

Explore an International Education for Training the Creative Engineering Talents

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Abstract—The cultivation of creative engineering talent is the most essential mission in higher education for present and future perspective. All Engineering Universities, Colleges are responsible for educating the high quality engineering and technical talents. In this paper, the connotation of engineering, creative talents is analyzed and discussed. The cultivating strategies and solutions for the engineering, creative talents in author's school are elaborated in different aspects, such as how to implement the engineering practice and how to improve the innovation ability and widen the scope of international perspective. Finally, we explore an effective way in which the engineering creative talent in universities is cultivated.

Index Terms—Creative engineering design, International teaching, Engineering creative talents, Cultivation

I. INTRODUCTION

The Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010-2020) has been proposed to explore the ways and means to cultivate innovative engineering talents [1]. The creative talents must be encouraged jointly by the engineering universities and colleges in training. Universities, research institutions may cooperate with high schools to set up format for innovative talent, training, carry out the necessary test in relation with innovative talent and to conduct research based innovative talent training. On June 23, 2010, the Ministry of Education in China launched the "excellent engineer education and training plan", starting to practice the spirit of the Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010-2020). The aim of this training plan was to educate a large number of high-quality of technical persons with a different engineering background. Jiangsu University is also in the top list of 61 universities in China to start the "Excellent engineer education training plan". Jiangsu University has contributed in active exploration and practice .While focusing on the management mode,

educational philosophy, teaching mode and teaching contents of creative talents. In 2013, Jiangsu University united Yamaguchi University in Japan and jointly launched the "international innovative engineering design teaching project". Every year, outstanding students from China, Japan and South Korea are selected to participate in the innovative engineering design project during their holiday. The project mainly focuses on the training of the student's abilities, including interdisciplinary, internationalization, information and engineering innovation, etc. The international engineering, science and technology talent, training mode and mechanism will be established and further it will provide an effective way for universities to explore the cultivation of excellent engineering talents.

II. CONNOTATION OF CREATIVE ENGINEERING TALENTS

The word "Engineering" was first appeared in Europe. Its original meaning was about the weapon manufacturing and different works relating to military. Afterward, it was expanded to many areas, such as building the houses, manufacturing different type of machinery, construction of bridges and roads and so on. In modern society, its general meaning is concerned with "Project engineering, fortifications and manipulation". It is organized to accomplish a specific task with the value orientation, integration of science, technology and the related elements, the connotation is from top-notch Innovative talents [2]. The top-notch innovative talents are talents with innovative spirit and innovation, consciousness in various fields [3]. It is the general term for various types of innovative talents, such as, academic, management, skills, and application talents. Xiang argues that the cultivated top-notch innovative talents in our country should be the talents who can make a significant contribution to the development of the country in various fields, especially in science technology and management [4]. The characteristics of top-notch innovative talents include strong dedication and sense of social responsibility, innovative spirit and ability. These

characteristics of top-notch innovative talents in leaders will lead the nation to prosperity within the country and especially in the world. Wang et al. think that more advanced and flawless cultures of top-notch innovative talents are relying on the more refined thinking, cleverness, philosophical knowledge, with more efficient, excellence method, along with noble and progressive spirit [5]. The talents cultivated by this kind of culture will be of Higher level and better quality, the influence and effect of these will be on higher side and greater than anything else. Liu Apelian believes that top-notch innovative talent is the combination of innovative spirit, innovation ability and innovation achievements [6]. Generally, these are not the exhaustive talents, but support the excellent skills in certain areas, such as in the natural sciences, social sciences, literature and art.

Through the literature review, we found that the top-notch innovative talent is a unique word used by Chinese academic scholars and worldwide academicians to represent creative talents. There are "Innovative Talents" or "Outstanding Talents" with the supplementary similar words in other countries, but a direct expression and specialized definition of top-notch innovative talent cannot be found. The Related research shows that there were few scholars have summarized and defined the connotation of the term [2]. "The word all along is used as a vague concept." Different individuals may express different meanings when using this word. In summary, top-notch innovative talents are defined as the outstanding persons that can make a significant contribution to the country and social society. They should have an extraordinary innovative spirit and innovation ability.

These qualities will let them lead the creative development in certain professional field. Therefore, a top-notch innovative engineering talent refers to the talents with strong, innovative spirit, innovative thinking with innovative engineering practice ability, whoever has received engineering course education and training. They usually make outstanding contributions to various engineering fields, such as in machinery, electronics, electrical, energy, computer, civil, construction, mining and so on. The basic benefits of engineering lie in its practicality. The contents of engineering practice include the initial investigation, the engineering design, and participation in the construction, operation, management and engineering maintenance. The beauty of engineering technology is on the basis of engineering practice which is the objective approach towards the real process of engineering concept and engineering thinking. Therefore, engineering, top-notch innovative talents must possess these qualities and characteristics.

