CDIO Practice in Telecommunication Engineering Program

Tianbao Wang
Chengdu University of Information Technology
Weidong Cheng
Chengdu University of Information Technology

ABSTRACT

A CDIO practice scheme for telecommunication engineering program is described in the paper. In order to cultivate talent engineer, an integrated adaptive curriculum, based on industrial real needs and CDIO syllabus, is developed for telecommunication engineering program. Unlike the traditional bottom-up method, the top-down method is used to develop the new curriculum according to CDIO syllabus. And the double tutor system, one from university and the other is engineer from industry, is developed to educate the student with the personalized education plan. The distinguished students are selected as tutor to help other students study. The problem-based, case-based and project-based teaching methods are adapted in the class and the multiple assessing methods are used in the examination. Three years practice shows that CDIO reform in telecommunication program has succeeded. Students are benefited from this reform and more and more teacher involved in.

KEYWORDS

CDIO practice, Engineering Education, Talent Cultivation

In China, teaching the discipline knowledge is always the core in traditional engineering education, and the education of professional morality and responsibility on society and environment are ignored, especially in the past ten years. Therefore there is huge gap between the requirements of modern enterprise on talent person and the actual ability of graduated student[1] [2] [3] [4]. Based on the profound studying of CDIO[1] philosophy of engineering education and our actual situation, a complete scheme of talent cultivating include aim of education, plan of cultivating, group of courses, practice and experiments system, methods and standard for examination and education quality control system in global competing and cooperating environment is conceived, designed, implemented and operated in telecommunication program. Investigation results show that the proposed scheme is suitable for our students. The rest part of this paper is organized as following:

1. RETHINK THE ENGINEERING EDUCATION

Based on CDIO engineering education and experiences of education reform, a new talent cultivating mode which is natural layered and personalized according to student's aptitude and interesting is developed: encouraging personal development, focus on the development of integrated quality and combined with conceive-design-implement-operate. By

combining the thoughts of education in accordance with students' aptitude with CDIO engineering education mode, we hope our students graduated with best professional morality, integrity and responsibility and always nurtured by humanity in our university.

According to the philosophy, syllabus and standard of CDIO, an integrated talent cultivating scheme is carefully developed based on requirements of knowledge, ability and quality for our graduated students. The proposed scheme is developed by applying the principle of layered education mode, personalized education plan, integrated education contents and multiple assessment standards.

First of all, the traditional talent cultivating mode targeted for imparting knowledge is transferred to the new talent cultivating mode targeted for developing the ability and quality of students by means of teaching knowledge.

We all know that the main purpose of traditional mode is to teaching student the specialized knowledge, however, the purpose of the new one is to educating student to meet the requirements of being an engineer, such as special technology, social knowledge and innovation spirits.

Second, the content of the new talent cultivating plan is targeted on the professional requirements of future engineer, guided by engineering design, layered by architecture of application system, functional modules and basic elements, focused on the students' personalized development.

Third, the old standard for evaluating talent cultivating plan, which is based on only one standard and one method for all student, is broken. We believe that every student will be success if they learn to learn, learn to be and learn to do [5] according to their interesting and aptitudes.

Fourth, in order to solve the problem that our teachers are lack of industrial experience, a dual tutors plan for student team, i.e. teacher in the university and the engineer outside the university, is proposed and carried out.

All students enrolled in telecommunication engineering program are divided into eight students each team by mutual selection and two tutors are assigned to the team. The member of each team can be regrouped after first year through mutual selection and then fixed in the next three years. In order to develop the abilities such as organization, administration and coordination etc., each member must be the team leader in turn during four years study. Team supervisor must develop the education plan for each team member and for the team and must keep the education records for both. The actual projects for the team are well implemented to develop students' CDIO ability.

Fifth, distinguished student selected as team's study tutor

Distinguished undergraduate students are selected as course studying group tutor for helping their classmates to study. Student tutors are best suiting for understanding what is difficult to understand for their peers and they also knew the best way for communicating with them.

2. CONSTRUCTING THE NEW INTEGRATED SCHEME FOR TALENT CULTIVATING

During the development of the new integrated talent cultivating scheme, the principles of personalized education plan, integrated contents and multiple assessment standards are complied with so as to realize the knowledge, ability and quality aims.

