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RESEARCH ON PRACTICE TEACHING SYSTEM AND MODEL FOR EXCELLENT ENGINEERING PERSONNEL TRAINING

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ABSTRACT: *The cultivation of excellent engineering talent has become an important guide for personnel training in engineering schools in China. As the first implementation of excellence plan, School of Energy and Power Engineering in Jiangsu University,with the opportunity to train excellent engineering talent, in response to the major problems in the process of student engineering practice training, puts forward the concept of excellent engineering personnel training with "capacity-oriented, multiple synergies, and undergraduates and graduates integration". A series of positive and effective explorations have been carried out on multiple synergies and the long-term cooperation mechanism of school-enterprise cooperation, the practice system of deep integration of production and education, and the cultivation for integration of undergraduates, master students and doctoral students.*

KEYWORDS: Excellent Engineering Talent, Practical Teaching, Training System, Model, School-Enterprise Cooperation

In order to improve the quality of engineering education, to return engineering education to engineering, to promote China's progress from a big country of engineering education to a powerful country of process education,and to implement the Outline of the National Medium and Long-Term Education Reform and Development Plan (2010-2020), the Ministry of Education launched the "Excellent Engineering Education Training Plan" in 2010. The plan first piloted 61 undergraduates majors, and then extended to master's and doctoral degrees. The core of the "excellent plan" is to improve students' engineering practice abilities through joint training of schools and enterprises[1]. Jiangsu University, formerly a national key university of the Ministry of Machinery Industry, which has long been adhering to the reform and exploration of energy and power professional excellent engineering personnel training，has distinctive industry features, a solid engineering foundation, and an excellent tradition of emphasizing the cultivation of students' engineering abilities. Since the Ministry of Education has implemented the "Excellent Plan," Fluid Power Machinery and Engineering in Jiangsu University has been selected as the first excellent engineering plan, and personnel training has sought to establish a new consensus. There are some problems : lack of interaction between theory and practice in the cultivation of student engineering practice, lack of interaction between teaching and research, and lack of interaction between teaching and learning; single-minded training and loose cooperation between schools and enterprises; lack of integration of undergraduates, master students and doctoral students. In view of these problems, taking the

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opportunity of excellent undergraduates and excellent master students training in energy and power sciences as the turning point, the concept of excellent engineering talent with "capacity-oriented, multiple synergies, and undergraduates and graduates integration" was put forward. At the same time, it has formed the excellent engineering personnal training characteristics of undergraduates, master students and doctoral students. The main focus of the training is on improving the abilities to enhance excellence. The training system focuses on the tight integration of top-level design between the school and the enterprise. The training process is based on the multiple synergies and the deep integration of production and education. And the training method highlights the "student center". This article considers and summarizes the theoretical insights and practical experiences of excellent engineering personnel training on School of Energy and Power Engineering in Jiangsu University, with a view to attracting valuable comments and jointly promoting the research and development of higher engineering education in China.

1. Giving full play to the advantages of the industry, and building a long-term mechanism for multiple synergies and deep integration between production and education

The cooperation of government-industry institutions, multi-stakeholders and deep cooperation between schools and enterprises is an important guarantee for the implementation of the excellent engineering personnel training plan[2]. Relying on the State Key Discipline of Fluid Machinery and Engineering, the national water pump and system engineering technology center platform, the first brand specialty of Jiangsu Province, and the industry advantages and the long-term scientific research cooperation relationship with the enterprise, the School of Energy and Power Engineering in Jiangsu University specializes in further seeking the breakthrough of multiple cooperation. According to the orientation of students in this major, the first is to select the leading enterprises in the energy and power industry and large enterprises, especially the central enterprises and large and medium-sized state-owned enterprises. The second is to cooperate with internationally renowned foreign companies and joint ventures, especially the world's top 500 companies. The former has a high level of engineering and technical personnel, advanced technology and strong strength, a strong sense of responsibility, and showed great initiative in school-enterprise cooperation. The latter mastered cutting-edge technology, advanced and sophisticated equipment, modern management systems and a mature corporate culture. These companies regard the participation in the training of talent in universities as their due social responsibility. Through the exploration of the points of cooperation and win-win point of school-enterprise cooperation, in-depth study of the policy-making mechanism of government-industry studies, as well as the multi-subject linkage of international resources. In order to expand and deepen the connotation of school-industry cooperation in terms of the company's excellent talent demand, research needs, business development needs, and corporate social responsibility, the government led the formation of the Jiangsu Province Mechanical and Mechanical Excellence Alliance. And leveraging on the "Belt and Road" initiative, it is necessary to develop joint training of talent with universities in foreign countries, build an international team of talent for excellence, and form a multi-agent "coordinated resources, collaborative education, and collaborative promotion" mechanism. In particular, through close cooperation with leading companies in

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research and development, excellent talent bases, and employee training, a win-win benefit-sharing mechanism is formed to fully mobilize the enthusiasm of companies to participate in the training of excellent personnel. It has formulated a series of documents including the evaluation methods for corporate teachers, selection methods for excellent production, research and research bases, calculation methods for corporate teachers to guide students' compensation, and reward systems for school-enterprise cooperation. With a sound system and management system, it provides guarantees for companies to participate in the sustainable development of excellent personnel training and excellent personnel training.

