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Research and Practice on the School-Government-Enterprise Cooperative Education Mode of "Trinity, Quartet Linkage"

—Taking Mechanical Engineering College of Beihua University as the Example

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***Abstract*—Under new economy background, local universities need to carry out open-door education to build the new education ecology with open and harmonization. With the principle of "resource sharing, complementary advantages, mutual benefit, common development", Mechanical Engineering College of Beihua University actively promoted the joint school-running, cooperative education, cooperative development and cooperative employment between school and enterprise, explored and implemented the school-government-enterprise cooperative education mode of "trinity, quartet linkage", to deepen industry-education integration. In many ways such as order training between school and employer, staged training between school and enterprise, alternately training between teaching place and work post, we focused on training the applied engineering and technical talents who meet the needs of industrial development, strived to comprehensively integrate the structural elements of supply side and industrial demand side of talent training.**

Keywords—school-government-enterprise cooperation; cooperative education; industry-education integration; applied talent

I. INTRODUCTION

At present, a new round of scientific and technological revolution and industrial transformation is accelerating around the world, and China's economic development has entered the new normal and higher education has entered the new stage. Engineering education is closely related to and mutual influence on the engineering technical talent training and the industrial development. How to adapt to the development of strategic emerging industries and meet the urgent demands of these industries for high-quality applied talents is an important topic faced by local university engineering education.

Now, there still exists the supply-side contradiction that university students cannot find the ideal jobs and enterprises cannot find the suitable employees in China's higher education. The root of the contradiction is that supply side and industrial demand side of talent training isn't fully corresponding in the structure, quality and level, the "two-layer skin" problem remains. The root cause is: Universities' training process does not introduce the teaching resources of enterprises in time, the teaching content fails to timely increase the actual needs of enterprises, the effective mechanisms which industry personnel participate in formulating talent training program, teaching and evaluating have not yet been established or incomplete, the effective ways which students and teachers carry out the practice and training in enterprises have not yet been found. To promote school-enterprise cooperation and deepen industry-education integration, to encourage enterprises to participate in the whole talent training process, and to promote organic connection between education chain, talent chain and industry chain, innovation chain are the urgent requirements to push forward the supply-side structural reform of human resource. Also have great significance to improve education quality comprehensively, to expand employment and entrepreneurship, to promote economic transformation and upgrading, and to foster the new drivers of economic development under new situation.

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II. The School- Government-Enterprise Cooperative Education Mode of "Trinity, Quartet Linkage"

To promote Beihua University's education system and mechanism innovation and improve the quality of engineering talent training, since October 2015, the school leaders, related personnel of Recruitment and Employment Office and Mechanical Engineering College have gone to Ningbo region of Zhejinag province in China several times to investigate, survey, negotiate. Since then, we have explored and practiced on the school-government-enterprise cooperative education mode of "trinity, quartet linkage". Now, the work pattern of cooperative education by government, university, enterprise and third-party professional personnel service agency is formed.

The trinity means that government, university and enterprise cooperate to set up the practice and employment platforms for students. The quartet linkage means that government, university, enterprise and third-party professional personnel service agency jointly construct the talent training system.

Government is responsible for issuing policies, establishing platforms, regulating and guiding macroscopically. University is responsible for carrying out teaching capital construction, implementing teaching reform and providing customized student source. Enterprise is responsible for participating in university teaching, providing internship positions and recruiting graduates. Third-party professional personnel service agency is responsible for developing internship base, assisting enterprise to establish the internship system of undergraduate, providing internship guidance services for undergraduates, assisting universities to carry out education and teaching reform and recommending undergraduates for employment.

III. Order Training Between School and Employer

In July 2016, with the support of human resource and social security bureau of Ninghai county and the coordination of Ningbo Lvxing enterprise management consulting co., LTD (third-party professional talent service agency), Beihua University signed the school-enterprise deep cooperation agreement with Shuanglin group. In September 2016, we established two outstanding engineer classes of mechanical manufacturing and mold design and manufacturing for order training among 2016 mechanical specialty undergraduates, named Shuanglin customization class. The two classes will implement the "3+1" training mode, namely, the undergraduates will study on campus for the first three years and will enter the enterprise in the last year. During on campus, the additional enterprise courses such as vocational quality, enterprise culture, engineering technology, project management, enterprise expert lecture, enterprise innovation case analysis, etc., are set and taught by part-time teachers in the enterprise. During in enterprise, enterprise cognitive practice, workshop post practice, department post practice, post-practice and graduation design is arranged and jointly guided by the college teachers, enterprise engineering technical personnel and management personnel.

In the process of order training, third-party professional personnel service agency shall coordinate with university and enterprise to jointly formulate talent training standards, jointly plan training programs, jointly improve the curriculum system, jointly develop textbook, jointly construct teaching teams, jointly build practice bases, jointly implement training process, and jointly evaluate training quality [1]. To do so, will enhance the cooperation and understanding between university and enterprise, can make university that is relatively closed to the updated information of technology, knowledge and talent demand type get a better understanding to the social needs, the teaching focus, can carry out teaching reform with a definite aim and establish the much-needed talent training system in the future, and can make the university talent training closer to the actual needs of society.

