Industry – University Based Curricula to Address Skill Needs in Microelectronics

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ABSTRACT: *This paper describes the industry based curricula that forms a key component in revitalising the microelectronics industry in Victoria, Australia. The program is a partnership between universities, industry and the State Government of Victoria to provide the skill needs of the microelectronics industry. The Master of Engineering (Microelectronic Engineering) course has a number of features that are unique amongst Australian coursework postgraduate programs. It has been developed and delivered cooperatively by partner universities in the inner Melbourne area. The program is comprehensively supported by industry in a range of ways, namely, by including it as part of their staff development activities, by funding student scholarships and placements, by assisting in the curriculum development and modification, by assisting in the curriculum delivery and assessment and by offering and supervising thesis and project work. The salient feature of the course is a Major Project, which is equivalent to one semester of full time study and undertaken by the student in partnership with the university and industry. A three-way process between industry, universities and the project candidates is implemented to bring together the best available team for a particular project. The "Non-disclosure Agreements" and IP issues are resolved and an agreement is seen and signed by all parties before the commencement of the project. Industry based project has resulted in the following outcomes: immediate relevance to the industry; improved probability of a commercially relevant outcome; better and improved student employability; safe and positive recruitment process; strengthened industry-academia networking; improved usage of the university-industry infrastructure; increase in university-industry R&D collaboration and friendly university-industry Intellectual Property Agreements.*

1 INTRODUCTION

Microelectronics is a key enabling technology of the information society. The enabling character of microelectronics underpins the development of many sectors of the economy. This is nowhere more evident than in the impact of microelectronics on the Information Economy and its role as the driver of the Internet. The design and production of microchips is highly research intensive and requires skilled engineers, designers, software programmers and other technical skills. The microelectronics industry is therefore a key knowledge industry requiring highly skilled people.

There are several key characteristics that influence the development of the microelectronics industry [1]. The degree to which these are present in a community will influence ability of the local microelectronics community to prosper and grow over time. These characteristics are:

- the availability of skilled people;
- the presence of universities with education and research programs in microelectronics; and
- a cluster of microelectronics companies that can take advantages of the above characteristics.

Microelectronics companies will be attracted to a location if the first and second of these characteristics exist. The level of skill and training required is specialised and not readily found. Integrated Circuit (IC) design is an activity that is becoming increasingly mobile, and companies whose business it is to design integrated circuits and systems are prepared to establish operations where a pool of microchip design skills may be available

The growth in microelectronics industry is the result of changes in technology in which microelectronics is becoming increasingly important in shaping the development of many other industries, such as telecommunications, medical, IT, defence, agriculture, automotive, transportation, environment, biotechnology and manufacturing.

Microelectronics is a fast changing field of knowledge. The pressure to have products ready for the market is growing. In order to keep up, companies need access to well-trained people who are current in the latest technologies. Microelectronics companies therefore look to universities to carry out research and development tasks that will drive the future development of the industry.

2 MICROELECTRONICS INDUSTRY IN VICTORIA - AUSTRALIA

Ericsson, NEC, Agilent Technologies, Fujitsu, Bosch and Telstra have operated microelectronics design centres in Melbourne for a number of years. More recently, number of other companies, such as SemiTech, Bandspeed, Analog Devices, Calyptech, CEOS, Clarinox, Hydrix, Redcentre, Spangaro and Dynamic Hearing have also established local design centres. Further, Melbourne has recently become the location for the only large-scale microchip fabrication facility in Victoria, and only second in Australia. In December 2003 NEC announced that it would inject an additional A$70M in mobile telecommunication research and development. Companies such as Infineon and Motorola have also shown interest in establishing their microelectronics R&D centre in Victoria.

There are a few issues that need to be addressed in order to further develop the microelectronics cluster and develop Victoria as a Centre of Excellence in microelectronics in Australia. They are shortage of talent, the prohibitive cost of EDA tools, research and development, and the right venture capital environment.

The Victorian Government has had the foresight to recognise the need to support the growth of the microelectronics cluster in Victoria. It already provided funding to develop and implement postgraduate programs in Microelectronic Engineering, encouraged industry-university R&D collaboration and established network with the microelectronics industry in Victoria and overseas [2]. This goes a long way in addressing some of the issues highlighted above.

3 MASTER OF ENGINEERING - MICROELECTRONIC ENGINEERING

The Master of Engineering – Microelectronic Engineering course [3 - 4] has a number of features that are unique amongst Australian coursework postgraduate programs. Firstly, it has been developed cooperatively by staff of four universities in the inner Melbourne area - Victoria University, RMIT University, Latrobe University, and Swinburne University of Technology and is the first time that this level of cooperation has been attempted and achieved in an Australian context. The course is cooperatively delivered by two of the partner universities, namely Victoria University and RMIT University. This decision was based on the expertise available in these two universities. Even though the partnering universities are in within easy commutable distance to one another, the course delivery is programmed so that students do not have to travel to different university on the same day. This contrasts with programs such as Alba [5] and Socware [6] that tend to focus on one central point of delivery. It has the advantage of permitting the various universities to leverage their existing resources and support skills.