A natural layered and aptitude and interesting based personalized CDIO talent cultivating framework is developed by matching the professional role of engineer. Under this framework, course groups are organized from top down to bottom otherwise the bottom up method. In the bottom up method of organizing course groups, the basic knowledge is provided before the professional knowledge, and the micro one is studied before the macro one and local one is learned before the whole one. This results that the beginner does not know why he needs to study the course or the knowledge module and what are their usages. However, the method for organizing the course groups top-down is guided by actual engineering design and the whole systematic engineering concepts are considered first and then from macro to micro and from system to local and from the project related specialized knowledge to the corresponding fundamental knowledge.

As illustrated in figure 1 and 2, on the basis of detailed analysis of the professional requirements of electronic engineer, we developed three role-based match designs for system architecture, designers(include mixed signal circuit designer, RF circuit designer, integrated circuit designer and embedded software designer) and application engineer.

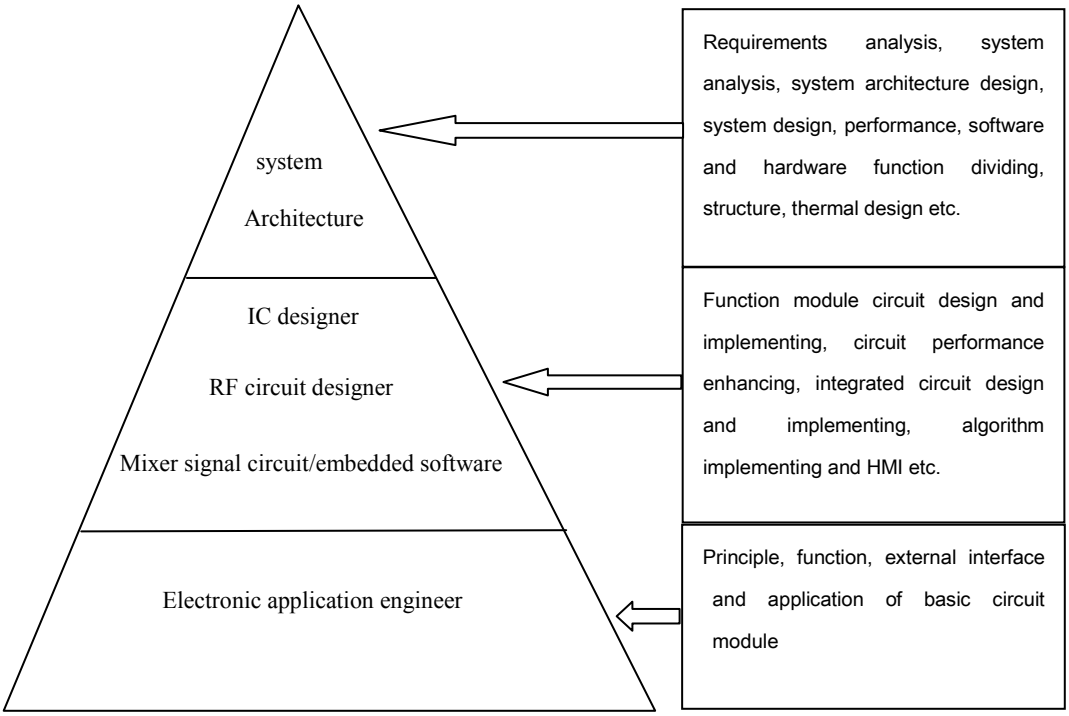

Figure 1 Basic requirements and match designs for role-based education

These three kinds of roles are the targets our students can archive after systematic learning step by step. All students start to learn from being an application engineer, and some of them may become designer gradually and few of them can become system architecture at last. The basic requirements of each role are consists of the knowledge needed, tools needed and skills needed. The knowledge needed consists of the fundamental knowledge module, the knowledge needed to study further and the advanced knowledge modules. All the modular knowledge modules are the core of these course groups.

On the basis of application engineer, students can select different designers related knowledge modules according to their aptitude and ability so as to form the role related personalized talent cultivating scheme and towards the target of becoming a designer. Meanwhile, students need to meet the requirements of the system architecture designer

through studying hard to be a system architecture designer when they are already the design engineer.

