Curriculum Development and Progressive Engineering Practice Design in Embed System Education

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***Abstract*-the development of courses system for embed system and the exploration of realistic embedded systems design experience for students are described in the paper. The design pay more attention on developing students's professional skills that will serve students well in their careers besides the requisite related basic theory. The curriculum design is shaped into two technology courses mainstreams, one is for universal processors system and the other focus on system on programmable chip (SOPC).a novel schedule of embedded systems education with professional engineering practice and progressive cooperative experiential learning is putted forward. The effect of the schedule from lecturers' response and student's assessment comments show that it iseffective to develop the student's engineering practice, teamwork and active-learning skills.**

Key words embeded system curriculum, course design, Professional engineering practice, progressive experience.

I. Introduction

Embeded computer systems are quietly changing our world and are used in a diverse range of products, including the automobiles, home appliances and medical equipment. More recently, wireless communication capabilities have greatly expanded the embedded applications space The role of embedded systems will become more and more prominent in every aspect of technology and life[3]. The students will be well equipped for the further learning and development or future careers, if they grasp the common embedded systems components, embedded systems design, and embedded system functions, such as data acquisition, processing, and delivery. So we should pay attention on how to development the proper education method for embeded system.

The methods of embedded systems education are varied with the learning motivation, teaching objective, design experience and even the knowledge background of student's. One of the customary way is to incorporate embedded systems modules into several courses in the computer science , information engineering, computer engineering, and electrical engineering curricula [2]. For example, requirements analysis and specification design for embedded systems is the part of content of software engineering course; real-time systems and scheduling are disscuised in operating systems course, and then made the student team to develop the integrated embedded system projects, embedded systems concepts and general design method is acquired by practice project of some coureses, which means "learning by doing". But usually such projects are limited the application-specific use of embedded systems within a particular field, which mostly made student specify, design, and implement their own designs. So this situation simulates basic professional engineering practice, and the experience very likely is the student's first exposure to the design process . Moreover, the successes of this teaching & learning processes require careful and resource intensive supervision, for example, pretty enough faculty resources and structured laboratory experiences (each student or group of students perform rigid and contrived experiments) etc. Otherwise, The method would do little to develop student design and project management skills. A systematic and progressive approach is presented in the paper, which combines the theoretic and practice learning &teaching.process.

II. Development of courses system for embed system

A novel schedule of embedded systems education with professional engineering practice and progressive experiential learning is putted forward. The design pay more attention on developing students's professional skills that will serve students well in their careers besides the requisite related basic theory. One of an important learning goals are to expose the student to a realistic embedded systems design environment and to develop the student's teamwork and lifelong learning skills base on the solide and broad founderation. The program relies on a core curriculum shared with the

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computer & electronic engineering program. It consists of introductory courses in programming, circuit principle, digital circuit foundation, formal methods, comparative programming languages, and computer architecture. second-tier courses such as operating systems, networks, embedded software, and digital

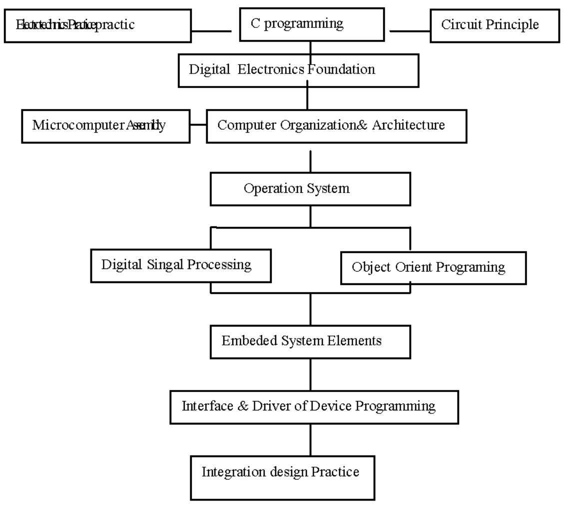

figure 1. courses schedule for universal processors system

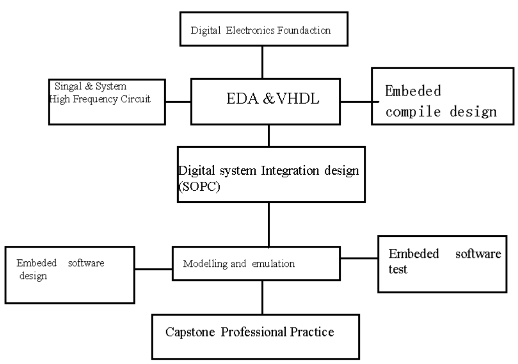

Figure2. courses schedule for SOPC

system design are provided, as well as a comprehensive integration design course that takes a product idea from concept to prototype. The curriculum design is shaped into two technology courses mainstreams, one is for universal processors system (show in figure 1) which is prepare for a grasping basic related theory and technology of general processors, and the other focus on system on programmable chip (SOPC) (shown in figure 2), which systemly offers the all-round understanding of the design on engineering specific-purpose embded system . It provides students an access to application what they have learned and their skills to the products that will appear on the market two or three years after they graduate.

