

Research on the Cooperation Model of Cooperative Education in Deep Integration of Universities and Enterprises*

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Abstract—Higher engineering education is closely related to the development of social economy and the upgrading of industry in China, and it has two attributes: education and engineering. This decides that only the deep cooperative education of universities and enterprises can ensure the quality of engineering science and technology personnel training. By analyzing the demand foundation of the deep cooperative education of universities and enterprises, and problems and causes in the process of cooperative education of universities and enterprises in China, this paper explores and researches the cooperation model of cooperative education in deep integration of universities and enterprises, taking the reform and innovation of Engineering Education in college of communication engineering in Chengdu university of information technology as an example.

Keywords: *higher engineering education, cooperative education, deep cooperation*

I. INTRODUCTION

Higher engineering education is a kind of education which combines the theory of natural science and engineering technology with the practice of modern production technology, which is an important part of Higher Education. It is mainly to train engineering science and technology talents which have the ability to engineering planning, design and development, the ability to engineering organization and management, benefit concept of engineering quality, and innovation. [1] [2] [3] [4] Engineering science and technology is an important driving force of social and economic development. The development of engineering science and technology is inseparable from

engineering science and technology talents. Moreover, the development of engineering science and technology is inseparable from higher engineering education for training engineering science and technology talents.

Higher engineering education is regarded as the cornerstone of promoting economic and technological development of a country in future. The quality of higher engineering education will have a profound impact on comprehensive national strength of a country.

Since the 21st century, information and globalization bring about fierce competition in economy and technology. How to train engineering science and technology talents in line with the requirements of the times has become a subject that higher engineering education in the world. Developed countries such as Europe, America and Japan had started a new round of reform and deployment of higher engineering education as early as last century. The "sandwich" model in the UK, the dual system model in Germany and the "New Apprenticeship" model in Australia are all based on the needs of enterprises. They pay more attention to the cultivation of students' professional ability, social ability and comprehensive professional ability. This kind of training concept and model promotes the development of industry and economy of the country. The "enterprise education" in Japan, the "cooperative education" in the United States, the "contract system" in France, the "simulation company" in Denmark and the "teaching factory" in Singapore all strengthen the connection between universities and enterprises. They carry out the cooperative development of technology and the cooperative cultivation of students' engineering ability and quality for application of engineering. [5] [6] [7] [8] [9] [10] [11] [12]

At the beginning of the founding of new China, colleges, especially all kinds of engineering colleges have trained a

*Fund: This paper is supported by Sichuan Science and Technology Association and Research on the School-Enterprise Deep Integration Innovation Mechanism Based on Sichuan School-Enterprise Collaborative Innovation Platform under Grant No.2018kxkjzkc10.

large number of engineering science and technology talents to serve the economic development and modernization for our country. But, with the rapid development and gradual transformation of social economy, higher engineering education can't meet the requirements of industrial upgrading and overall economic sustainable development at present. Many problems have been exposed, Such as unclear training objectives, education without regard to social reality, imbalance of teaching and research, assimilate education, few engineering practice links, and so on, which seriously affect the quality of Engineering Science and technology personnel training. Colleges are the main body of engineering education, and the enterprise is the implementation unit of the project. The two attributes of higher engineering education, education and Engineering, decide that the deep cooperative education of universities and enterprises is the inevitable way for improving the quality of higher engineering education and training qualified engineering science and technology talents.

II. ANALYSIS OF COOPERATION DEMAND IN COOPERATIVE EDUCATION IN DEEP INTEGRATION OF UNIVERSITIES AND ENTERPRISES

The model of higher engineering education in cooperative education in deep integration of universities and enterprises is combining the advantages of universities and enterprises, transforming enterprises from simple employing units to joint training units for talents, letting enterprises deeply participate in the implementation process of higher engineering education, and achieving the goal of complementary advantages, resource sharing, mutual benefit and common development, based on the actual application requirements and engineering projects.

A. Demand for talent training in cooperative education in deep integration of universities and enterprises

Colleges, especially engineering colleges, as main training places for engineering science and technology talents, most of the graduates are sent to enterprises for employment every year. They are the new force in the production, operation and innovation activities of enterprises. The quality of talent training in universities will directly affect the production efficiency and business development of enterprises. A qualified graduate needs to master solid theory and excellent skills and corresponding professional quality for completing the transformation from college students to enterprise employees quickly, integrating into the corporate culture and adapting to the requirements of enterprise posts. So, as talent consuming units, enterprises must not stay out of the process of talent cultivation. In order to cultivate engineering science and technology talents to meet the needs and standards of enterprise talents, they need to actively cooperate with universities.