By using this method, individual education problem according to students' aptitude is effectively solved. In traditional class, we focus more on analyzing and computing techniques, and care more on the complete of theory and neglects to teaching the methods of thinking and the techniques of application of engineering. After reform, the classic contents and modern technology are balanced, when the basic theory is taught in the class and the method of thinking is also practiced in the same time.

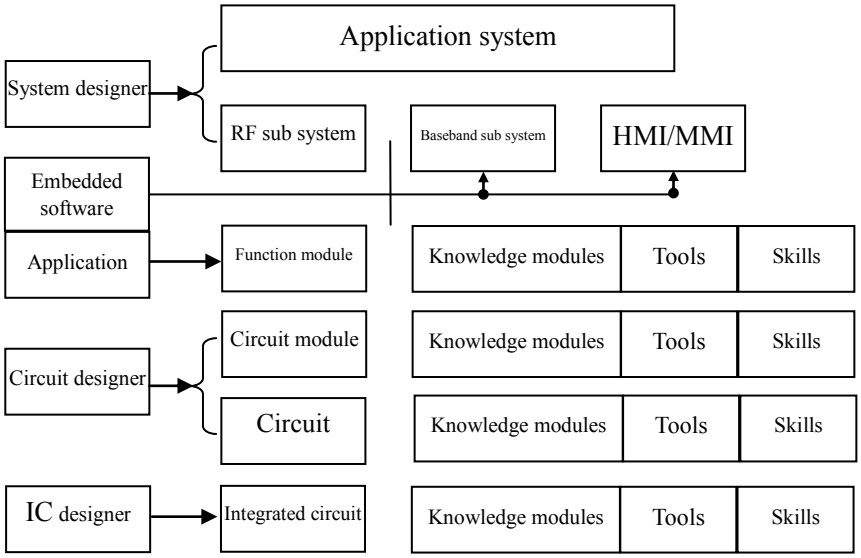

Figure 2 Requirements of knowledge module, tools and skills for role-based education and the related match design

3. IMPLEMENTING AND OPERATING THE PROPOSED SCHEME

During the reform of engineering education, we all think that in the content point of view there exists little difference between china and western countries. For example, to meet the requirements of ABET, all most all school in USA adjust the content of their course and their different features are reflected in their courses.

Although the target of educating the qualified engineer is very clear, the huge difference exists on how to educate student to have professional skills and qualities, philosophy of education, pedagogy and student's learning mode. The following problems are seriously considered and rethought: how to educate each student to be a talent when the difference exists? How to assess students' integrated ability? How to develop the quality assurance system of engineering education? How to cope with the relation of research and teaching? How to combine theory with practice effectively? How to cooperate with high integrity while competition exists? After deeply discussion and thinking, a specific implementation scheme is developed to answer these questions.

3.1. Reform of the curriculum system and optimization of curriculum content

In order to implement our scheme, we must reform our curriculum system and optimize the content of curriculum. The new curriculum system with one core, one guidance and three layers is proposed. One core means taking the role as the core. Three kinds of jobs are selected as the role that graduate student in telecommunication engineering may take, e.g. system architecture designer, designer(mixed signal circuit designer, RF circuit designer, integrated circuit designer and embedded software designer) and application engineer. One guidance means taking the engineer professional training as the guidance. The education of engineering basic knowledge, personal ability, communication skills, teamwork and ability of system engineering is carried out by combining with the comprehensive projects, the projects related with course group and the projects in the course in the form of eight students as a group. Three levels mean that the structure and contents of the curriculum are divided into "application system, functional modules and basic elements".

In figure 1 and 2, the reform approach of "one core, one guidance and three levels" is illustrated. In figure 3, how to optimize the content and structure of curriculum of electronic technology in telecommunication program is shown.

