

Establishment of Three-dimensional Graduation Project Teaching System with Engineering Characteristics

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Abstract—The teaching system with “one mainline, two platforms, three levels and four modes” is the connotation of three-dimensional graduation project teaching system with engineering characteristics. Its three-dimensional characteristic is manifested by collecting diversified topics and organically integrating theories, methods or thoughts of different discipline by depending on the university-enterprise collaboration platform. Students can achieve different levels of ability enhancement through staged training, thus laying foundations for innovation and entrepreneurship.

Keywords—teaching system; graduation project; engineering; three-dimensional characteristic

I. INTRODUCTION

For local engineering universities, it is one important connotations of construction of characteristic specialties or key majors to establish a graduation project teaching system with engineering characteristics. As the most important practice in universities, the graduation project is a comprehensive and overall test on students' four-year learning outcome and practical abilities, which lays solid foundation to their practice, innovation and entrepreneurship. According to the training elements composing the application-oriented undergraduate talents, including comprehensive quality, spirit of innovation, practical ability and entrepreneurial ability, the graduation project can be divided into four types, namely, common graduation project, comprehensive graduation project, creative graduation project and developing graduation project. During the primary preparation, teaching link is added at appropriate time and knowledge and techniques are reserved, aiming to establish corresponding teaching system. The three-dimensional education mechanism regarding theoretical study of graduation practice and practice as equally important, combining universities and enterprises together and developing engineering practice and technical reform simultaneously is established gradually in considering of various factors, such as characteristics of majors, engineering practice, cross-disciplines, etc.

II. CONNOTATION OF THE THREE-DIMENSIONAL TEACHING SYSTEM

The connotation of the three-dimensional graduation project teaching system with engineering characteristics can be summarized as “one mainline, two platforms, three levels and four modes”. It mainly aims to cultivate application-oriented engineers with engineering practice ability and spirit of

innovation, receives support from university laboratory and enterprise mass production platforms, reflects three practice teaching levels of creation, innovation and entrepreneurship, and applies four modes of technical reform, product development, quality evaluation and scaled implementation. It integrates into the innovation-entrepreneurship integration education by taking the advantage of cross-disciplines and knowledge combination.

III. MANIFESTATION OF THREE-DIMENSIONAL CHARACTERISTICS

A. Goal-oriented Characteristic

With clear overall goal of major construction and based on school-running orientation, the professional talents cultivation system shall be targeted at cultivating application-oriented engineering technicians for engineering first-line, oriented to technical innovation and engineering technology management, modeled on government-industry-university-research co-cultivation, and emphasized on the development of engineering practice ability and innovative awareness. This not only can highlight engineering characteristic education through teaching practice, especially the graduation project, but also can be popularized to other majors through the demonstration effect of characteristic specialty.

Take the bioengineering program for example. Bioengineering program is multidisciplinary and comprehensive science and technology, which is characteristic of experimental discipline. As one important branches of biotechnology field, the bioindustry is a new modern industry that produces tens of millions of products by taking the vital process as the mean of product production and processing under controlled conditions[1]. The biotechnology has been widely accepted as one of effective ways to deal with population, resource and environmental crises in 21st century and achieve sustainable development[2]. It becomes the key of economic and social development strategy of various countries in the world. China also gives priority to develop biotechnology industry as a Hi-tech industry, which increases the talents demand continuously[3]. The application-oriented bioengineering professional talents with engineering practice ability are the main force to improve traditional brewing and associated modern bioengineering technologies of enterprises. As the protection of product upgrading and reconstruction of these enterprises as well as their survivals, the modern biotechnology requires the bioengineering program to cultivate “creative, innovative and entrepreneurship capable”

application-oriented engineers with systematic training. The bioengineering program shall orient to engineering first-line, reinforce science and biological foundation, highlight the development of engineering practice ability and innovative awareness, strengthen the combination of upstream and downstream of bioengineering, emphasize on the integration and permeation of modern biotechnology, and achieve the features and advantageous of bioengineering program improved through the reform of traditional fermentation engineering. This provides strong talent and intellectual supports for local economic development.