B. Demand for cost effective in cooperative education in deep integration of universities and enterprises

Cost is an important factor affecting the profit and market share of enterprise products. How to reduce costs and

maximize profits is the unremitting pursuit of enterprises. With the rising price of labor market in China, the proportion of employment cost in the cost of enterprises is increasing. The process, that they as employees can create value for the enterprise from recruitment publicity, personnel condition review, staff pre job training to staff on duty, requires the enterprise to invest a series of human costs. Meanwhile, the enterprise needs to bear the loss caused by brain drain. On the other hand, the effective implementation of higher engineering education needs the engineering environment and conditions for personnel training. Colleges need guidance teachers with teaching and engineering experience as well as reasonable and detailed engineering practice syllabus and assessment mechanism which need a lot of human and financial resources and the cost of management coordination. However, these investments have greatly increased the pressure on university personnel training funds.

So, we have explored an effective way to reduce the cost and risk of enterprise employment and reduce the pressure of funds for engineering talents training in universities: making rational use of the resources of the enterprise in the field, equipment and personnel, putting the training, investigation and selection of talents what should have been done in the enterprise into the stage of engineering education in universities, and realizing the seamless connection between students' university study and enterprise work.

C. Demand for innovation and transformation in cooperative education in deep integration of universities and enterprises

Innovation is essential to maintain the long-term vitality and market advantage of enterprises. Enterprises without innovation advantages and core technology are difficult to develop sustainably. Some large enterprises have R&D centers or science and technology innovation bases. But, they still do not have R & D strength in some cutting-edge or cross cutting areas. Small and medium-sized enterprises basically do not have independent scientific research institutions and specialized scientific and creative personnel. In the process of production and operation, it is difficult for them to arrange funds, personnel and time to promote innovation. On the other side, colleges have the advantages of talents, scientific research and innovation. Every year, colleges accumulate a large number of scientific research achievements in the academic frontier, national and local special subjects at all levels. And, these achievements need to be transformed to produce economic benefits.

So, we should do something to improve the level of research and creation of enterprises and maintain technical advantages, strengthen the connection between scientific research, engineering, and engineering education, and promote the cultivation of innovation ability of engineering science and technology talents. Such as, we can combine the advantages of colleges and universities in talents, scientific research and resources with the expertise of enterprises in project implementation, project management and marketing, and develop depth cooperation in technological innovation and personnel training.

III. ANALYSIS OF PROBLEMS AND CAUSES IN MODEL OF COOPERATIVE EDUCATION OF UNIVERSITIES AND ENTERPRISES AT PRESENT

The cooperative education of universities and enterprises in higher engineering education in China has a long history. The university mainly completes the teaching of students' basic knowledge and professional theory, and sends students to enterprises and other production and operation units for practical training. With the development of economics, some universities carry on the reform and attempt in the aspect of cooperative education of universities and enterprises. Some modes are established, such as "3 + 1" mode, learning and work alternation mode and enterprise order. Yet, it's not obvious in effect of comprehensively improving the quality of engineering education. According to a series of survey results on the comprehensive quality of Chinese engineering graduates by the Department of higher education of the Ministry of education and the Consulting Service Department of the Chinese Academy of Engineering, the engineering science and technology talents are still seriously inadequate in the overall development of comprehensive quality in China. These talents have many deficiencies, such as narrow knowledge, poor social adaptability, lack of innovation spirit and ability, poor sense of social responsibility and lack of team spirit.[4] The decline of the training quality of Engineering Science and technology talents in China is closely related to many problems existing in the cooperative education between universities and enterprises. [13] [14] [15] [16] [17] [18] [19] [20]

A. *Not strong enough in cooperative education of universities and enterprises*

At present, the policy environment and guidance mechanism are not perfect in China. As the direct participant of cooperative education of universities and enterprises, universities, enterprises and students all have different degrees of insufficient willingness, resulting in the weak promotion of cooperative education of universities and enterprises.