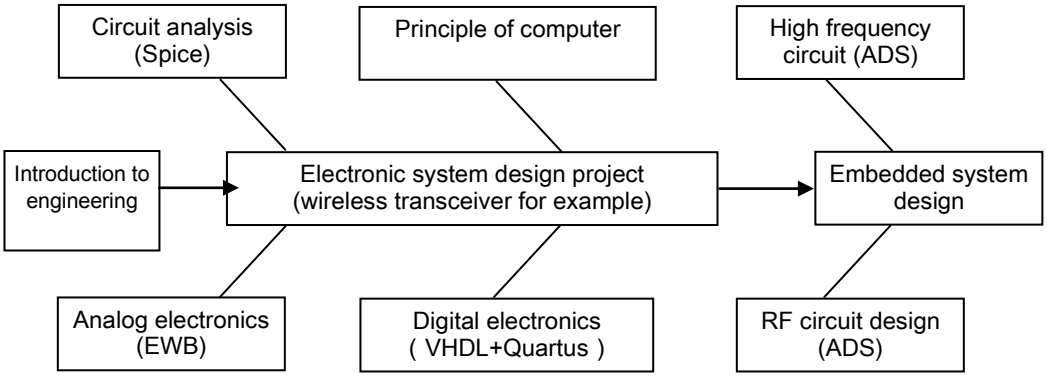

Figure 3 optimization example of electronic technology curriculum group

Electronic technology curriculum group consists of introduction to engineering, circuit analysis, analog electronics, digital electronics, high frequency circuit, principle of computer, fundamental of electronic design, advanced electronic design and embedded system design. All contents in the course are organized in application system and all students knew it is useful and is worth studying.

The content of introduction to engineering design is organized in the implementation example of control system, radar system and communication system from the system point of view. By using design methodology of top-down, systematic concept and the needed knowledge are introduced first and how a system is designed is described in detail. This led the student must learn with questions and must find the way to solve the problems. So, in this mode, teacher is only a guider or helper and student becomes the master.

As for each course, besides the ordinary requirements, more requirements such as course description, relation with other courses, audience of the course, content of the course, learning outcome and main pedagogy, credit hours needed, and examination are required to describe in detail in the course description.

3.2. Constructing an integrated practice structure

Although we attached great importance to the construction of the practice system, we still found that there has big gap compared with CDIO, all exist practice projects are developed independently and lack of system planning and system design. Two or more high level projects, cornerstone project and capstone project, are required in CDIO. Based on our pre-exist comprehensive design project which covers more than two course groups and the design projects in the course, three level design projects for student team are developed. The first level project covers the scope of majority core courses and is highly related with the telecommunication engineering program. The second level project covers a group of several core courses and the third level project is the in-course project, just for helping student deeply understanding the content of the course.

Two first level projects in which a complete system will be realized are carried out in whole four years study. Students will receive the systematic training through conceiving, designing, implementing and operating a project. In the cornerstone project, a ready product is used for student to disassemble and understand its principle of operation. This will arouse the curiosity of students and the redesign activity will demonstrate their innovative thinking and stimulate students to learn in their specialized subject. In figure 4, the components of the first level project of CDIO are listed.

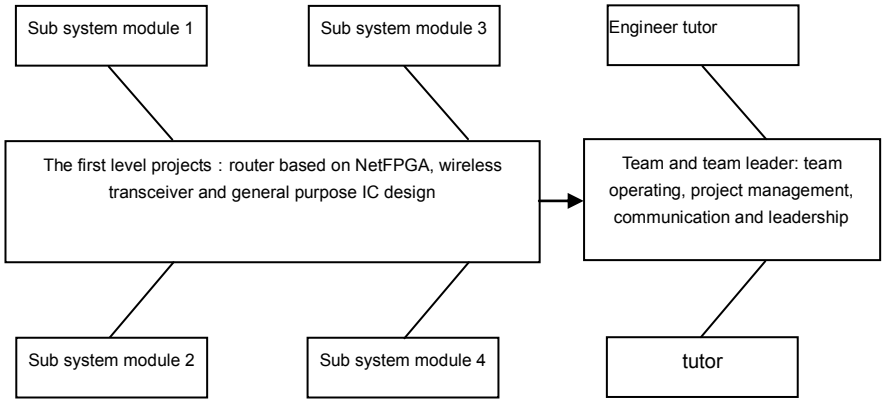

Figure 4 Diagram of component of CDIO first level project

The second level project based on the course group form the sub-system module of the first level project. The ability of using the related knowledge is trained and the ability of creative thinking is cultivated in the process of developing project. Four to six second level projects must be completed in the four years study.

