Research and Practice of Engineering Practice Ability Strategies with Software Engineering Professional Education

Liu TieLiang and Wu XiuQin

***Abstract*—CDIO is the newest research result of international engineering education reform in recent years. This article will explore the new system of integration which about CDIO and engineering practice ability for software engineering professional education. Be aimed at the main problem that the engineering practice training mode with software engineering professional education for current students of university, it proposed the new software engineering professional engineering practice training strategy in several areas such as curriculum, training projects and team building based on CDIO philosophy, in addition, it practiced the training strategy, and achieved well results.**

***Index Terms*—CDIO, Engineering Education, Education Reform, Software engineering Professional Education**

I. Introduction

Since the Industrial Revolution, engineering and technical personnel has played a huge role in promoting of the national economic and technological progress. Whether it has a large number of the high-quality engineering talent has become the important factor of effecting national core competencies. In recent years, as a typical engineering academics, the software engineering professional education is being subjected to the thought of science has absolute predominance than engineering, it emphasizes theory study too much, doesn't attach importance to engineering practice and synthesis capability. It needs more to carry on innovating with education idea and reforming with teaching mode. How to foster a large quantity high talented engineering technical persons who can apply modern science theories and the technical means synthetically，understand the economy and management, and have the humanities and society knowledge, is realistic problem that college, especially the engineering college, need urgently to research and resolve. Although some universities are already aware of these problems and begin to take some measures for educational reform, but from the real goal of engineering education it is still a big gap. How to train the university students in the school environment to possess the ability of adapting, the society and the future work, is always a hard nut with educational reform.

CDIO denotes Conceive, Design, Implement and Operate, it is the newest research result of international engineering education reform in recent years, it not only inherits but also develops the idea of European and American engineering education reform more than twenty years [1]. Even more important, it proposed systematic ability cultivation, comprehensive implementation guide, complete implement process and rigorous inspection including twelve standards and has strong operability. The theory of "learning-by-doing" and "Item-Based educate and study" focus on summary and abstract expression with R&D and product operation as its carrier, so that students can learn in the way of active and practical courses which link to learn engineering[2]. CDIO philosophy is in line with our major of software engineering engineering practice on capacity-building for reform.

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II. The Status and Problems with the Engineering Practice Ability in Current Software Engineering Professional Education

China's current software engineering professional education model is still in a traditional subject-based professional education, this model train the students with more heavy theory of light practice, lack of team spirit and innovation consciousness. With the employment aspects of IT companies continue to mature and rational, they have formed the integrated requirements gradually for the professional skills, project experience and professional quality, and urgently require for fostering out software engineering professionals with modern software engineering environment for the survival and growth of lifelong learning ability, team cooperation and communication skills, operational capacity of large projects, this led to the disconnection between the education and social needs. At present, college software engineering professional education with the engineering practice ability exist the following questions:

A. Curriculum content is distributed, lack of engineering coherence between the courses

The software engineering specialty course has a strong practicality, however, in the existing training system it is divided simply according to the content of the course teaching units, the students have no clear realistic goals in the process of learning, and lack of landmark intermediate link. Conventional practice mode, such as computer experiment, curriculum design and training practice, is set in separately for specific teaching knowledge or specific courses practice target, and limited itself in fixed classroom theoretically, as the result, it results in the lack of consistency in practice process. In practice, either the goal or the content, the student is one-sided, and the system of practicing is not coherent, it is out of the question for gearing to the employment or for gearing to the practicing training.

B. Lack of the practical engineering training in the engineering education, be weak to practice

Engineering training is essential for higher engineering education, but in recent years, the practice teaching of many colleges is weakened in varying degrees, the proportion of experimental course is decreased, and the opportunity for the students to practice is reduced, these all make the engineering training could not reach the minimum requirements, and seriously effect quality of engineering education. Currently, it makes the engineering education become armchair strategist with these reasons, such as the engineering education is basically completed in school and does not contact the enterprise closely, curriculum design, graduate design escape from engineering physically, there is the tendency to heavy theory of light practice in the process of practice teaching, and so on.

C. Teachers lack of the experience and ability of engineering practice

Currently, the typical teachers for engineering education are lack of practice of engineering and production experience, and there is not much engineers with rich practical experience to teach in the university. Many teachers of engineering colleges mostly come from graduate student, and many of them walk up to the podium after graduation, directly become the student to the teacher. although these young teachers with higher academic qualifications and deep professional knowledge, because of scarcity with practice experience, they can not take the actual problem with the industry to enrich the course content, or quote from the engineering example to elaborate basic theory and principle while teaching professional lesson, these disadvantages against to improving the quality of engineering education.