On this basis, In cooperation with enterprises, 4 national engineering practice education centers, 1 national experimental teaching demonstration centers, 1 international joint experimental centers of the Ministry of science and technology, and a number of provincial practical education centers and platforms have been built. Practical practice bases with 65 units including the world’s top 500 companies and leading companies in the domestic industry have been built. And 16 graduates workstations in Jiangsu province with enterpriseshave been built. The closeness of school-enterprise dependabilities has effectively solved the contradiction between the company's appeals, stress, and social responsibilities, spurred the motivation of the company to actively participate in it, and formed a long-term mechanism for the integration of sustainable excellent talent-cultivation environment and the deep integration of production and education. .

2. Schools and enterprises closely unite top-level design to build a practice teaching system that integrates undergraduates and graduates

The purpose of the "Excellent Engineer Training plan" is to meet the needs of the country's strategic development, to face the world, to face the future,to face the industry, to cultivate a large number of excellent engineering talent who can adapt to the needs of economic and social development and have strong innovation abilities, to lay a solid human resources advantage for building an innovative country, to realize industrialization and modernization, and to enhance the country’s core competitiveness and comprehensive national strength. The cultivation of students' engineering abilities is the core of the joint training of engineering talent and school[3], and the most important is that the school-enterprise enterprises cooperate in depth to determine the personnel training objectives and construct the engineering practice training system. Under the long-term and stable mechanism of close cooperation between schools and enterprises, the school attaches great importance to the development of docking communication with enterprises and fully brewing all aspects of engineering practice training. Through the cooperation and construction of national and provincial-level experimental and practical platforms, as well as the company's real engineering environment, advanced large-scale equipment and systems engineering projects, etc., a practical teaching curriculum system was constructed. For the undergraduates Excellence plan and graduates plan for Excellence, we set up experiments and practices that are independent and intertwined with each other. At the same time, it stresses the disconnection between theory and practice in the training of engineering talent, the separation of practice and research, the close cooperation between schools and enterprises, and the practice training plan and training system for excellent engineering talent

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in top-level design energy and power engineering. Relying on the high-quality practical teaching platform jointly established by schools and enterprises, with the goal of cultivating excellent abilities elements, a brand-new “2333” practical teaching system focusing on “superior competence” and “student center” is built. That is, synergies between resources (universities and enterprises) in the two places, creating three approaches (three trainings in schools, three links outside the school), linking three levels (this, master, and blog) and cultivating three capabilities (engineering abilities, innovation abilities, and internationalization abilities).

The practice in the school takes "Three Trainings" as the main line, namely experimental training, research training and international training. The experimental training includes basic experiments, professional experiments and comprehensive open experiments. It is subdivided into basic laboratory course experiments, professional core course experiments, professional course experiments, and student team independent design experiments. Scientific research and training mainly includes national, provincial, school, and hospital level four scientific research project training, training with "Challenge Cup", "Energy-saving emission reduction competition" and other competitions, and project training based on teachers' topics with hobbies and interests as the theme. The internationalization training section mainly conducts language training, combines short-term exchanges and joint training abroad, and adopts the same classroom teaching with international students.

Enterprise practice takes “three chains” as the main line, that is, three ways to set corresponding practice links in the process of product production chain, product development chain and project management chain. The product production chain is mainly the product processing process and equipment, product processing technology and product processing and manufacturing links. The product development chain mainly includes product design, product molding and product testing and verification. The practice of project management includes project research and analysis, project project budget, and project implementation and management. The "three-training and three-chain" practice content is progressively step by step. There is an independent link between undergraduates and graduates, and more emphasis is paid to the integration practice of undergraduates, master students and doctoral students. The contents of "Three Trainings and Three Chains" have been implemented in a cross-cutting manner. The training system fully embodies the close connection between theoretical study, analytical research and practice. Through “learning, researching, and practicing”, we have cultivated and improved the engineering abilities, innovation abilities, and internationalization abilities of talent at different levels. Figure 1 shows the framework of the "2333" practice training system.