1) *The lack of awareness of the importance of university enterprise collaboration leads to the lack of willingness to cooperate*

At present, universities mainly rely on professors' academic reputation and overall scientific research level to improve their popularity and influence in China. Therefore, in the design of talent selection, professional title evaluation, assessment and reward system, we pay more attention to teachers' scientific research topics and achievement indicators. On the other side, compared with the long process of personnel training and difficult to evaluate, university teachers prefer scientific research with fast output and relatively clear benefits. The education in China has some attributes, such as the value orientation of evaluating universities, the evaluation index of teachers by university, teaching and research. It's the different attribute itself leads to the phenomenon that scientific research is more important than teaching in universities. It is this phenomenon that directly affects the full play of the basic function of higher

education. The cooperation between universities and enterprises is often limited to scientific research. The lack of willingness and motivation of University executives and teachers to introduce school enterprise cooperation into education leads to the relatively closed teaching system in universities. Now, we can see the disconnection between teaching and social needs, less class hours of engineering practice courses, insufficient training of students' practical ability.

2) *The difference of construction value between universities and enterprises leads to insufficient continuous investment of both parties*

The purpose of training students in universities is training students' sound personality, improving students' professional skills and ability to master knowledge, training students to be successors of socialism. The social responsibility of universities is to train talents. Their social attributes in education are difficult to bring profits to enterprises directly. And yet, there is a strong economic brand in the construction value of the enterprise, which focuses on the maximization of the economic benefits. Under the pressure of market competition and survival, it is difficult for small and medium-sized enterprises to invest limited capital and human resources in such fields as higher engineering education, which have slow results and uncertain returns. At the same time, some factors seriously affect the enthusiasm of enterprises to participate in collaborative education. The operation and management mode of enterprises do not fit well with the education mode of universities. The rhythm of enterprise project implementation and the process of university education lack of sound planning and design. We lack of good communication and bonding mechanism between universities and enterprises. And there is a phenomenon of poor cooperation or half-way progress in cooperative education projects.

3) *Low recognition between universities and enterprises influences the willingness of both parties to invest*

The form of educational activities in universities is that students are the main body and teachers play a leading role. In the meantime, universities take cultivating high-quality students as the core to fully display spiritual culture and material culture.

On the otherwise, the main body of an enterprise is its employees. Employees are the creators of corporate culture and the main force of corporate development, bearing the important task of creating wealth for enterprises. While creating material wealth for the enterprise, employees display the spiritual wealth of the enterprise, which directly affects the economic benefits and the healthy development of the enterprise. Only when students enter the society can they become employees. The difference of the two social roles leads to the different recognition of each other, which indirectly affects the development of school enterprise coordination.

4) *Whether the ability of students to adapt to and respond to social development matches the needs of enterprises directly affects the results of school enterprise*

collaborative education, and indirectly affects the willingness of both sides to invest

As the object of cooperative education of university and enterprise, students lack systematic guidance and effective management in professional learning and career planning. They have certain blindness in learning, and unclear learning direction. Their learning process tends to be fragmented and superficial. Also, their study mentality is impetuous and utilitarian. They lack the spirit of serious concentration and hard work. This leads to their poor technical ability and engineering ability, weak social adaptability, and inability to be competent for the relevant work of the actual project. In the end, they lose their confidence and interest in participating in engineering projects.

B. A single form of cooperative education of universities and enterprises

At present, universities in our country generally adopt the ways of visiting practice, centralized practice, graduation practice, establishing the university enterprise joint education laboratory and establishing the talent training fund project. This is mainly to reduce the cost of teaching, reduce the complexity and workload of practice and control the risk of personnel management.

But, there are some defects in these ways, which directly affect the effective play of school enterprise cooperative education:

- Students are too concentrated to ensure the effect of practical training;
- Elite training can't cover all students' problems.

C. Superficial depth of cooperative education of universities and enterprises

At present, the main contents of cooperative education are centralized visit and training, production practice or customized training of talents. However, there is still a lack of effective mechanism to introduce enterprise projects into the training system of engineering education, and curriculum system for enterprises to participate in the training of engineering talents. The enterprise is the assistant and passive role in the process of cooperative education. This leads to the fact that some practical training links are at a shallow level. Interns in the production line often become the "burden" of enterprises due to their insufficient capacity. The uncertainty of the future employment of these interns also leads to the unwillingness of enterprises to carry out in-depth training. These shallow modes of cooperation lead to formality in some aspects in cooperative education of universities and enterprises. Part of the joint education bases lack the content of substantial education.

IV. RESEARCH ON THE DEEP COOPERATION MODEL OF HIGHER ENGINEERING EDUCATION IN UNIVERSITIES AND ENTERPRISES

The college of communication engineering (College of Microelectronics) in Chengdu university of information

technology makes full use of their own disciplinary advantages and professional characteristics, carries the cooperation between universities and enterprises and promotes the integration of industry and education to connect with the development of local information industry and talent demand actively. They insist on Open Education and take resources of industry, industry and enterprise attracted to the whole process of Engineering Science and technology personnel training. The college has gradually formed a mechanism cooperative education between universities and enterprise and a teaching mode. There is a carrier for business participation, support for practical teaching, guarantee for project progress, maintenance for school-enterprise relations, guidance for student practice, and passion for teachers.