III. PROBLEMS IN HIGHER EDUCATION

A. Lack of Practice for Engineering Cultivation in Higher Education

The fundamental task of higher engineering education is to cultivate modern engineering talents with practice ability. The characteristics in higher engineering education are to use the technical science as the subject

basis, the application technology as professional content, and the engineering application as service objective. Therefore, engineering practice is the most essential characteristics of the engineering education [7]. China is the first one in the world for the scale of higher engineering education which is a great power in engineering education. In the current scenario, the scale of the engineering practice teaching base and teaching contents are greatly expanded. However, the time for engineering education practice is continuously tightening from 8 weeks to 5-6 weeks, whereas in some areas up to 2-3 weeks. Only a few schools ensure that it should be up to 6 weeks. It is an indisputable fact that engineering education practice and innovation are deficient in our country. The prominent problems in the engineering talent cultivation are the weakening of the engineering capability and quality, along with the lacking of engineering consciousness, engineering background, and engineering practice in university engineering education. There are some internal factors. For example, some colleges and universities are only pursuing the so-called "research", because engineering education is more and more far away from the project. Pan Yunhe, an academican of Chinese Academy of Engineering, clearly pointed out that there is a lack of engineering and innovation in higher Engineering education in China [8], [9]. The specific performance areas are:

- 1) The lack of procedures and work practices in engineering education
- 2) The lack of diversification and adaptability in the talent cultivation model.
- 3) The lack of cultivating interests in science and technology innovation.

The reason is that all colleges and universities in China pay attention to the academic research and look down on practical teaching. If the teachers/professors only do the teaching works and is sort of achievements in academic research, they will not be promoted to the higher technical position. On the other hand, the curriculum development of engineering practice is generally insufficient, and which cannot meet the requirements of the outstanding engineering talent's cultivation. In all colleges and universities in China, the engineering education courses depend on subject education, whereas the combination of courses and industry collaboration are not in depth. Furthermore, the frontier and substantial contents of engineering practice and education are insufficient. As a result, it is difficult to improve the student's practical engineering ability and innovative ability. The education experts pointed out that lack of skills for teachers of engineering education is a big dilemma, because the teachers engaged in engineering talents' cultivation are usually lacking the tools and skills for teaching and engineering practical experience. The deficiency of engineering practice and innovation in engineering education of universities and colleges in China is obvious. Even doctors and teachers in universities have no engineering practice background up to almost 100%. Therefore, it is difficult to cultivate real excellent engineering innovative talents.

B. Insufficient Internationalization in Higher Education

The survey shows that only 10% of Chinese engineering graduates can reach the employing standard of multinational companies. Many multinational companies cannot employ qualified talents in China; therefore they recruit graduates from overseas to work in China. This phenomenon reflects that the internationalization level of Chinese engineering in higher education is not up to the mark and insufficient to satisfy the international market requirement. The internationalization of engineering education is to learn and to use the world's best students and educational resources to cultivate engineering talents for the global market. The key objective is to cultivate engineering talents in accordance to the international standards. The internationalization of higher engineering education should be reflected in theoretical teaching as well as in the strengthening of the practice [10], [11]. Therefore, universities in China should actively introduce the foreign excellent engineering education resources and carry out the cooperation in running schools to make Chinese engineering education in line with international standards as soon as possible and realize the internationalization. At the same time, under the critical situation of economic globalization, the requirements for engineering talents of international enterprise are also constantly rising, which is creating a new era of challenges to the universities. Many universities in other countries insist on "learning by doing", while making cooperation between learning and production and improving internationalization levels [12], [13]. Besides, they are continuously improving and accumulating the experiences of engineering education, and establishing closely related with enterprises so that a large number of international Innovative talents could be cultivated. The experiences of engineering education from foreign universities are worth of our references. To promote the quality of the engineering talents cultivation, there are useful ways, including comparing and testing the development of school, discipline and individual with international standards, learning foreign advanced experiences and practice and creating a good atmosphere for teacher's communication and for the cultivation of engineering talents. A lot of foreign universities carry out comprehensive reforms of engineering education in accordance to the need urges from the industry for innovative, entrepreneurial and international talent. Whereas any experience is relative to the specific conditions, it can't be copied verbatim. Chinese engineering education may absorb the advanced foreign experience, according to our national conditions subject to create a truly suitable environment for Chinese effective international engineering education. It will be not only the cradle of Chinese engineers, but has also become the cradle of international engineers.

