CORNERSTONE CONCEIVE FOR ELECTRONIC ENGINEERING FRESHER - EXPERIENCE WITH CDIO INNOVATION AND PROJECT

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Abstract
According to CDIO requirements, students should be trained to grasp abilities in technical knowledge and reasoning; personal and professional skills as well as attitudes; interpersonal, teamwork and communication skills; conceiving, designing, implementing and operating systems in enterprise and societal context. It's essential to begin the training when student is a freshman, which is of particular importance in China as the exam-oriented education in China makes students feel at a loss as there's nobody telling them how to make a plan for college study, what's the purpose of the curriculum significance, and how to begin studies. This paper illustrates an ongoing project, Cornerstone, in Electronic and Information Engineering (EIE) Department, Shantou University for freshman directed by the concept of CDIO. In the beginning of the project we introduce the intensions and ideas of CDIO and how syllabus is designed accordingly to fresh students to give them a clear picture of professional courses and CDIO practices in their upcoming studies. After that, we provide them a road map of engineering studies by analyzing a particular electronic device to illustrate the connection between this product to professional courses. We also offer them visit to electronic production enterprise and invite its leader to give them a speech to show what requirements modern enterprises need from engineers. Finally, we divide students into groups to conceive and design an actual electronic system themselves. As students do not begin their professional courses yet, the purpose of this project is to train their abilities of conceiving (C) and designing (D). We plan to carry out implementing (I) and operating (O) training gradually according to courses procedure to complete full CDIO trainings for students.

Keywords: CDIO, Cornerstone, curriculum plan, project plan

Introduction

Global economy brings opportunities and challenges for every country, especially encourages technology playing a more and more important role in social and economic development. The essential point determining growth and levels of technology is engineer trainings, which motivates everyone especially developed countries to devote great efforts in engineering education reform. This kind of trying in College of Engineering in Shantou University can be dated back 10 years ago. Before 2005 we reformed our professional courses along with public courses reforms in Shantou University according to curriculums in international and domestic institutions such as MIT as well as recommendations and examples given by China's Professional Committee. In this reform we reduced class time, expanded the scope of professional knowledge, targeted at self-learning and wide-caliber talents. In 2005, CDIO concept was introduced in our college. We realized except for strengthening scientific basis, more emphasis should be placed on students' personal abilities, capabilities of teamwork,

adaptation and control. CDIO is such an effective way to achieve these goals. It is adopted because its idea is an inheritance and development of the concept of educational reform of industrial countries in 1990's. More importantly, it provides teaching programs and assessment criteria according to ability training, which makes it exercisable. We believe our practice on CDIO engineering education will be achieved substantive results.

Through cooperating and communicating with industry, we realized the soul of engineering practice is design because requirements and restrictions of functions, technology, economy, society and even history are reflected in the procedure of engineering design. Based on this understanding, we established design-directed learning and ability-oriented training on CDIO pattern. Undergraduate courses are integrated as a whole through design projects. All the points students required to study and master are focused on these design projects, and they become part of the projects themselves. Therefore, we developed Project Level One (PL1), Project Level Two (PL2) and Project Level Three (PL3) of different scopes in teaching program. PL1 includes core courses and projects; PL2 includes groups of relevant courses and projects; PL3 is designed for individual course to enhance students' understanding and ability of this course, whether it is carried out and how to carry out depends on each course's teaching program. Through this way, we connect the whole teaching points.

Among this three-layer project, PL1 is considered the most important as it runs ad-jointly through the entire undergraduate teaching, gives students complete and systematic training for conceiving, design, implementation, operation.

The rest of this paper is organized as follows. We first introduces framework of CDIO courses in EIE Department; then we focus on Cornerstone, the ongoing project in PL1 to illustrate how it is carried out.

1. Framework of CDIO courses

Not only because EIE Department has the largest number of students in College of Engineering, but also as electronic and information technologies develop rapidly, how to help students keep on the main line of the project to meet capacity requirements of CDIO is a big challenge. To achieve the goal, we develop a fishbone diagram as Fig. 1 shows.

