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An Innovative Training Program on Engineering Education

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ABSTRACT

From 2010, an "excellent engineer" undergraduate and graduate program had been initiated in higher education of China to promote the development of industry and social economy. In this circumstance, the engineering education programs in Dalian Maritime University are reformed to satisfy the requirements of transportation industries. And the engineering practice, engineering activities, and engineering courses are emphasized. In this training program, industrial communities are deeply involved in the engineering education and training procedure; the students are educated and trained in university and enterprise according to the common standards and industrial standards; and the engineering competences and creative ability are emphasized and are to be enhanced in the training schedules and procedure. A joint-training mode has been established already between Dalian Maritime University and enterprises in transportation fields.

Keywords: Engineering Education

I. Introduction

Dalian Maritime University(DMU) is located in southwestern Dalian, which is a famous coastal city in northeastern China. DMU is one of the largest and best maritime universities and is the only key maritime institution under the Ministry of Transportation, People's Republic of China. The university was designed to develop "a steadfast, rigorous, diligent, and pioneering spirit" for students. Regarding "Scientific Navigation" as its educational feature and through years of hard work and development, the university today enjoys a high reputation internationally as an excellent center of maritime education and training as recognized by the International Maritime Organization(IMO) and also in engineering education in China.

In the last three decades, tens of millions of engineering and technical talents had been trained to effectively support the formation and development of the industrial system, to support the rapid economic growth of China's reform and opening, and to have formed a more reasonable structure and higher engineering education system. The Chinese State Council had made a series of major strategies for a new road of industrialization with Chinese characteristics. To build an innovative country, a large number of engineering talents with creative ability and international competitiveness are urgently need to be trained to support the industrial and social development of China. In "the National long- term Education Reform and Development Plan Outline", the People's Republic of China, the education of engineering talents are repeatedly stressed[1]. In 2010, an "Excellent Engineers" undergraduate and graduate program had been initiated in higher education of China to promote the development of industry and social economy.

Under this circumstance of engineering education, the engineering education programs in DMU were initiated to reform the training mode and contents to satisfy the requirements of transportation industries and enterprises and to serve for national strategy of new typical industrializations. And the engineering practice, engineering activities, and engineering courses are emphasized in the training program and the cooperation between university and industrial enterprises are also emphasized in the training mode.

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II. Program Objectives

With the rapid development of global society, economy, and science and technology, the requirement of engineering talents with excellent quality increase quickly in industry and enterprises. In China, the higher engineering education has gradually emerged into the globalization education system, graded up the education quality and pursued to

scientific management of engineering education.

Every major aims to train the students to be excellent in morality, intelligence physics, and arts, and also in basic scientific principles, production techniques and technology, and management knowledge. The students are trained to have the ability of self-study, team work, and professional development. The graduates can work on engineering design, technology R & D, and technology management[2].

III. Program Features

1. To learn in the enterprise, to train excellent engineer candidates in a real environment

Practice is the soul and essence of engineering. The combination of production, learning, and fundamental research is an important feature for engineering education. In order to solve practical engineering problem, personnel training in professional education and engineering colleges is seriously disjointed fundamentally with enterprise requirements. A national "Excellence Engineers" program(EEP) will provide universities or colleges with a new training mode(joint training) for the students. In this mode, the learning procedures are divided as two categories: one in universities or colleges; another in enterprises, in which one year study is required for the undergraduate or master programs.

In the enterprise learning phase, a professional training for the outstanding engineer candidates is accomplished. According to the training levels and goals for students in the professional education, different engineering tasks are assigned. The undergraduate students can be arranged to complete the phase training tasks with understanding practice, production practice, graduation practice, specialized teaching, professional experiment, and graduation design. Graduate students are required to work on an actual engineering project. In this stage, the engineering practice ability and innovative ability is trained and expected to be formed. For the graduate students, teaching tasks could be designed and completed in enterprise including: courses teaching, professional experiment, engineering practice, assistant engineer, and completing the dissertation. Thesis topics are required from corporate practical problems or existing topic. In addition to learning of engineering practice ability, the cultivating, training, and forming of students' engineering design capabilities are emphasized especially, and innovative spirits and capabilities are developed accordingly. Meanwhile, a senior engineer from industry or enterprise is invited as an associate advisor to mentor the engineering research of every graduate student in combination with his/her advisor in university. The enterprise advisors are not only responsible for project activities in enterprise, but also are involved in the whole training procedure and the evaluation of research work and thesis of the graduate student.