III. BUILD THE ENGINEERING PRACTICE ABILITY STRATEGY FOR SOFTWARE ENGINEERING PROFESSION BASED ON CDIO CONCEPT

CDIO is the system of integrity, it is the quintessence of implementation with the project from the design to the engineer and the essence for engineer with comprehensive ability[3]. CDIO not only pays attention to the study of foundation knowledge with the students, but also more emphasize the applying capability, teamwork ability and the ability to adapt to large-scale system. This article will be aimed at the main problem that the engineering practice training mode with software engineering professional education for current students of university, it proposed the new software engineering professional engineering practice training strategy in several areas such as curriculum, training projects and team building based on CDIO philosophy.

A. Reform the content of curriculum, and relize the expansion from the classroom teaching to engineering

CDIO education model takes the industry demand as orientation, takes measures to synchronize the contents or methods of teaching with the industrial development, takes the training with qualifying the industrial development as the goal of engineering talent[4].In the process of reforming education based on CDIO philosophy, it proposes to take the ideas that "integration" or " integrated " to build the content and structure of curriculum, changes "Curriculum platter " for the integration of the engineering courses, to the question that college computer course content is distributed, lack of coherence in engineering. To the composition of the knowledge, not only emphasize the knowledge factor and unit, but also emphasize the correlation in the professional knowledge system.

For the content of course, we can build the modular curriculum which based on the enterprise actual duty construction, and form project-oriented teaching mode. Take the demand of enterprise as the target to design the teaching content, carry out the principle with duty actuation and project oriented. Establish the curriculum standards with technical personnel of enterprises, develop the corresponding task module, re-build and integrate the teaching content. Break the traditional teaching content of each module, distribute the overall curriculum task to teaching, learning, doing of the modular teaching, and create the "project" class. Encourage the students to complete every task actively, master the course points and technical points in the sense of achievement.

B. Attach importance to the general education of project teaching

The key with the general education is to emphasize the various capabilities with the students, not only teach them with specific knowledge. CDIO correlation principle reflects the essence of general education, it requires the students to achieve the general capability with studying and practicing some concrete engineering project, and then can solve some issues with general engineering project in the project life cycle. In other words, " learning-by-doing " could be carried out through specific projects, and abstract the capabilities and methods from the concrete engineering practice, this mode is in line with the general learning process that from the particular to the general. From the number of content varied engineering projects, which should be selected to be used in the teaching, the result may be same that all of them should make the students to access the general methods and improve the general capacities. At the same time, the nature of CDIO general education to study is within specialties rather than disciplines, the realm of the concrete engineering project to study is limited, but the capability to achieve is beyond the limits, even if meet the new projects in the future work, students should have the ability to settle all the problems rely on the general solution. Actually, the length of schooling is limited, any professional education should not teach their students with all the knowledge needed to their future work, the key lies in proper understanding of general education is to train students with the high-quality, high capacity, is to obtain self-study, practical ability and innovation ability , this is their inexhaustible treasure for their life.

C. Strengthen the practice teaching, increase the intensity of engineering training

The concept of CDIO emphasizes that students would “learn by doing”, and emphasizes the engineering practice[5].Provide students with a good way of learning theory with practice, we can make up for lack of theoretical teaching. The practice that we demand is complete in the whole process of projects, rather than be content with the commonplace, fragmented learning tests or technical training. However, it is heavily influenced by the economic situation of universities and the educational strength of the

objective factors in the implementation, and difficult to provide students with training opportunities and conditions. Therefore, we can make use of existing resource in the high school, strengthen practical teaching and increase the intensity of engineering training as follows:

- Construct the Innovation Lab, improve the student's ability of engineering practice. The establishment of the Innovation Lab provides a stage for training the student's project practical ability. We can construct the Innovation Labs in different research according to the professional characteristics, and guide the students by the teachers with strong research capabilities. In the Innovation Labs, students have the self-management and they will complete the design scheme independently or collaboratively, all of these would train the students with the integrative capability of analyzing or solving the complicated practical problem.
- Encourage students to participate in real research projects. School should guide and encourage students to actively take part in the teacher's research project, train the students with innovative spirit and practical ability rely on the project. Participation in research projects is to carry out the process of research training, it can train the students with the capability of identifying problems, asking questions and solving problems, and improve the students practicing ability and innovation ability with integrating theory with practice. Through participation in research projects, students can learn subjects of the latest research trends in time and recognize own search direction as early as possible according to the interest.
- Organize the students to participate in engineering practice, continuously broaden their horizons by this way. Let the students learn something other than textbooks in the contacting with the front-line enterprise personnel, experience their dedication, innovation and professionalism, develop the student's engineering consciousness and professional qualities, stimulate their desire to take the initiative to improve themselves, and make their thoughts be sublimated in the fulfillment.
- Attach importance to graduation project. Graduation project is a "real demonstration" before the students out of the ivory tower and into society, and it is an important step to train the students with innovation capability and practicing ability. In the process of completing the graduation project, require the instructor not only to guide students to read a lot of professional journals, extensively access to relevant literature, but also to provide valuable advice to the students about the design idea or design methods, and inspire students to give full play to creative spirit, guide students to improve their innovation capabilities in the practicing.

D. Construct the high-quality teaching staff with the capability of integrating theory with practice

Train high-quality engineering talent requires high-quality teachers as guarantee. As to the question that the teachers in the college of engineering are lacking of engineering fulfillment training and lacking of innovation consciousness, we should strengthen the construction of the teacher. On the one hand, efforts to attract a large number of social production personnel with experienced engineering practice to enrich teachers; Universities should also cooperate with the enterprise, send teachers to visit, practice or research with the factory and company, select some teachers to participate the building of experiment and practice base, all of these will enhance the teacher with practical ability and engineering technology applications, improve the relevance and application of teaching, and help to train the "double-quality teachers". On the other hand, requires teachers to change the concepts of education, foster innovative education, personally stand at the forefront of innovation to educate and guide students.

E. Attention to the cultivation of comprehensive skills and quality

In the current engineering education, more and more people realize that apart from teaching students of engineering technology, knowledge, but also need to develop interpersonal skills, honesty, responsibility and other professional spirits, develop the students with individual perseverance, innovation courage, life-long learning spirit, the daily time resource management and other skills, schools should not only teach but also to educate student. Now the problem in the engineering field are no longer a simple technical problem, but with the social, economic, ecological, cultural, and other humanities-related complex system problems. Problem of modern engineering is no longer the problem with a purely academic or an independent single domain. Work in the environment, it has to make the request of economic brains and supervision capability to majority of students, the reserve and development of this aspect in the school is necessary. Of course, it will be the method and link to achieve such knowledge from the course, but in the process of project study, the personal experience through served as team leader or a variety of roles in the project, the uses of various skills, the continues to improve the correction of perspective and way of thinking will be understand more deeply for the students. Therefore, the cultivation of comprehensive skills and quality not only achieved by the course, it must be combined with the project study, and also by "learning-by-doing".

IV. CONCLUSION

CDIO has already obtained success abroad, we can reform the teaching strategies based on this philosophy, and train the computer engineering talent that meets the actual needs of enterprise. We have reformed the strategies of engineering practice ability with software engineering professional education for many years. Over the years, we broke the traditional teaching mode, develop variety of research in the curricular teaching, and experimental models of independent innovation with a variety of experimental extra-curricular learning, emphasis on the teaching engineering concepts that "student-centered" , "system object "and "product as the goal ",promote students "learn-by-doing", and have already developed a large number of high-quality talent with innovative spirit and practical ability. Graduates received the praise of the employer.

REFERENCES

[1] Gu PeiHua,Shen MinFen, "Rethinking Engineering Education—The CDIO Approach," Academic Press. Beijing, pp.10-35, April 2009.
[2] Cha JianZhong, "A New Direction for Teaching Reform in Colleges and Universities," Higher Education of Sciences,LanZhou,pp.9-12,March 2009.
[3] Wang Gang, "CDIO engineering education Reading and Thinking Mode," Higher Education of China,Beijing,pp.86-87,May 2009.
[4] Chen XuHui, "Education Model of Computer Engineering Based on CDIO," Computer Education,Beijing,pp.141-143,September 2010.
[5] Shen Qi, "Constructing Practice Teaching System Refer to CDIO Model," Higher Education of Sciences,Beijing,pp.57-60, September 2009.