B. University-enterprise Collaboration Platform

During the practical graduation project teaching process, based on government-industry-university-research cooperation, the university practice and mass production of enterprises are combined organically according to the policy orientation to establish different types of engineering practice platforms, such as engineering simulation, engineering technology center, engineering production within enterprises, engineering application, etc. Focusing on engineering practice, the application-oriented bioengineers with strong manipulative ability, design ability, operational ability and management ability shall be cultivated at the production first-line[4]. The engineering design in university shall emphasize on engineering simulation, such as factory and plant design, equipment improvement, or develop new technologies and new products in considering of the practical demand of enterprises. The engineering training in enterprises includes technology improvement and implementation, R&D and pilot scale test of new product as well as industrialized production, product quality evaluation and supervision, etc. The practical engineering training enables students to consolidate and broaden their professional theoretical knowledge, get familiar with professional fields, enhance their learning initiatives and purpose, develop theory-practice combination ability, practical problems solving skills, professional engineering quality and engineering ability, intensify training of comprehensive ability and independent working ability, increase their innovative awareness and preliminary social adaptation capability, understand and master the production, running, management and marketing of biological products, and learn design, installation, construction and maintenance of biological product preparation project, thus becoming qualified application-oriented engineers with satisfactory skills and abilities. Students will learn and master solutions of a series of problems including product R&D, technical innovation, equipment upgrading, quality evaluation and scaled implementation by using various types of platforms.

C. Diversified Topic Source

The diversified topic source of graduation project is manifested by different topic source channels, different engineering degrees and different topic implementation conditions. Topics come from engineering practice, enterprise innovation and technical innovation (including technical improvement, product R&D, etc.), various horizontal topics, national and provincial as well as city foundation projects, industrial and agricultural technological supports, Scientific research projects, technology-based poor areas supporting, Spark Program, the Scientific and Technical Development Plan

of Northern Jiangsu, Students Research Fund (SRF), the project of science and technology innovation for student, etc. Generally speaking, the bioengineering topics are closely related with local special superior sources of biological product, such as attapulgite clay resources and biological controlled-release, traditional brewing and engineering strains, vegetables & foods and functional development, agricultural straw and comprehensive utilization, biosafety and quality control, etc.

Topics with different source channels have different requirements on engineering approaches as well as emphases of engineering training, platforms for topic implementation, environment, etc. For instance, technical reform of process route or equipments won't achieve success without basic theories and practices of engineering knowledge, such as engineering drawing, process technology, processing techniques, and so on. Furthermore, the development of new products requires comprehensive consideration to the function, value, quality, safety, production, environmental protection, energy conservation, and economic and social effect of the products.

D. Interdisciplinary Combination

As a teaching program with strongest comprehensiveness, graduation project can reflect students' ability training mostly in universities, which attracts attentions from government, industry, university, research institutes and application department. With human beings' continuously deepening understand on the nature, the current scientific and technological development represents a contradictory trend of high-segmentation and high-integration. Disciplines are divided further specifically, thus narrowing the knowledge scope of researches of different fields. Therefore, interdisciplinary cooperation is necessary to solve some problems. This requires graduates not only have solid professional foundation, but also can be engaged in interdisciplinary compound innovation. In other words, talents cultivation shall be shifted to diversified and interdisciplinary talents. Particularly, local engineering universities oriented at engineering first-line and targeted at application-oriented talents cultivation are more in need of interdisciplinary knowledge combination. The establishment of interdisciplinary knowledge system based on the organic integration of theories, methods and thoughts of different disciplines reflects the integration of science[5]. Substantially, this is permeation and integration of knowledge systems, integration of academic ideas, integration of cross-thinking modes, and reflection of systematic dialectical thoughts.

Traditional innovation often focuses on the benefit of single innovation, product innovation, great innovation and explicit innovation, but lacks of multiplicity, dynamics and collaboration. Therefore, to change such traditional perspectives, the technical innovation behaviors shall be studied from the perspective of systematic viewpoint, combination and integration, aiming to increase the innovation ability and innovation benefit[6]. For instance, the "Manufacturing of Solar Energy Temperature Controlled Carrying Case of Biochemical Products" requires multidisciplinary knowledge combination of biology, biosensor, electronics, mechanics, and measurement and control. The "Development of Water-free Alive Transportation Technology of Freshwater Fish" needs effective combination of biotechnology, physiology and biochemistry, transportation

mode, transportation vehicles, vibration control, quality evaluation, etc.

E. Staged Student Involvement

Graduation project needs comprehensive knowledge, involving knowledge points of all grade levels. Students can participate optionally at different times of different stage according their knowledge structure and topic demand. Different knowledge learned at different grades will result in different understanding on the topics. With limited knowledge structure, lower grade students can assist senior students, during which they will learn and get proficient in basic skills, thus having a preliminary understanding on the process and requirement of graduation project. Students are asked to be engaged in topic selection, information search, project design, implementation and operation and data processing previously since sophomore year of professional basic course learning, thus understanding and master the whole process of problem analysis and solving.