The students have access to high-end Electronic Design Automation (EDA) tools, such as Cadence, Synopsys, Mentor Graphics, etc used by industry. Their availability represents a major attraction to potential students.

The program is comprehensively supported by industry. Companies support the program in a range of ways – by including it as part of their staff development activities, by funding student scholarships and placements, by assisting in the curriculum development and modification, by assisting in the curriculum delivery and assessment and by offering and supervising thesis and project work. This level of direct industry involvement is not typical of coursework postgraduate programs in Australia.

3.1 Aims of the Course

The course aims to produce engineers with the necessary skills and practical experience to satisfy the requirements of the microelectronics industry. An important feature of the course is the opportunity it provides for the students to design their own integrated circuits and systems. This could be related to embedded systems design, digital design (FPGA/DSP/ASIC), mixed signal and system-on-chip systems design, RF and analog design, MEMS, fabrication, design for test and verification.

The specific aims of the course are to:

- develop integrated circuit design expertise in embedded systems design, digital design (FPGA/DSP/ASIC), mixed signal and system-on-chip systems design, RF and analog design, MEMS, fabrication, design for test and verification.
- develop a basic understanding of the fabrication process and the testing to the level needed by IC designers.
- develop the advanced technical and algorithmic skills necessary to master state of the art microelectronic technology;
- develop research skills necessary to obtain specialist knowledge of issues pertinent to integrated circuit design;
- cultivate logical and lateral thinking that leads to creation and innovation in the pursuit of solutions to engineering problems.

3.2 Course Structure and Entry Requirements

The course is structured to allow students to exit at different academic levels with either a Graduate Certificate, Graduate Diploma or Master of Engineering qualifications. The completion of a Graduate Certificate in Microelectronic Engineering requires successful completion of four units; the Graduate Diploma in Microelectronic Engineering requires successful completion of either eight units or six units and minor project, while the Master of Engineering in Microelectronic Engineering requires successful completion of either eight units and major project or ten units and minor project.

Admission to the course normally requires a four year Bachelor of Engineering degree in Electronic Engineering or Computer Engineering or Telecommunication Engineering or a four year Bachelor of Science (Honours) degree in an appropriate field, or an equivalent qualification.

Applicants with a three year Bachelor of Science degree (in appropriate field) or a Bachelor of Engineering degree in another field may also be considered for admission on the condition that they may be required to take additional (preliminary) subjects that will strengthen their knowledge and skills in digital systems, analog electronics and microprocessor systems.

Full-fee paying international students are required to have qualifications equivalent to those above, and in addition, they must provide evidence of proficiency in English Language; as assessed by: International English Language Testing - an overall band score of 6+, subject to individual profile.

3.3 Major Project

The salient feature of the course is a Major Project, which is equivalent to one semester of full time study and undertaken by the student in partnership with the university and industry. This time includes all aspects of preliminary research, consultation, design,, implementation, testing and reporting. A three-way process between industry, universities and the project candidates is implemented to bring together the best available team for a particular project. In the development of a project solution there are a number of parties that can legitimately claim partial rights to intellectual property (IP) generated by the project. There is also background IP that is owned by the involved parties. The projects are often “Commercial-in-Confidence” and subject to “Non-disclosure Agreements” by parties that need to know in order that the project progresses. The “Non-disclosure Agreements” and IP issues are resolved and an agreement is seen and signed by all parties before the commencement of the project.

Industry based project has resulted in the following outcomes: immediate relevance to the industry; improved probability of a commercially relevant outcome; better and improved student employability; safe and positive recruitment process; strengthened industry – academia networking; improved usage of the university - industry infrastructure and other resources; increase in university/industry R&D collaboration and friendly university – industry Intellectual Property Agreements.

All projects have a senior supervisor from one of the cooperating universities. The project supervising university is the one from which the student graduates. Supervisors are responsible for: providing advice and monitoring the project solution alternatives; monitoring progress; advising about reporting and assessment and providing a list for possible project examiners.

Each of the cooperating universities has in place regulations which apply to the assessment of the postgraduate course work qualifications with project reports. A typical project assessment include: an oral presentation, preferably public but subject to commercial non-disclosure conditions and a written report.

4 MAJOR PROJECT EXAMPLE - BLUETOOTH CHIPSET

This project involves the design and proof of concept of a Bluetooth chipset. Students would be expected to demonstrate mastery in chip design and implementation at a level considered no less than that of an experienced practitioner in the field. Students must demonstrate their ability to integrate and draw upon their coursework studies relevant to the project.

This project is undertaken in partnership with one of the local company (SME) that provides cost effective and innovative embedded systems and Bluetooth technology solutions to business, including both hardware design and software development. The company also specialises in processor and real time operating systems. The project includes design and verification of:

- Baseband components;
- Mixed Signal components; and
- RF Transceiver.