A. Reforming management model and establishing institutional guarantee

According to the guiding spirit of the outline of the national medium and long term education reform and development plan (2010-2020), the university (Chengdu university of information technology) accurately grasps the development orientation and optimizes the balance between scientific research, theoretical teaching and practical teaching. They respond to and implement national policies and measures on engineering education reform actively. They promote international CDIO Engineering Education Mode and excellent engineer program actively, too. They organize and coordinate the departments such as the academic affairs office, the science and technology office, the Youth League Committee and other teaching units to actively participate in the reform and practice of College Students' engineering practice and innovation and entrepreneurship. It has established engineering practice and innovation platforms such as Chengdu innovation space, college students' innovation and entrepreneurship club and college students' Innovation Laboratory of each secondary college. It has introduced relevant systems and implementation plans in terms of special funds support, school enterprise rights and responsibilities specification, practical training of teachers, mobilization and incentive of teachers and students, and achievement assessment and recognition.

The College of communication engineering further detailed the management of the practice teaching base outside the university, the training and selection of the engineering practice guidance teachers, the credit recognition of the students' practice innovation link and the performance evaluation of the teachers' practice teaching. These provide a strong institutional guarantee for the sustainable development of cooperative education of universities and enterprises.

On the management of the practice teaching base outside the university, the college and enterprises jointly build joint laboratories to encourage students to participate in innovation and entrepreneurship project competitions organized by all levels and well-known enterprises. Enterprise engineers and teachers train, select, optimize and manage student teams based on projects. They cultivate

technical backbone and innovative talents jointly in the process of promoting the implementation of the project. Meanwhile, the college serves the enterprise, meets the industrial demand of the enterprise and provides talents for the enterprise.

In the selection and employment of engineering practice instructors, the college requires teachers to have high level of professional knowledge, reasonable knowledge structure and the ability to solve complex engineering problems. Teachers must run the method (Conceive-Design-Implement-Operate) through the whole course of engineering practice. In the training of engineering practice instructors, the college has established a set of quality standards. Teachers must attach importance to the training and cultivation of students' comprehensive thinking ability, team cooperation method, leadership ability and effective communication ability. They must attach importance to the training and cultivation of students' systematic conception, engineering ability, design ability, implementation ability and operation ability in the limited environment.

On the link of credit recognition of students' practice and innovation, the college encourages students to participate in discipline competitions, innovation and entrepreneurship projects and scientific research projects for guiding them to learn the method of conception design realization operation. Under the guidance of the instructor, students have been approved and successfully completed the "university students' innovation and Entrepreneurship Project" at or above the school level, they can get the credit. Also, if they participate in the research project of the teacher and get the approval of the teacher, or, they participate in all kinds of subject competitions under the guidance of their tutors, they can get some credits.

B. Strengthening the construction and maintenance of the practice base outside the university

If colleges and universities want to strengthen their foreign cooperation, they should actively cooperate with their majors to cultivate talents, and establish an off campus practice base for enterprises with good educational conditions and development prospects. At the same time, they need to pay attention to the continuous construction and effective maintenance of the base.

In recent years, the college has established practice training bases for college students with more than 20 excellent enterprises including Sichuan communication planning and Design Institute and Chengdu Telecom Bureau. The college selects teachers with rich engineering experience and professional orientation as liaison persons to connect with enterprise engineers. The liaison person is responsible for communication with the enterprise and tracking the production and innovation needs of the enterprise to discover, plan and introduce projects suitable for collaborative education in time. Liaison persons and enterprise engineers complete the guidance and management of students. The college keeps close contact with its alumni. Through alumni docking,, the teaching and research office leads teachers to

investigate enterprises in various provinces and open up new off campus practice bases each year. This kind of way of special person docking, active and timely communication effectively keeps the viscosity and enthusiasm of the relationship in cooperative education of universities, and enterprises and ensures the effect of cooperation and communication.

