teams from Japan, Korea, and Australia.
- Technology forums: Add a Ph.D. forum for stduents to exchange their research ideas and experience.
- Databases: Construct and maintain the databases for VLSI courses and human resources to facilitate the access of information about VLSI courses and human resources.
- Newsletters: Issue monthly consortium newsletters to communicate and share information with people involved.
- Seed teachers: Cultivate seed teachers to extend the influence of the educational program.

The Future Years

The government has planned to allocate about 4.6 million US dollars for next year's educational program. We have tentatively budgeted the funding for five major categories: (1) 2.0 million US dollars for promoting designed courses, (2) 1.6 million US dollars for executing regular projects, (3) 0.4 million US dollars for designing undergraduate-level courses on analog IC design, (4) 0.2 million US dollars for sending seed teachers abroad to learn advanced technologies, and (5) 0.4 million US dollars for executing VLSI minor programs. We plan to increase the number of promotion courses and design more new courses (such as undergraduate-level EDA courses, embedded software for SOC design, nanometer electrical effects). See Figure 3 for the course planning roadmap for the 2nd-phase VLSI Circuits and Systems Educational Program.

Being a part of the national Si-soft project, an ambitious national project to further strengthen Taiwan 's IC design industry, the amount of government funding and the number of involved university faculty members are expected to increase steadily in the coming few years. The increases have paved a way to further enhancing the effectiveness of the educational program.

CONCLUDING REMARKS

We have presented the infrastructure for the current VLSI Circuits and Systems Educational Program in Taiwan. Though the technology-oriented, inter-collegiate consortia, we have developed a more effective methodology to improve the VLSI circuits and systems educational environment, promote educational materials, and more importantly cultivate a sufficiently large number of high-quality human resources in IC design to meet the industry demand. It is our belief that this educational program has been playing a very significant role in upgrading the capability of the research and development in IC deisgn in Taiwan.

ACKNOWLEDGEMENT

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[3] C.-W. Jen, "Multi-dimensional cultivation of human resources for the national Si-soft project (in Chinese)", slides, 2002.

FIGURES AND TABLAS

FIGURE. 1
THE SIX TECHNOLOGY-ORIENTED CONSORTIA.

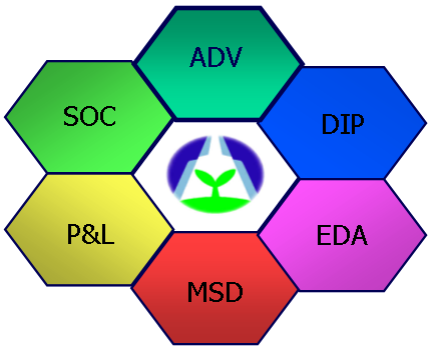

FIGURE. 2
THE ORGANIZATION FOR RUNNING THE EDUCATIONAL PROGRAM.

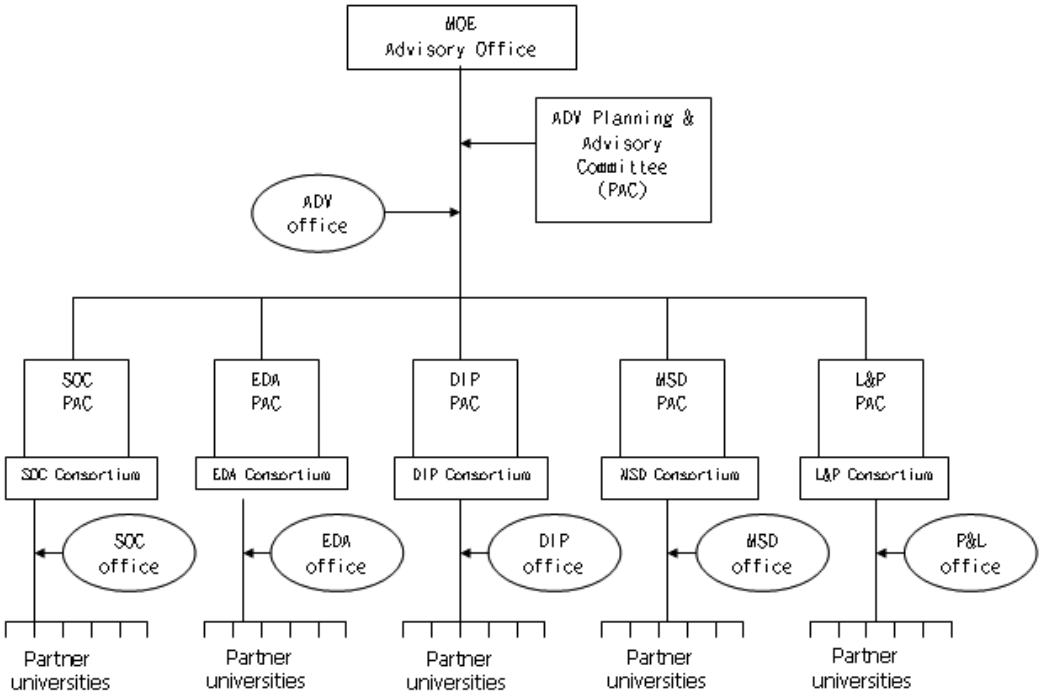

FIGURE. 3
ROADMAP FOR COURSE PLANNING.