The embedded software, digital circuit design, and integration design courses show the computer character of the engineering program. They integrate software and hardware design skills and prepare students to build modern digital systems from start to end. In the embedded software design course, students learn to use microcontrollers and their interfaces effectively to build systems that control physical devices.The digital design courses teaches them to program algorithms into hardware. The students in our embedded software design and embedded software tests courses have finished computer architecture and digital circuit design courses, and also have studied operating systems.These courses make the students further step into the design issues that characterize embedded systems. These include constrained resources, such as limited memory space, I/O, and CPU frequency; the absence of an operating system to handle low-level tasks such as interrupts and peripheral device interfaces; and a variety of protocols for communication between components. Furthermore, embedded systems often require a debugging tool set different from that of the full scale systems familiar to our students. Through prerequisite courses on C Programming, digital electronic foundation design, and computer organization & architecture, students have a solid understanding of how the hardware works and how to build efficient data structures for their algorithms. This gives them the foundation they need to write software at the low level required by embedded systems. The students build on these prerequisites with a hands-on project that is designed to lead them through the process of applying what they already know while making them face the new issues that arise with embedded systems. After students finish the class, they should be comfortable writing code that directly manipulates I/O registers and establishes communications between multiple devices. They should also understand how interrupts work and how to handle them as well as how to interpret the datasheet of whatever chip they decide to work with in the future.

Since the portion of software is getting larger and larger than hardware, it is natural that software engineers play more and more important roles in management of system-level designand integration. To supply qualified software engineers, a series of courses about hardware drivers and related softwares design and test on embedded systems are offered, Includeing FPGA design, board-level hardware design, microprocessor-based embedded system and system software design. Actual prototype implementations are mandatory in these courses.

In the later progressive courses, which consist of comprehensive professional integrative practice, the students could apply all their skills to a product that is made similar to those which industry engineers are currently working on.

III. Design for progressive practice

It is found that courses assignment or single design experience is often not very sufficient for students to develop design skill, engineering practice quality, self-learning ability, communication and team wok skills, So a series of progressive (varied from low level to high level) engineering experience or project should be designed and offered to students. From the beginning, students are required to practice following given examples, which in some extent is a cognitive leaning process. By the process students can experience and have a better knowledge about gengral embeded system concepts, design compontents, subsytems and design procedures. The aim of the secound stage is to prepare students with effective use exisiting workbench, platform and tools for embeded system design, development and research, and students can grasp how to design, build and troubleshoot an embeded system by exisiting tools or components based on progressive design and devepolment specification. For example, students can experience and have a better understand of the principle of interrupt, timer, RS232 communication, A/D transition, I/O device drivers and Flash-programming after they have gotten familiar with the integrated development environment of embeded system, repertoire and assemble language for embeded system by having experiencing first stage elementary practice project. After having completed several design tasks described above, students have confidence in their hardware and software design skills, and some students show stronger desire for additional hardware design experience, and even prefer to building their own “intelligent robots”. Moreover, as shown in figure3, typically the design of embeded system is the combination of harware design and software design and qualified software engineers are often in charge of system architecture design, system software design and many hardware-related issues. So the integrated, practical, and problem-solved embeded systems design experience are needed for students.