The entire project involves 10 students, with the majority of the students working in the baseband and RF sections and two students working in the mixed signal area. Students work as a team. This encourages the development of team work culture in the student, which is essential in large project. Figure 1 represents the building blocks required for the baseband section of the project.

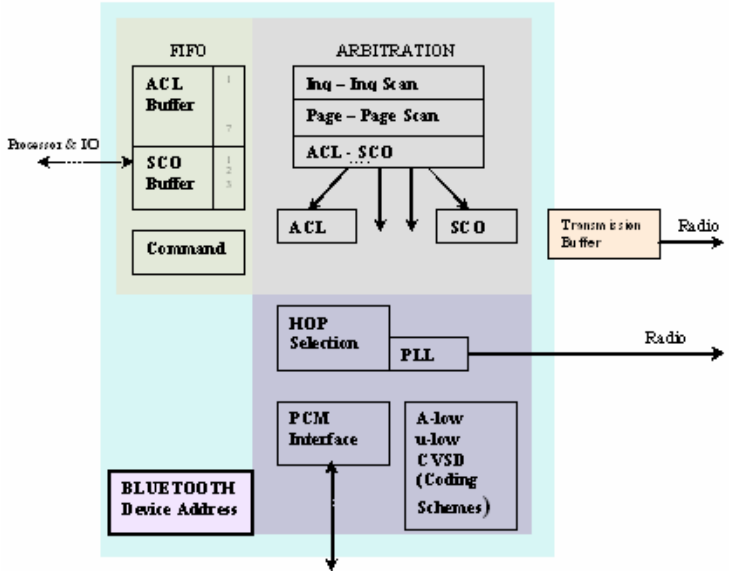

Figure 1. Baseband components for the Bluetooth Chipset

The project is supervised by staff from Victoria University and the partner company. This involves entire project management; advice and monitoring the project solution alternatives; monitoring progress; advising about reporting and assessment.

The "Non-disclosure Agreements" and the Intellectual Property were agreed and signed by all the parties involved in the project to legally protect the commercial interest of the project source. Upon successful completion of this project, students should have:

- Gained mastery in integrated circuit/system design and implementation.
- Enhanced their expertise in the specialist area of microelectronic engineering.
- Broadened their expertise in related areas.
- Developed experience in communication and presentation skills.
- Gained experience in project management, creativity and innovations.
- Developed theoretical knowledge, practical skills and analytical ability to undertake further research studies.
- Have carried out significant tasks designed to improve desired generic skills and attributes.

At the end of the project students will submit a dissertation to be examined by two examiners selected by the examining panel for this module. Final assessment is based on project proposal (10%), progress report and seminars (10%), project (40%) and final report (40%).

5 PROPOSED NEW STRUCTURE

There has been a request by the industry partners for longer project time. This will result in the course duration being extended from 1.5 years to 2 years thus enabling students to spend 1.5 to 2 Semesters on the major project. The proposed structure is presented in Figure 2. Discussions are continuing with the university partners, industry and government to finalise the course structure and units. It is planned that the new course structure will be effective from 2005. The new structure will enable students with exit at different points with either Graduate Certificate (1 Semester), or Graduate Diploma (2 Semesters), or Master of Engineering Science (3 Semesters), or Master of Engineering (4 Semesters).

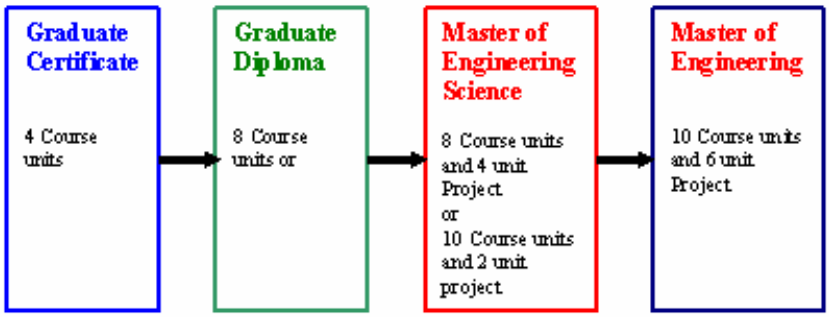

Figure 2. Proposed Course Structure

6 CONCLUSION

Unique partnership between universities, industry and government is established to provide the skill needs of the microelectronics industry and thus support the Government's economic strategy to attract the semiconductor industry to Victoria, Australia.

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While the postgraduate programs in microelectronics will stimulate a supply of engineers with high level microelectronic design skills, the programs represent a long-term solution to industry skill needs. Industry can't always wait eighteen months to get a graduate with new skills, and, smaller companies particularly, can't always afford to travel to relevant training courses and workshops overseas. Government, industry and universities engaged in microelectronics are also trying to address the short term needs through development and delivery of professional development courses.

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