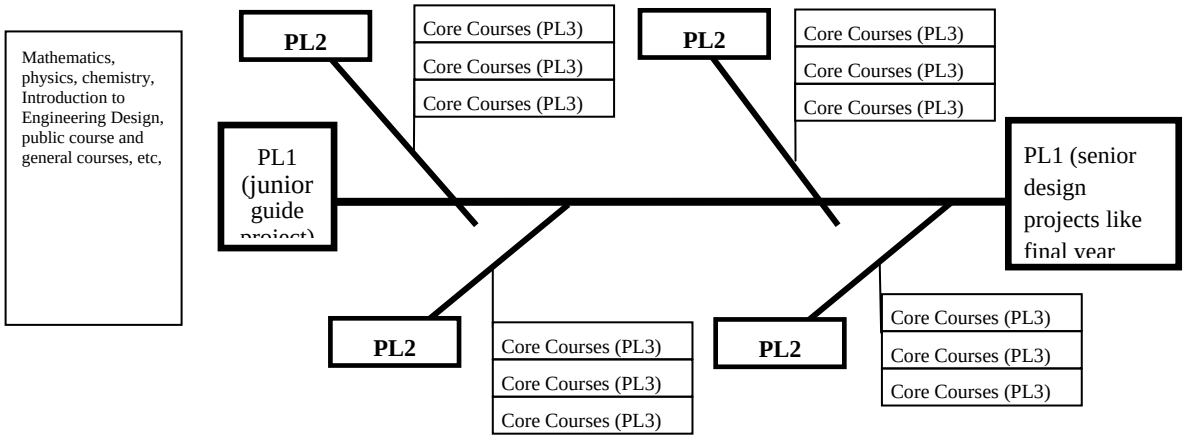

Figure 1. Fishbone diagram of CDIO courses in EIE Department

Known from Fig. 1, we require freshmen acquire a good knowledge of basic science like mathematics, physics, chemistry because we believe sense of scientific quality and life-long learning ability won't be possible unless they possess a solid foundation of scientific knowledge. These fundamental courses prepare them for their next step in engineering studies, based on which we continue our teaching leading by project design.

First of all, we build professional teaching on base of core courses, and focus on implementing PL3 in class. Students are encouraged to have a deeper understanding of these courses through PL3 projects training.

After that, we establish PL2 grouped by a series of courses. Every project in PL2 is designed to cover all courses in the group to give students a comprehensive training.

The most important and core part of the fishbone diagram is PL1, as shown in Fig. 2.

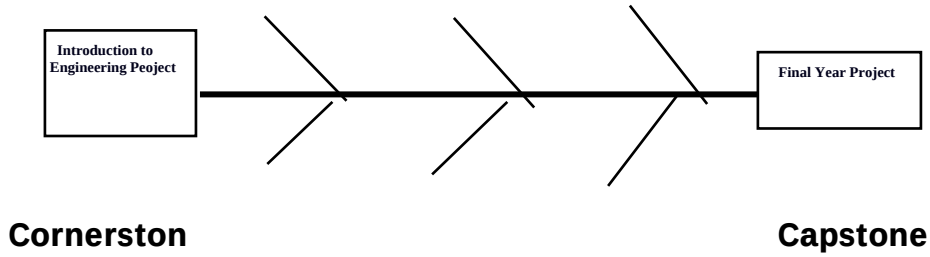

Figure 2. PL1 in the fishbone diagram

PL1 is a complete, ad-joint project throughout the whole undergraduate teaching, aiming at overall training of conceiving, design, implementation and operation. It is composed of two parts: Cornerstone and Capstone. Cornerstone usually is carried out at grade one to three, mainly for freshmen. After providing freshmen basic idea of CDIO, teachers analyze a particular electronic device to illustrate its structure, design thoughts and connections between this device to the professional courses, from which freshmen learn how to organize each course and practice study in their future years as an engineer. Then students are divided into groups to design an actual electronic system for their first time to inspire their creativity and systematic view as early as possible. Capstone includes final year project. This one is connected to the Cornerstone, requiring students complete their CDIO product projects by what they learn these years. From above description, PL1 project as a whole is to inspire students' interests for engineering problem and grasp ways of finding solutions. This paper mainly introduces Cornerstone part in EIE, College of Engineering, Shantou University. Details are given in the following sections.