IV. Staged Training Between School and Enterprise

In October 2017, with the help of employment management service bureau of Ningbo city, administrative committee of the binhai new district in south Ningbo, human resource and social security bureau of Ninghai county, human resource and social security bureau of the Fenghua district of Ningbo city and Ningbo Lvxing enterprise management consulting co., LTD, Mechanical Engineering College of Beihua University contacted a number of enterprises in Ningbo region to hold the "graduation practice plus employment" supply and demand meeting of the college 2018 graduates. 134 students selected some enterprises for graduation practice, which broadened the channels for graduation practice and job hunting.

The enterprises provide practice instructors for graduates who are fully responsible for the specific internship affairs and safety management. The graduates get specialized skill training first under the guidance of enterprise practice instructors who teach specialized skills adopting the method of "modern apprenticeship" and the standardized mode of "imparting, help, leading", so as to ensure the graduates are familiar with the standards and requirements of respective posts in the enterprise, to achieve "zero distance" docking with post of duty [2], to lay solid foundation for the post practice. After the specialized skill training, the enterprise will assess the specialized skill of graduates. The graduates who have passed the assessment will begin to carry out post practice and work as "the prospective employee". The enterprise will give preference to graduates who perform well during the practice. At the same time, the practice period of the employed graduates can offset the probation period in the enterprise. For graduates who have participated in the entire practice process, the enterprise will issue corresponding practice evaluation and employment recommendation, and give priority to recommend to the relevant enterprises or directly arrange to the cooperative enterprises for employment.

V. Alternately Training Between Teaching Place and Work Post

Off-campus practice base is the practice and cognition base of undergraduate, and is an important place for undergraduate to contact with actual production and complete engineering cognition. Local universities must make full use of the region's resources and build the stable and effective cooperation bases of production, education and research relying on the surrounding enterprises to provide undergraduates with good practice place and conditions outside campus. Doing these can

enrich students' perception process from theory to practice, and train undergraduates' ability of knowledge application and transference, engineering practice, discovering and solving problem.

In recent years, our college has built 23 new off-campus practice bases. Relying on these enterprises, the mechanical engineering cognition practice, curriculum practice, specialty practice and so on has been carried out. We employed the engineering technical personnel and management personnel of these enterprises and set up the "enterprise teacher group" who participated in planning talent training programs to make the curriculum system more grounded, regularly came to the college to conduct the expert lectures, and served as practice and graduation design instructor. At the same time, our college established the technical cooperation relationships with these enterprises, jointly applied for the scientific research projects, organized technological breakthroughs, etc. Also we made full use of the faculty and laboratory conditions of our college to carry out employee training for the enterprises.

VI. JOINTLY CONSTRUCTING "DOUBLE-QUALIFIED" TEACHER TRAINING BASE

After the policy and environment is available, the specific teaching, guidance and demonstration need to be implemented by teachers. The ability and level of teachers are the key factors influencing applied talent training in local universities. Local universities should actively construct the platform for specialized teachers to go deeply into the first line of production and society to practice and train, and should strengthen the construction of "double-qualified" teachers, so as to constantly improve their practical skills, teaching and research level.

Since September 2017, under the coordination of Ningbo Lvxing enterprise management consulting co., LTD., our college has cooperated with two large and medium-sized enterprises in Ningbo to construct "double-qualified" teacher training bases. The enterprises undertake the training task of improving skills and rich experience of the teachers participating in training. The training mainly focus on studying the technology, skill, process and standard that applied in actual production in the technological post, as well as on perceiving and investigating of industry development trends.

A. Skill Training Content

The training helps teachers understand the variation tendency and update dynamics of new technology and new career development, taking the latest technology and vocational post needs of industry and enterprise as the main line. It attaches importance to the introduction and application of new knowledge, new process, new method, new standard, new material and new equipment, focuses on training teacher's skills, and cultivating their vocational quality and vocational spirit.

B. Skill Training Carrier

Through the task-based teaching, project teaching and post experience presentation, the training focuses on training the knowledge, skills and working attitudes required from fulfilling the products, tasks, projects and positions closely related to training the applied talents in university.

C. Skill Training Methods

The training is conducted by combining the guidance of "master leading apprentice" with the completing tasks by research and study group. The enterprise bases select technical backbone, project director, etc., as the master to guide teachers' training in the enterprise. The training focuses on group teaching, on-the-spot teaching, case teaching, role play, actual practice to really embody teaching by doing and learning by doing.

VII. JOINTLY CONSTRUCTING INNOVATION BASE OF INTELLIGENT MANUFACTURING BASED PRODUCTION AND EDUCATION INTEGRATION

To jointly train the intelligent manufacturing industry talents and conduct the applied technology innovation by enhancing cooperation of the education and scientific research resources between university and enterprise is effective way to train the industrial talent with higher vocational skills, certain innovation ability and international competitive ability, also is real response to the Outline of National Medium and Long Term Education Reform and the Development Plan(2010-2020) and Manufacturing Talent Development Planning Guide.