The third level project is in course project and set up for further understanding the knowledge in the course.

The professional ability for future engineer is trained during the implementing of these projects in student team. Each team member will be the leader of the team once a time and the ability of leadership, management and communication skills are trained during the project development process.

In general, the proposed scheme of the talent cultivating has following differences compared with the old one.

(1) By introducing the introduction to engineering design course, all methods needed are taught and the interest of student to engineering is stimulated. The beauty of engineering is demonstrated in advance.

(2) The number of selective courses is decreased, the fundamental knowledge is emphasized, and the content between course and course group is optimized. The

contents and specific requirements for college math, physics, college English and physical exercise are provided clearly.

(3) Three levels practice projects are developed for training the professional ability of future engineer. All students experienced the development of the engineering and bridging the knowledge learning and the using of the knowledge.

3.3. Re-organizing the content of the textbook

The content of the textbook is re-organized in the form of the basic part and the enhanced part. In the basic part, we organize the content of course in the order of principle, performance, implementing method, typical circuit schematic, typical application environment, performance measuring and tools needed including software and instruments used. All students must study this part of knowledge. In the enhanced part, the extended knowledge, performance improving, the assessment method of practice education, the advancement of the cutting-edge technology and the materials for further reading are provided for the interested students.

3.4. Learning and teaching methods

All student-centered teaching methods are encouraged and project-based and problem-based teaching methods are practiced. It is essential for teacher to combine scientific problem with engineering practice problem to set the right problem needed to be solve by student. And the use of new technology which is good for teaching is encouraged also. Student should change the passive learning to active learning and find the way to solve the problem provided by teacher. Active learning includes cooperating learning, group discussing, debating and self designed experiments. Good learning habit is important for student and life-long learning habit for future engineer is most important. All students must learn to learn and be ready for life-long learning.

3.5. Examination reform

The assessment of learning outcome of student is very difficult. Examination can test students' knowledge in specific subject. However, it is hard to evaluate the ability of practicing, communicating and managing. The flexible and diversity test method must be found to assess learning outcomes. For example, communication skills are evaluated by writing, technique reporting, PowerPoint authoring and presentation. The integrated evaluation standard is under developing.

4. SUMMARY

An integrated adaptive curriculum, based on industrial real needs and CDIO syllabus, is developed in telecommunication engineering program. The contents of textbook are reorganized in top-down form. Three levels practice projects are well developed and two tutors scheme and student tutor scheme are carried out. A new teaching and learning quality control scheme is developed to ensure the quality of teaching and learning

outcomes. And the ability list which bachelor student should have is under constructing. Three years practice shows that CDIO practice in telecommunication program succeeded. More and more students benefited from this reform, more and more teachers involved in the CDIO reform to help student reach the aim of learning to learn, to know, to live together, to be[5].

5. REFERENCES

[1] Binling Gu, “Reform and development of higher engineering education in china”, Research on higher engineering education , 2004.5.

[2] Zheng Li and feng Lin, ”Trends of development of education of engineering, view from nature of engineering ” Research on higher engineering education , 2007.2

[3] The Engineer of 2020: Visions of Engineering in the New Century, Washington DC: The National Academies Press, 2004.

[4] Educating the Engineer of 2020: Adapting Engineering Education to the New Century, Washington DC: The National Academies Press, 2005.

[5] Jacques Delors, Learning: the treasure within: report to UNESCO of the International Commission on Education for the Twenty-first Century, UNESCO pub. 1996.

Biographical Information

Tianbao Wan is a Professor in School of Telecommunication Engineering at Chengdu University of Information Technology. His current research focuses on wireless sensor network, integrated circuit design, curriculum development for higher engineering education.

Weidong Cheng is a Professor in Institute of Higher Education at Chengdu University of Information Technology, Chengdu, China. His current research focuses on signal processing in wireless communication and evaluation methodology of learn outcomes.

Corresponding author

Tianbao Wang
Chengdu University of Information Technology
No.24 Section one, Xuefu Road, Southwest Airport Economic Development Zone
Chengdu, Sichuan, China. 610225
86-28-85966496
wangtianbao@cuit.edu.cn