

Mode Construction for Cultivation of Teachers and Students on the Perspective of Synergy Theory

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Abstract: As economy and technology have developed rapidly, it is necessary to reform the current cultivation mode for talents on engineering technology. The writer puts forward to '1+2+3' cultivation mode of excellent engineering talents for undergraduate students on the perspective of synergy theory by drawing from the concept of CDIO engineering education and 'Excellent Initiative' after analyzing the current situation of engineering education.

Keywords: Engineering Education, Excellent Initiative, CDIO, Double Subjects

1. Introduction

In order to addressing the problems of engineering education, Massachusetts Institute of Technology(MIT) in collaboration with other three universities formally founded an international collaboration and raises the CDIO Initiative (Conceive-Design-Implement-Operate) [1]. The western countries stress the students creativity and practical ability and carry on educational transformation systematically [2]. At present, the studies on the concept and application of CDIO are tremendous [3], while the collaboration between the CDIO and synergy theory 'Excellent Engineers Initiative' are seldom. Since CDIO is still a pilot project at home, the model is void of localization. In addition, students' practical capability and team working awareness are free from efficient cultivation. Therefore, it is indispensable to outline the Local CDIO Initiative from the view of synergy theory.

2. The Current Situation of CDIO Engineering Education

The CDIO initiative was first applied in aerospace engineering department of MIT. To meet the requirement of CDIO aerospace engineers, the department reformulated the syllabus and optimized curriculum and laboratory, according

to CDIO. Currently, the relatively authorized and comprehensive work about CDIO is Edward F. Crawley's Rethinking Engineering Education: the CDIO Approach, which summarizes the experiences of CDIO educational transformation in several European and American universities and discusses the forming process of CDIO engineering education and its practice contents in detail.

Gu Peihua and other professors implemented EIP-CDIO in Shantou university, which provided new concept for Chinese engineering education and talents cultivation modes [4]. The CDIO initiative, therefore, can be applied in several important factors [5-11]. Although, the theoretical studies and practice of CDIO has achieved great progress, few researchers combined 'Excellent Initiative' with CDIO, especially from the perspective of synergy theories.

3. The Main Characters and Content of Synergy Theory

Synergy theory, or synergetics, an important branch of systemic principle, embraces a broad of studies and combines systems and environment. It emphasizes the resource superiority of the systems as well as the relationships between the systems and environmental variation. In the theory, nonequilibrium open systems are exchanged with the external

world in material and energy and are unveiled from disorder to order of time, space and function on the impact of synergy [12].

CDIO, Conceive—Design—Implement—Operate, is an innovative educational framework for producing the next generation of engineers. Acquiring over the life circle of products, considering the need of engineering production and the students' development and guiding by concept 'learning by doing', CDIO aims at cultivating students' technological knowledge, inferential capability, professional ethic, professional ability, interpersonal skill, team-working capability and application of engineering systems. CDIO is superior to provide a new engineering educational strategy. The experts in various fields listed learning objects of knowledge, ability and attitude for the new syllabus according to the principle for modern engineering practice. The syllabus concludes the abilities required by engineers and conduces to addressing two main problems that what knowledge, technique and attitude a student of engineering should have and how to guide students to grasp the techniques.

The core content of CDIO educational concept:

(1) A vision. CDIO aiming at establishing students' fundamental knowledge of engineering is an engineering education on the background of development and application of products, process and life cycle of system that is conceiving, designing, implementing, operating.

(2) A syllabus. The capability syllabus concludes technological knowledge, inferential capability, personal professional skill, professional ethics, communication and team working capability and application of synthetic system.

(3) 12 standards. It covers basic environment, learning objects, integrated teaching scheme, introduction to engineering, experience of design-implementation, place for engineering practice, comprehensive learning experience, active learning, promotion of teachers' learning and teaching ability, evaluation of students' performance, professional assessment.

4. The Main Problems Existing in the Current Advanced Engineering Education

As the scale of advanced engineering education is enlarging in China, the number of engineering student in general undergraduate colleges and technical colleges grew by 14.31% year on year and the growth rate of engineering masters and doctors is 7.27% each year. On the whole, the capability of Chinese faculty has upgraded and achieved a great success. The problems, however, in the current education is unavoidable.

(1) Unreasonable curriculum system and content.

Curriculum system in the most colleges have not been adjusted to meet the social needs so that the problems have been exposed as follow: firstly, the professional courses are theory-orientated while practical courses are ignored; secondly, the courses lack unique features. The professional

courses are comprehensive in great quantity. The relevant courses are included in the curriculum. Therefore, the curriculum did not highlight specialty and practicality, leading to weariness and confusion of the students upon the courses. Actually, from the design to implementation of the curriculum, contradiction between practice courses and theoretical courses have yet been selected down. Since the practice can not be combined with teaching methods, students are confused about the reason to learn the curriculum [13].

(2) Estrangement between colleges and enterprises.

To cultivate qualified engineers, colleges and enterprises should strengthen connection and exchange in terms of foster schema so that the colleges make well acquainted with social and enterprises' requirements for the engineers [14]. The target cultivation enables students to better adapt the society. However, most colleges act blindly and students put full heart into studies while turning a deaf ear to anything else. For example, a great number of students majoring in engineering management are not familiar with equipments, infrastructure, process engineering, and the national standard, industrial standard, local standard, enterprises' standard of the professional system [15]. In addition, the short-term internship would be cut down on the condition of bad weather when the projects could not be preceded, so the students acquire nothing from the internship.