Since November 2017, relying on the "Internet Plus Made in China 2025" Industry-Education Integration Promotion Project of Ministry of Education of the People's Republic of China, our college has jointly constructed the innovation base of intelligent manufacturing based production and education integration with Beijing huashengjingshi economic information technology co., LTD. (third-party professional talent service agency), General Electric Company and Asea Brown Boveri Group(project cooperation enterprises). Based on the innovation base, three parties carried out the deep school-enterprise cooperation, including jointly building intelligent manufacturing system platform, jointly planning talent training programs and constructing curriculum system, jointly developing specialized course, servicing for innovation and entrepreneurship education.

A. Jointly Building Intelligent Manufacturing System Platform

The enterprises have invested in building an intelligent manufacturing system platform that can independently operate, support the specialized practice teaching and innovation and entrepreneurship education for the innovation base of intelligent manufacturing based production and education integration. The platform includes three units: the intelligent manufacturing production line experiment center, the industrial robot system integration experiment center and the industrial robot process application experiment center. The platform builds an ecological environment of future intelligent manufacturing factory which truly reproduces the whole production process of intelligent factory including design, production, debugging and operation. Each experimental unit not only can demonstrate the future intelligent manufacturing technology, but also can be disassembled flexibly, operate independently, so can train students' manipulative ability, solidify the knowledge learned, and improve students' comprehensive practice ability.

B. Jointly Planning Talent Training Programs and Constructing Curriculum System

With enterprise experts, we jointly planned the talent training programs of mechanical design & manufacturing and automation specialty. Also, we constructed the specialized curriculum system for the training orientation of intelligent manufacturing technology and industrial robot technology, and the hierarchical, modular, progressive innovation practice curriculum system formed four-level and stepped innovation practice teaching framework which is composed of the verification experiment, the comprehensive and designing experiment, the CDIO (Conception, Design, Implementation, and Operation) project, the innovation and entrepreneurship practice and scientific research training [3]. The verification experiment deepens students' understanding and application to the course learning content, and strengthens the training of their manipulative ability. The comprehensive and designing experiments deepen students' comprehensive understanding and application to the multiple knowledge points in the course, strengthens the training of their problem-solving ability. The content of CDIO project involves multidisciplinary and takes complex engineering problems as the background to simulate the whole process of product design and production. The innovation and entrepreneurship practice and scientific research training are based on the discipline competitions, scientific research projects and innovative and entrepreneurial projects, and focus on strengthening students' innovative ability.

C. Jointly Developing Specialized Course

Driving course reform with the industrial technological progress, we integrated and optimized the course content, constructed specialized courses by integrating enterprise and classroom, and focused more on training students' technology, skills and innovation and entrepreneurship ability [4]. Cooperating with the enterprises, we developed 10 applied courses, wrote 8 textbooks and 14 experiment guidebook. Taking textbook innovation of as the carrier, we carried out the construction of teaching resources and the organization of teaching activities in the form of virtual teaching, engineering case, micro class and engineering video. Also, we constructed the innovative practical courses by integrating enterprise and campus and implemented the task-type teaching mode oriented to the real production environment of enterprise.

D. Servicing for Innovation and Entrepreneurship Education

The enterprises participated in our college's innovation and entrepreneurship education process, our college and the enterprises jointly built the innovative industrial support environment, and improve the ability to participate in industrialised and large-scale industry projects through the integration of enterprise resources and the aggregation of product technology resources of the innovation and entrepreneurship team. We strengthened the construction and implementation of training system of innovation and entrepreneurship ability, and trained the innovative talents with initiative spirit, entrepreneurship awareness and innovation and entrepreneurship ability through the dual training path of innovation and entrepreneurship quality and innovation and entrepreneurship technology. Through teachers and students of the college participating in the practice activities of innovation and entrepreneurship project, teachers' and students' ability to solve practical engineering problems and the ability of technology innovation, technology integration and technology implementation would be trained.

VIII. Conclusion

The school-government-enterprise cooperative education mode of “trinity, quartet linkage” effectively inspires social forces to participate in the process of talent training. Enterprise personnel participating in the whole process of talent training enables the enterprise to change from simple employer to common talent training organization [5], which make university school-running move from the internal training in school towards school-enterprise cooperation training, and establish the good platform for improving students' social adaptability, practical ability and quality of employment and entrepreneurship.

Mechanical Engineering College of Beihua University took university-enterprise cooperation and industry-education integration as the sally port [6], further solved the student's problems “ideas more than practical ability, participator more than signatory at fairs, entrant more than remainder in enterprises” and teacher's problems “theory more than practical experience”, and have created good conditions for training the graduates who can endure hardship, master skills quickly, be proficient in professional work, have enough potential and stay in the original enterprise for a long time [7].

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