C. Establishing an effective guidance system and refining the guidance work of students

The engineering education teachers are organizers and implementers of engineering practice teaching. The cultivation of high engineering science and technology talents is inseparable from the careful guidance of engineering education teachers. Only by establishing the teacher-student relationship can we meet the requirements of meticulous and continuous engineering practice teaching. In view of this, the college took the lead in the implementation of the undergraduate tutorial system in China. This tutorial system starts from sophomore year. Students in a group of 5-6 establish a guiding relationship with their undergraduate tutors through voluntary double selection. The original intention of the system is to eliminate the blindness in students' study, guide students to find the direction of major, and promote students' rapid growth and talent through the guidance of undergraduate tutors in professional study and career planning.

With the implementation of CDIO Engineering Education Concept in our university, in order to meet the requirements of refined guidance of engineering education, the college creatively combines the engineering practice course originally adopting centralized teaching with the undergraduate tutorial system. This way disperses the pressure of centralized guidance to ensure good teaching effect. In order to ensure the quality of personnel training, undergraduate tutors need to have good teaching ability and engineering experience. The undergraduate tutor is usually the enterprise liaison teacher of the college. The undergraduate tutor cooperates with the enterprise experts to guide the students in communication ability, engineering comprehensive ability, talent demand for enterprise development, etc.

In addition, the college has also implemented the student guidance system by making use of the closeness and model effect among students. Undergraduate guidance students are senior students with excellent performance and strong practical ability. They provide supplementary guidance to junior students in professional learning, discipline competition, innovation and entrepreneurship. At the same time, the college takes the class as the unit and provides a class tutor for the freshmen. Class tutors can help freshmen adapt to university life quickly, answer students' doubts and understand the knowledge system of their major, etc. Through the effective implementation of the guidance system, student guidance system and class guidance system, the college has gradually formed a multi-level and refined guidance system.

D. Integrating engineering practice teaching links and establishing an engineering education curriculum system that is conducive to the effective promotion of engineering projects

In the training program, the college invites enterprise experts to work out training programs together. Enterprises put forward specific requirements in terms of education concept, training objectives, graduation requirements, practical curriculum system, etc. At present, the college has established a three-level practice teaching system of professional course experiment, professional comprehensive practice project and engineering practice project. During the internship, the metalworking internship, the visiting internship, the production internship, and the graduation internship-based internship training system have been established. In the field of innovation and entrepreneurship, the comprehensive literacy and innovation ability teaching system based on innovation and entrepreneurship education, subject competition and graduation design has been established.

According to the characteristics of each practical teaching course, combined with the engineering projects of enterprises and the continuous requirements of students' ability training, and taking the engineering practice course as the carrier of cooperative education, the college has integrated the practical teaching links such as innovation and entrepreneurship education, discipline competition, production practice, graduation practice and graduation design. From the first semester of sophomore year, the undergraduate tutor introduces the collaborative education project into the course from the enterprise. In the following five semesters, the undergraduate tutor and the enterprise engineer jointly guide the student team to complete the conception, design, implementation and operation of the project. At the same time, they find innovation points in technology and application, apply for patents, publish papers and participate in discipline competitions. According to the needs of project implementation, they guide students to the corresponding off campus joint education base to carry out internship and practical training in various stages and even complete the graduation project.

At present, the college introduces nearly 50 collaborative education projects from enterprises through undergraduate tutors every year. These projects can meet the needs of engineering practice teaching of all students in a grade. In recent years, students have made outstanding achievements in the application and conclusion of innovation and entrepreneurship projects, patent application and paper publication, as well as award-winning discipline competitions, etc. Students' engineering ability and element have been improved, social adaptability has been enhanced, and industry recognition has been significantly improved.

It has been proved by practice that with the engineering practice course as the carrier and the collaborative education project as the main line, the reasonable integration of multiple links in the engineering practice teaching system ensures the personnel stability and time continuity necessary

for the implementation of the engineering project as well as the consistency and continuity of the training of students' engineering technology direction. This kind of education mode promotes the improvement of students' comprehensive ability, the implementation and innovation of enterprise engineering projects, and also promotes the formation of a win-win situation between school and enterprise.

V. CONCLUSION

The improvement of the quality of higher engineering education cannot be separated from the in-depth cooperation between universities and enterprises. Colleges are the main body of the implementation of engineering education. Colleges must recognize the importance of engineering education. Colleges must actively change their ideas, break through the traditional ideas, find out the development orientation, strengthen foreign exchange and cooperation, comprehensively reform the management mode and training system, and explore and practice a way of school enterprise collaborative education in line with their own disciplinary advantages and professional characteristics. The model of cooperative education in deep integration of universities and enterprises, proposed and implemented by college of communication engineering in Chengdu university of information technology, provides reference for the reform and innovation of engineering education.

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