According to the teaching system, there are many approaches for students to be engaged in topics or engineering practice training, including technical improvement, equipment upgrading, new product R&D, market survey, project design, quality control, mass production, etc, aiming to improve the cultivation of practice ability and spirit of innovation. Among these approaches, specific single approach has different main content of ability training from each other. For example, equipment upgrading emphasizes on improvement of mechanical structure and circuit or equipment selection, and quality evaluation focuses on analysis, detection and indicator control, whereas product R&D focuses on project design and implementation on the basis of market survey and determined goal. Since the engineering implementation platforms for different types of topics have different demands, staged involvement and whole process involvement are optional to students.

F. Hierarchy of Ability Cultivation

Graduation projects can fall into four types, namely, common graduation project, comprehensive graduation project, creative graduation project and developing graduation project. The cultivation of their corresponding comprehensive quality, practice ability, spirit of innovation and engineering ability has the characteristics of hierarchy. Basic practice ability and engineering application ability are necessary for common engineering simulation design, while engineering comprehensive ability and engineering innovation capability are essential for technical improving and developing graduation project. For specific topics of graduation project, some are represented with single hierarchy, whereas some belong to the comprehensiveness of multi-hierarchies. The three-dimensional graduation project teaching system with engineering characteristics adopts various measures such as regarding theoretical studying of graduation practice and practice equally important, cooperation between universities and enterprises, developing engineering practice and technical reform simultaneously, in order to foster application-oriented engineers with practice ability and spirit of innovation. In this system, experimental learning and creative learning in universities are the basis, whereas innovation and entrepreneurship are the goal, which can be achieved through

different approaches at different stages and different hierarchies. The systematic training enables students to understand and master the method of mass production of technological products preliminarily, thus laying technical and ability foundations for future innovation and entrepreneurship.

G. Integration of Entrepreneurship and Innovation

In considering of graduate employment situation and state advocated entrepreneurship situation, the entrepreneurship education and venture entrepreneurs cultivation in university to driving employment through entrepreneurship become an important solution of graduate employment[7]. Under the innovation and entrepreneurship education background, integrating entrepreneurial technological reserve and innovation practice organically to develop and reserve innovation entrepreneurial technologies is not only the reification and improvement of innovation and entrepreneurship education, but also the organic combination of learning and reserving of entrepreneurial technology and innovation practice. The innovative entrepreneurial technology is different from entrepreneurial technology. Entrepreneurial technology is not always a new technology and has technological inventiveness. Even it is a new technology, the entrepreneurial technology still has to be improved under the idea of integration of entrepreneurial technological reserve and innovation practice. At least, technological improvement according to the conditions of entrepreneurship is necessary to develop a new entrepreneurial technology appropriate for the conditions of entrepreneurship and strive to reach the highest level of new technology or become the representative of the highest level of new technology. The integration of entrepreneurship and innovation is different from innovation practice. Innovation practice doesn't always develop entrepreneurial technology, but may develop a new theory, method, idea or technology. However, the integration of entrepreneurial technological reserve and innovation practice will surely result in innovative entrepreneurial technology. Universities, as important base of talent cultivation, assume the important mission of fostering high-quality talents with innovative awareness, spirit of innovation and entrepreneurship.

Such integration can be realized the most easily during graduation project as it enables students to try the combination of innovation and entrepreneurial technology and experience innovative entrepreneurial technology in universities. Innovation is the basic requirement of graduation project. It is common to develop a technology, such as proposing a new production technique, accomplish product design and processing, develop a new kind of food, etc. All students can develop a technology. If these developed technologies are applied to start a business, then the goal of ability training is achieved through the integration of innovation and entrepreneurship in graduation project. The integration outcome can acquire intellectual property protection by patent application. For example, the water-free transporter of living fish, a technology that was developed during graduation project and can be used to start a business, has complete design drawings and design instructions, and achieves patent protection. Since this patent technology was developed by teachers and students together, it is shared by teachers and students. Furthermore, the joint patent application between teachers and students not only can stimulate students'

enthusiasm for participating in the integration of entrepreneurial technological reserve and innovation practice, but also enable them to increase their achievement protection capability by learning and experiencing patent application.

IV. CONCLUSION

To sum up, graduation project is the core teaching program of cultivating engineers for engineering first-line, which requires various pre-training bases. Students' practical manipulative ability, R&D capabilities, ability to solve practical engineering problems and innovation entrepreneurship are all closely related with graduation project. The achievement of the three-dimensional graduation project teaching system with engineering characteristics results from the integration of various aspects. Currently, it has been widely applied in pharmaceutical engineering and vehicle engineering except for the bioengineering and achieved good effect, thus indicating its applicability to other engineering programs.

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