2. Learning CDIO and courses structure

At the very beginning of Cornerstone, teacher introduces ideas of CDIO to freshmen before their professional studies. First the CDIO teaching program is introduced to make them aware of four-level ability an engineering undergraduate student supposed to capture. Those are engineering basic knowledge, individual ability, teamwork and engineering systematic ability. Freshmen are required to set targets for these levels accordingly. Although the first level, engineering basic knowledge, only includes basic science knowledge, core engineering knowledge and senior engineering knowledge, they are very important to 14 items of 70 points specified in the other three levels. We make students understood these requirements are of considerable thoughts, they reference to the requirements in industry, like Boeing's quality requirements, and EC2000 standards of ABET. The concept of CDIO not only is a continuation

and development of engineering education reform of industry countries in the past decades, but also proposes systematic training, overall guidance including training plan, teaching method, student assessment and learning framework, as well as 12 standards of testing the implementation. Teachers also explain content of CDIO teaching program and plan to freshmen to make them have a clear picture of future professional courses and CDIO practices; understand the importance of developing individual and teamwork ability, especially the project organization, design, developing and implementation ability, as well as strong communication and cooperation skills. We inspire students sense of innovation, spirit of partnership and ability of linking theory with practice through various case studies in classes.

As Chinese students are shy in nature, we propose well designed CDIO topics for group discussion regularly. Every student is required to put forward his or her own understanding and opinion. Through this way freshmen learn their first lesson how to communicate in a team, overcome difficulties in expressing themselves, which establish a good foundation for their future teamwork required in project design.

3. Analysis of Electronic Products, Understand the connotation of professional courses

In the second part of Cornerstone, we aim to show students correlations between professional courses and product. Fig.3 illustrates a pulsed Doppler ultrasound medical device as an example, from which freshmen learn what is the actual product structure and its design ideas. Thus they are capable of planning future studies and practice in view point of a product system, as a consequence, know how organize each course and practice study in their future years as an engineer.

Known from Fig.3, the very front part of ultrasound sensor relates to basis of scientific knowledge such as mathematics, physics and chemistry; the following amplifier, receiver, signal generator, power amplifier and detector are related to circuit principle, analog electronics, digital circuits, high-frequency electronic technology, etc; computer control, A/D converters, pulse width, sample control and so on involve principle of computer interfaces, application and principle of Single Chip Micyoco, embedded systems; ultrasound signal processing and image processing deals with signals and systems, digital signal processing, adaptive signal, digital image processing, stochastic signal processing. Through this way, freshmen have a deeper understanding of professional course.

We also offer them visit internship to electronic production enterprises to have some idea of manufacturing process and the functioning of the modern enterprise. In the end of the visit we invite the leader of the enterprise to give them a speech to show what requirements modern enterprises need for engineers, which makes them capable of planning studies in a systematic way.

4. Creative ideas

To inspire their creativity as early as possible, we divide students into groups to conceive and design an actual electronic system themselves. To guarantee quality of the project, a detailed plan and requirements are formulated as shown in Fig.4. Each group is guided by an experienced teacher team who makes it sure that the next step won't be proceeded unless current one reaches the standards. As students do not begin their professional courses yet, the purpose of this project is to train their ability of conceiving. In the design stage, emphasis is on the blueprint diagram and system design. Training on D and I will be carried out along with their professional progress. During all the stages, students are required to go through lots of materials to improve the conceiving and design continuously to reach the final standards.