In the campus learning phase, professional and general fundamentals for the outstanding engineer candidates are taught and enforced: courses teaching, fundamental experiment, engineering experiment, and research activities. The college should pay more attention to the important role of the extracurricular learning activities and learning environment for outstanding engineer training. Extracurricular activities, such as a variety of innovative practices, participating teacher's R & D projects and interdisciplinary learning, can be taken as an important and effective pathway to carry out innovative education for students, including the development of practical, innovative, teamwork, communicating abilities.

2. To establish a faculties' team with high level and engineering practical experiences

Teachers engaged in engineering education should not only be the scholar in theory of engineering education, but also an experienced specialist in engineering practice. However, the faculties in lack of practical experiences are currently ubiquitous in the colleges of engineering education. Therefore, a combined team of full-time and part-time faculties with high level and engineering experiences is required for the EEP engineering education.

To establish the full-time teacher's team in engineering education, we should start to build up the reasonable system from both the policy and the appointment. In policy, on the one hand, for the full-time teachers in universities or colleges a system or requirement must be established to arrange them to work in enterprises as a post engineer for 1-2 years, to accumulate, update, and enrich experiences in engineering practice. On the other hand, the full-time teachers are encouraged consciously to involve in the actual

research cooperation projects with the help of working in enterprises and other ways to get rich experience in engineering practice. In the appointment and assessment of full-time teachers, the achievements in theoretical studies and published papers in the past are not mainly focused. The project steering design, R & D, intellectual property and patents, as well as industry-university cooperation and technical services etc are predominantly. In addition, in the recruitment of new teachers, the candidates with engineering experiences or postdoctoral engineering experience in post-doctoral enterprise stations will be given a priority. In the promotion of the teachers, the engineering experiences are the basic requirement.

For the part-time teachers in engineering education, a variety of ways were used to hire highly qualified experts and engineers with extensive experience in engineering practice from the industry community and company. The appointment system and remuneration policy of part-time faculty had been developed and established to stabilize the part-time teachers, play better their important roles in the EEP.

Full-time teachers in university are clearly divided with part-time teachers. The full-time teachers are mainly responsible for the professional basic courses and specialized courses, which are strong theoretical teaching tasks. Part-time teachers are mainly responsible for the strong practical tasks of teaching specialized courses.

Therefore, the training program has three obvious features. First, industrial communities are deeply involved in the engineering education and training procedure. Second, the students are educated and trained in university and enterprise according to the common standards and industrial standards. Third, the engineering competences and creative ability are emphasized and are to be strengthened in the training schedules.

IV. Courses design

Curriculum system and teaching content is the main carrier of personnel training in university, and a bridge to put the guiding ideology and advanced concept of EEP engineering education into practice. If the goal of EEP is the ideal expectation for the participated students in the fundamental knowledge, ability, and quality with the inevitable requirement of engineering education, the corresponding curriculum and teaching content will largely determine the realization of the training objectives in the knowledge, ability, and quality of the students in participation of training.

According to the EEP objectives, we follow the features of practice, integration, and innovation in engineering and take the enhancement of the students' ability of engineering practice, engineering design, and engineering innovation as a core of education. We refine the knowledge and ability outlines by the training standards, reconstruct the curriculum system and teaching content, and put the knowledge and ability outlines into the implementation of specific courses and teaching.

In general, the training procedure is oriented by the social demand in the background of practical engineering technology as the main line, with the integration of scientific spirit and humanistic spirit, the integration of general education and professional education, and the integration of personalized training and social responsibility, to strengthen and develop student's engineering complex capabilities and overall high quality for meeting needs of talents in the future[3]. On the operational level, it is to refine the knowledge and ability outlines, to reset, integrate and optimize the program course system, in order to guaranty EEP training goals. The main measures are:

1) To build and to merge interdisciplinary curriculums. With absorbing new results and achievements of modern engineering science and technology development, the curriculum should reflect the integration of interdisciplinary technology, extend the contents, and increase the proportion of integrated curriculum.

2) Strengthen the humanities and social science courses. It is paid more attention on the role of the humanities and social science courses in engineering ability and quality of trainee. Engineering ethics, social responsibility, humanities, literacy, teamwork, communication skills and other aspects are enhanced in the well-designed courses and corresponding choice of content.

3) Attention to and strengthen practice teaching[4]. It is to improve teaching methods, to reduce the number of hours of theoretical teaching, to increase the number of hours of teaching practice, to increase the design, integration, and innovative experiments, and so on.

4) Construction of the course structure suitable to the training objectives. Generally speaking, the course structure

of undergraduate-level engineering talent cultivation is constituted by general education courses, professional courses and practical courses; the master's level engineering course structure is constituted by basic training courses, professional courses and innovation practice.