IV. STRATEGIES FOR THE INTERNATIONAL ENGINEERING EDUCATION

According to the general idea of the excellent engineering training program with the Ministry of

Education, and the successful experience of Higher Engineering Education in the advanced countries (such as the United States, Germany and France, etc.), Jiangsu University kept up with the international pace and established the engineering education idea of "facing industry, facing the future and facing the world". Furthermore, Jiangsu University explores the new training model of engineering talents with Chinese characteristics, set "the social needs in new industrialization process" as good" and set "engineering education must return to engineering practice" as a principle. At the same time, Jiangsu University established a corresponding policy, strategy and mechanism to improve the students' engineering consciousness, engineering quality, engineering practice ability and international perspective etc. Summer Program for Innovative Engineering Design (SPIED) was started in 2013, which is launched by the Jiangsu University in Japan and Yamaguchi University in Japan. The goal of SPIED is to share the teaching resources, establish an international innovative teaching platform, and promote academic exchanges. As a result, the innovation and practice abilities of engineering students are promoted.

Being different from the traditional practice teaching model, students in SPIED are from different majors, different nationalities and genders, who sit together, and use brain storming method and the way of collective thinking to produce the effect of 1+1>2. SPIED respect students' interests and hobbies and increase the expression of students' initiatives, expertise and creativity. All teams involved in SPIED aim to an explicit theme, and mutually understand and inspire each in one day. Then, they create an innovative idea after stimulating the creative sparks. In the following two weeks, students in SPIED completing the project design independently according the creative idea. The international perspective, innovative thinking and engineering practice and other aspects of the ability of the brain storming generated by the project are educated quickly.

A. Establish an International Teaching Team

SPIED is completely different from the traditional practice teaching curriculum, and teachers' background is essential to the success or failure of innovative engineering design. The tutor team in SPIED is composed of teachers who come from China, Japan and South Korea and have long-term cooperation in scientific research, and teaching experience. The teachers with different cultural background actually produce the collision of culture, which is not only conducive to the innovation of knowledge, But also conducive to the learning, enthusiasm of students. Students involved in contact with different educational methods with different cultural background, will expand their international vision. Reflecting the interactive mode of "students as the main body, teachers guide", SPIED requires teachers to strengthen students' active consciousness, cultivate autonomous learning, active practice and conscious

innovation, and enrich students' knowledge, ability and quality.

B. Train the International and Innovative Ability

SPIED focuses on cultivation for the international creative engineering. In other words, the students' professional background and nationality in each team should be different. Each team is composed of students who are from China, Japan and South Korea, and major in mechanical, electrical, electronic, or computer, etc. Those students must learn and cooperate each other, and complete the preliminary design using the brainstorming method. The students utilize the internet and other information technology to complete the design in their own schools after the SPIED class. The cooperation strategy will enhance the students' internationalized and communicated ability. Furthermore, SPIED will also promote the students' English expression, and comprehensive application ability, which lay out a solid foundation for them to join in the international community quickly.

C. Train the International and Innovative Ability

Being different from the traditional practical teaching, SPIED doesn't assign a definite topic and only use the brainstorming method to train the students, which stimulate the team's creative spark. Each team members have a round table and propose their free imagination on the hot issues of the society (e.g. the topic of SPIED2013 is Life Innovation; the topic of SPIED2014 is Population Aging; and the topic of SPIED 2015 is What can we do for old people). The tutors help students to optimize the original creative idea, such as science, practicability, feasibility, economic benefit; the final design is determined by the intelligent collision from each team member. Then, the product is finished by means of data collection, design analysis, project design. After SPIED, the team members continue to cooperate and improve innovation through the internet in their own university. The final product will be taken the international innovation, engineering design competition (CEDC) held at the end of each year.

D. Organize the Sharing Teaching Sources

To support international and practical teaching objectives and plans, the SPIED needs a large number of teaching resources in many aspects, such as teachers, textbooks, international curriculum, network interactive platform, assessment and so on. Therefore, the international requirements must be considered and reflected in the teaching sources when we set a teaching goal and content of related courses. Universities need to actively organize their own international teacher team and diversified teaching methods. Meanwhile, it is necessary to advocate bilingual interaction and let the students be familiar with the professional terminologies. The establishment of a network MOODLE platform can provide the opportunity, and let students interact and exchange with each other about their interesting/core subject course contents. Centralized training can improve students' innovative ability, but lack of long-term

mechanism. Therefore, we must establish a comprehensive management system of international practice. The project should be implemented in the unit team and the mentor team tracks and strengthens the management. They should not only manage the actual system, but also write the relevant papers. Participating universities must integrate the practical and experimental strength and establish some open and creative experimental platform (for example shared equipment, laboratories and talents). Those strategies can ensure the sustainable development of innovative engineering design teaching.

V. CONCLUSION

It is proved that the international teaching project of SPIED is an effective way to train outstanding engineering talents with international engineering background, innovative thinking, innovative consciousness, design concept, team spirit and practical exploration ability. It can be seen that international students from multicultural and interdisciplinary improve their innovative ability and broaden their scope of international vision. The teaching mode conforms to the trend of internationalization, information and integration of engineering, which emphasizes on the teamwork training, internet interaction, instructive teaching, and provides a good reference to the inspiration for the universities to cultivate engineering creative talents.

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