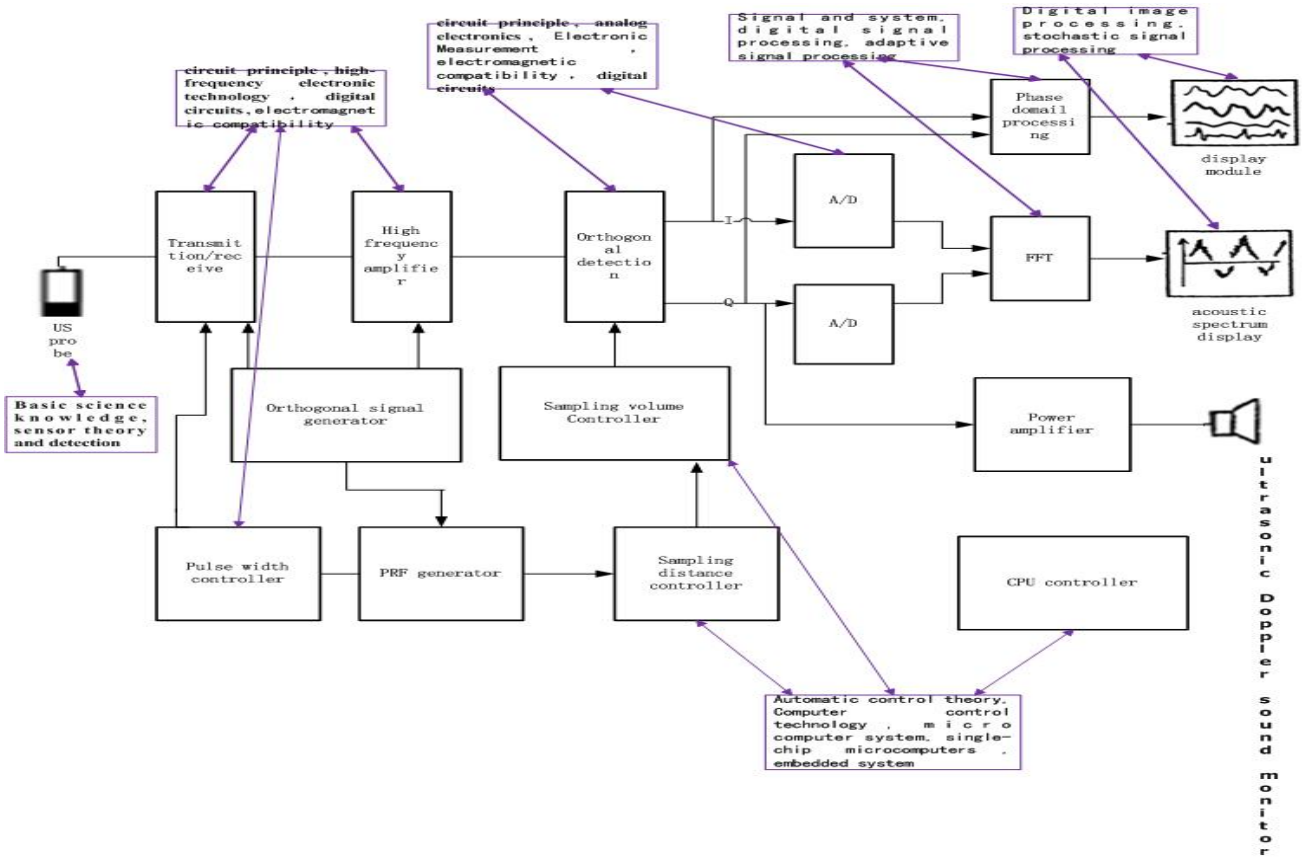

Figure 3. Relationship of ultrasound medical device with professional courses

In short, our students overcome some inherent shortcomings in China, improve their individual and teamwork ability, and the capability of creative thinking, which meet our expectations.

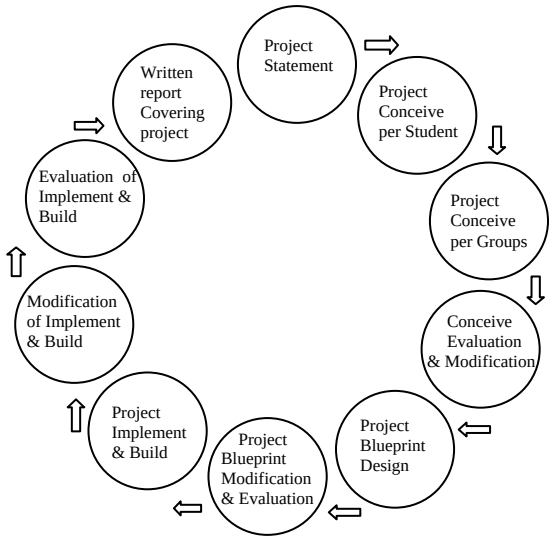

Figure 4, Procedure of Cornerstone

5. Conclusion

Due to the importance of PL1 project in CDIO teaching in EIE Department, especially the importance of Cornerstone who plays the role of linkage between past and future, we attach great importance to practice in the part of Cornerstone. During its procedure we keep on improve the modes of teaching and training in order to provide students continuously practice in conceiving, design, implementation and operation.

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