5) Focus on the student-centered learning methods with the implementation of research. In the reform of curriculums system, the teaching methods and learning methods are also emphasized simultaneously. In the student- centered learning method, the ability of self-learning, analysis and solution are improved and risen up. In the enterprise learning a cognitive apprenticeship approach is encouraged under the advisor of part-time teachers, especially for graduate students[5]. In campus learning, a learning method of the research-based is encouraged. The research-based learning is a teacher-led, student- centered learning approach. In this method, there are three forms[6]: the research topic inquiry-based learning method, the case discussion-based learning method and project-based learning method.

According to the training goals and the requirements, the Eng. master's programs are designed as two-year study for full time student and three-year study for part time students from enterprises or companies with more than two years industrial working experiences. The Eng. Bachelor's programs for full time undergraduate students are designed as 3+1 years. The undergraduates study in university or college for 3 years plus 1 year in enterprises. The training modes are shown in Fig 1.

According to the training program, the courses are designed to basic courses, core courses and feature courses. In the technology knowledge, scientific fundamental and professional fundamentals are enhanced. In the professional ability, the practice activities are emphasized combining with a practical engineering project. The feature courses are related to the marine engineering and industry. A semester is used for student's internship in company or industry enterprises.

For example, in major of material science and technology, the undergraduate program has 120 hours technique training and 80 hours understanding practice for freshman, 32 hours experimental measurement and 120 hours metal processing practice for second-year students, 200 hours production practice for senior(3rd year) students and 640

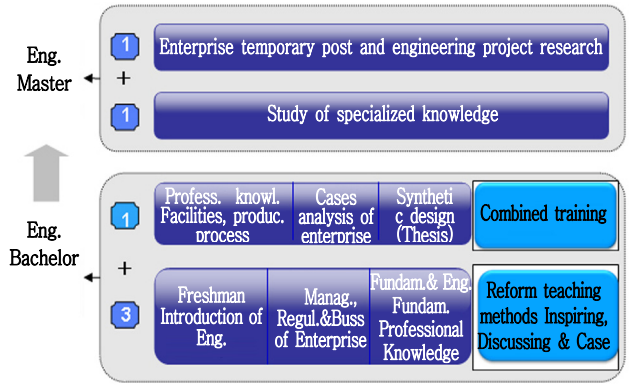

Fig. 1 The training modes in engineering education

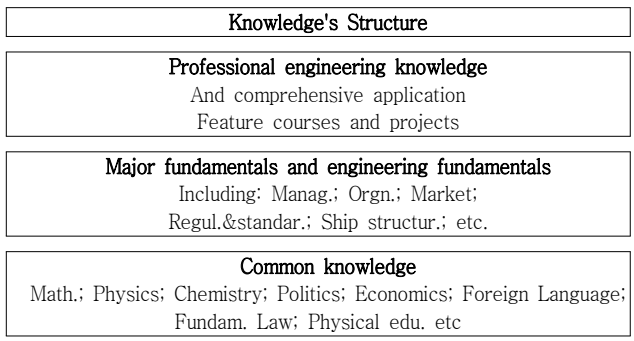

Fig. 2 The knowledge structure for major of material science and technology

hours comprehensive training for thesis for 4th year students in university campus and enterprises. The knowledge structure in the major of materials science and technology is shown as following Fig 2.

V. Innovative activities

To stimulate the interests of students to study and professional development, many competition activities are hold in a range of major students or college. Some times a project is assigned for the participated students to put forward a scheme to be executed then put the scheme into a practice. The experimental results are evaluated by teacher judge group. In other times, the project is designed freely by students themselves and the results are evaluated by teacher and student judge group.

For example, in the teaching of "Metallic Materials" course, the teacher divides the students into three-person groups, asks each group to choose a typical part in machines or

machinery of transportation vehicles, to design the manufacturing procedures and processing parameters to satisfy the required properties of the parts from the choice of raw materials to the final workpiece. This is a home work. The students in the group will be trained in team work, literatures' indexing, metallic material fundamentals, machine process, heat treatment, and evaluation of material properties. The group would present their procedure, the obtained results, and the used scientific principles and theoretical analysis in the relationship of microstructure, process parameters, and properties of materials. The evaluation of the home work is judged as a routine score by student judge group and the teacher. The students is very interesting this activities in course teaching. In extracurricular activities, the similar competition activities on a project are organized often and routinely.

VI. Summary

In DMU, the mode of engineering education is being reformed and improved according to the development of Chinese transportation fields to satisfy the requirement of industries in transportation engineering, marine engineering, ship building and repairing engineering, environmental engineering and information engineering. In the training schedule and procedure, the industrial communities have been deeply involved in the engineering education and a joint-training mode has been established already.

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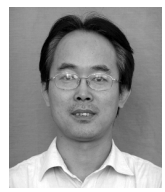

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