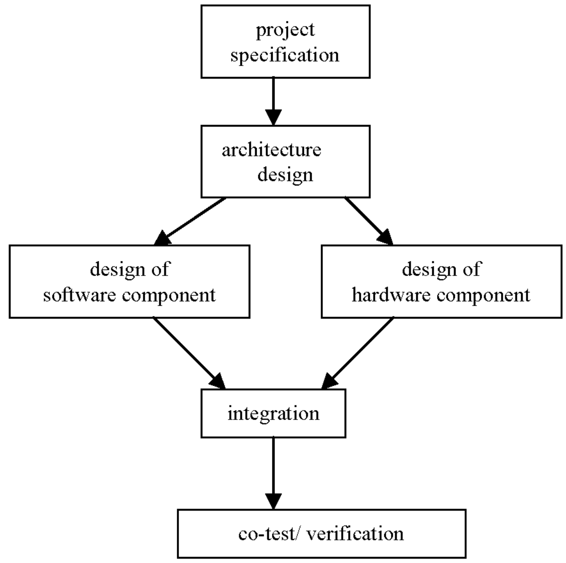

Figure3. the experience of embeded system project

Furthermore, nowadays more and more embedded systems are equipped with fully-functional operating systems, multi-media applications, communication protocols, and so on, on the other hand wireless communication capabilities have greatly expanded the embedded applications space, leading to new system paradigms such as sensor networks. Educational excellence requires exposing students to the current edge of research[10]. To ensure that student projects are along the same direction and trajectory that the industry is traveling, we should continually introduce emerging techniques, practices, and applications into the curriculum. For example, wireless sensor networks technology can be integrated in an undergraduate embedded systems course, which exposes students to an important emerging technology in the core of the our major curriculum. Other efforts including introduction students to some important application areas have focused on using important emerging technology in capstone project courses, which offer senior students challenges to apply their acquired knowledge and skills to a final project. The comprehensive projects are design to integrate the theory and practice of emerging techniques (such as wireless sensor networks etc.) into the mainstream curriculum early enough to form a basis for all students’ understanding of embedded computing—not just a short-lived application exercise for some capstone design projects.

IV.Integrated and realistic professional engineering experience

Usually experiential learning that student involved is classified into two categories: “simulated” and “authentic” [5]. Simulated experiential learning contains carefully guided learning activities in order to create a specific learning outcome. Authentic experiential learning often made the student engaged in completely open-ended learning and sometimes with limited guidance. engineering practice should paly a more important role in embeded system education. High level synthesis engineering experiential learning is necessary for students, and the students complete designs within strict hardware design and embeded software programming conventions which are similar to those on which industry engineers and rearchers are currently working on. So comprehensive integration design projects should be chosen from industry, university-sponsored research, or other practical application environment. As students practice problem solving, project management, teamwork, and design skills, their confidence and interest in their project, learning and profession grows. Design activities with solutions that require multiple points of view emulate the problems faced by professionals and engineers. Working in teams is helpful for building cooperation, leadership, and communication skills which is necessary in student’s fucture work. A cooperative, practical and structured embedded systems design experience was needed in embeded system education. On the other hand, the realistic design experiential should be progressive, requiring each successive subsystem to be incorporated without disturbing previously completed subsystems. Furthermore, the design experience is based on a problem-based learning approach that motivates student learning and develops skills required by the student in a future professional capacity. These procedure include designing to specification, use of third-party intellectual & technology products, teamwork, communication, and self-learning and self–professional-improving skills. The design experience can be offered in conjunction with lectures using active learning techniques. Design software tools include“industrial-strength” features such as real-time, in-circuit debugging and field programmability, and students will be trained to conform to corporate design practices, such as design and coding conventions. For instance, hardware design conventions include specific rules on integrated circuit placement on breadboards, wiring color conventions, and limitations on wiring resistances, loading capacitances and so on; programming conventions require develpoers to follow specific variable, subroutine, macro, and library naming rules, moreover, the memory usage is strictly specified, and all code written is to be as independent of hardware, memory, peripheral, and frequency as possible. Our investgation showed employers hiring recent graduates complaind that new engineering graduates do not know or understand abiding by corporate design and code convention . Obviously, the experience should be created, in part, to give students exposure to strict design specifications and the need to follow them faithfully, which is one of the most popular request for a engineering project development. Responces from Students showed that the students would get used to follow the aboved hardware&software design and programming conventions after exercised with integrated and realistic professional engineering projects. Furthermore, these experience is very helpful for engineering students to improve teamwork and communication skills, and students have opportunities to practice such workplace social skills as conflict resolution, interpersonal skills which are exercised further with cooperative work and active-learning on projects. Survey shown that more than 86% of investigated students had enthusiam for this kind of learning mode.

V. Conclusion

In order to meet the current and future needs for embedded systems engineers, a novel schedule of embedded systems education with professional engineering practice and progressive experiential learning is putted forward. The design pay more attention on developing students’s professional skills that will serve students well in their careers besides the requisite related basic theory. To ensure that student projects are along the same direction and trajectory that the technology and industry is progressing, educators must continually introduce emerging techniques, practices, and applications into the curriculum. the paper describe the development of courses system for embed system and an embedded systems design experience that emulates industrial situations as much as possible. The experience is made more realistic by a progressive design specification, design conventions and tools like those used in industry, and multiperson design teams. The test result of the schedule from lecturers’ response and student’s assessment comments show that it can increase engagement enthusiasm and perceivable relevance of the what they experienced which also helpful to develop the student’s teamwork and self-learning skills through team work and problem-based learning.

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