(3) Lack of double-professionally-titled teachers with both engineering education background and engineering capability.

Lack of double-professionally-titled teachers with both engineering education background and engineering capability is a prominent problem in advanced engineering education. Teachers are the key point of talent cultivation. A great amount of colleges are strict with teachers' educational background and academic research other than practice experience. Most teachers with redundant theoretical basis have taught in colleges after acquiring master or doctor degree, but they have been short of practice capability which is trained from the practical engineering programs [16].

5. Construction of CDIO Excellent Initiative on the Basis of Synergy Theory

The writer puts forward to '1+2+3' cultivation mode of excellent engineering talents for undergraduate students on the perspective of synergy theory by drawing from the concept of CDIO engineering education and 'Excellent Initiative' after analyzing the current situation of engineering education. Also, the cultivation mode is in line with the principle of expanding the profession, stressing practice, frosting capability, improving quality.

1) One background. It is based on conceiving, designing, implementing, operating program.

2) Synergy of two subjects. It is the cooperation between colleges and enterprises in cultivating engineers.

3) Three phrases for promoting capability. The three phrases are theoretical knowledge and ability of analysis,

technique and practice ability, application and innovation ability.

(1) To set CDIO - conceive, design, implementation, operation as the background of Excellent Engineers Initiative.

The background of education should be a cultural framework, on which students may acquire knowledge and ability and promote qualification. From the perspective of culture of engineering education, teachers should explicit that an engineer plays roles as conceiver, designer, implementer and operator in social service. There are three arguments to illustrate that the complete process of a engineering program, conceive, design, implement, operate, is the background of Excellent Engineers Initiative.

1) The basic works of modern engineer are to conceive, design, implement and operate partial or all products.

2) The second argument is the enterprises' requirement to the engineers. Profits are obtained from the conceiving, designing, implementing and operating program, which is to be done by the engineers with corresponding ability.

3) The third is to foster the natural background of students' capability. The most efficient way is to guide students to utilize the ability of CDIO on the background.

An engineering talent needs to grasp the theories, ways and means of modern management science and make correct decision for engineering projects at home and abroad. However, we should clear that CDIO of engineering products are the background instead of the content of excellent engineer cultivation, because not every engineer should specialize in the whole process of CDIO and it is impossible to cultivate students as generalists who are good at the whole process of conceiving, designing, implementing and operating.

(2) Two subjects work together in depth to cultivate excellent engineers.

Reviewing cultivating experience of colleges around the world, we found that all the colleges join hands with enterprises to make up the shortage of colleges' education in engineering practice and vocational education. For instance, the managers in Britain enterprises are the framers for the standards of occupational qualification and evaluators of advanced education result. 'The two subjects' mode in Germany advanced engineering education integrates the role of colleges and enterprises. The requirements for graduates' knowledge, ability and quality are formulated by the association. Colleges are responsible for passing on professional knowledge and enterprises take charge of job training. Therefore, job training can be interfaced with professional knowledge and students' engineering capability can be efficiently promoted. However, domestic colleges seldom apply this mode.

In line with the principle of resource complementarities and mutual benefits, the two subjects, the colleges and enterprises, make joint effort in cultivating excellent engineers. There are reasons as follow:

First, the CDIO Initiative emphasizes the importance of stakeholders taking part in engineering education. The stakeholders of engineering education are mainly students, faculty, enterprises and society, among which the enterprises

are the primary parts because they are the ultimate clients of graduates whose ability should satisfy the need of the companies.

Second, enterprises provide engineering students with condition and environment that can not be afford by colleges. Firstly, enterprises clear social requirements for engineering talents. Secondly, enterprises possess the most sophisticated equipments and latest engineering techniques. Thirdly, enterprises command a team of engineering elites. Fourth, the real engineering practice and innovative environment are supported by enterprises. Fifth, enterprises offer learning environment of advanced corporate culture.

It is important to note that the in-depth cooperation in cultivating engineering talents between colleges and enterprises does not mean students only can go on a field trip after accepting theoretical knowledge from school. Instead, it should be applied through every link of the cultivation, from the formulation to realization. The in-depth cooperation addresses the problems of unreasonable curriculum system and content, estrangement between colleges and enterprises, lack of double-professionally-titled teachers with both engineering education background and engineering capability.

(3) Three phrases for promoting engineering capability.

On the basis of the principle of in-depth cooperation between colleges and enterprises in cultivating talents, the cultivating mode of the three phrases for promoting engineering capability is formulated in accordance with the diverse requirements and characteristics of different grades. Students lay a solid foundation of knowledge in schools and then accept technical training and finally improve their practice ability and engineering awareness at learning phrase in enterprises.

The first phrase (freshmen, sophomore): basic knowledge. The colleges set up the basic courses, the professional basic courses and advanced courses, strengthening the learning of basic knowledge, including techniques, management, economy, law, so as to improve students' knowledge basis and analyzing ability. The enterprises provide internship opportunities for students so they make initial acquainted with the content of engineering management.

The second phrase (junior): professional skills and practice ability. Students apply the basic knowledge in discipline competition, project design and internship in companies to upgrade their professional skill and practice ability.

The third phrase (senior): comprehensive ability of application and innovation. Students accept education of professional qualification, take part in undergraduate' innovation and specialty program, the program of industry-university-research cooperation and internship to enhance their comprehensive ability of application and innovation.

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