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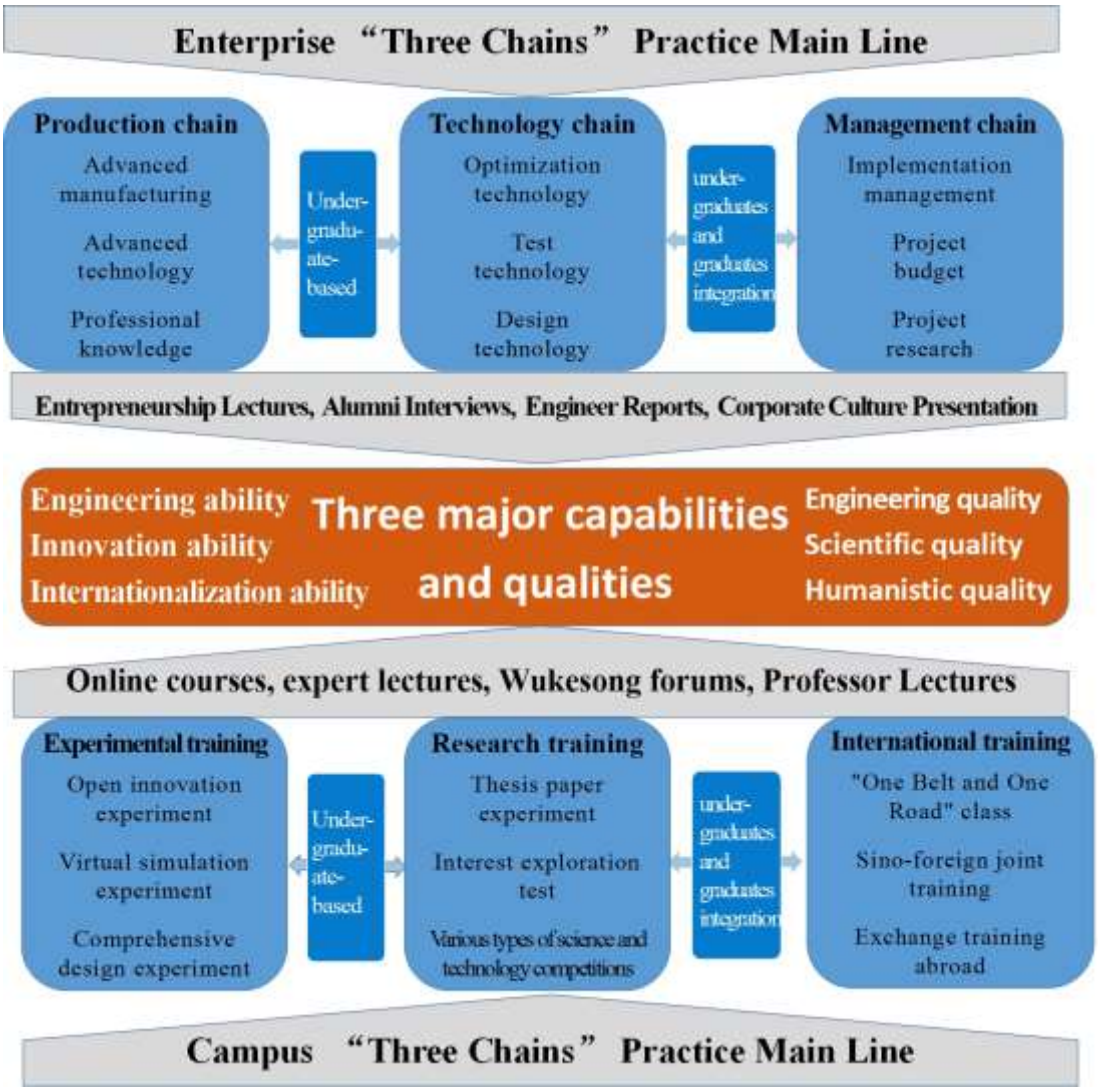

Figure 1. "Three-training and three-chain" practice teaching system with equal emphasis on ability and quality, and integration of undergraduates and graduates

3. based on the "mentors + graduates + undergraduates" team to build "undergraduates and graduates integration" teaching model

The training of excellent engineering talent includes the cultivation of excellent undergraduates and excellent graduates. Both are based on the mentor system, both of which have their own characteristics. In terms of training the abilities of engineering practice, how to make more efficient use of school-enterprise resources and give full play to the guiding role of mentors to achieve complementarity and win-win between undergraduates and graduates in the practical process is a question worth exploring. The "2333" energy engineering excellence engineering talent practice training system is centered on the cultivation of "engineering abilities, innovation abilities, and internationalization abilities". Whether in the "three trainings" in the school or in the "three-chain" practice of the enterprise, the practice links of the research and integration are set. The most important way for the development of these practical links is to

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build a practical team of "mentors + graduates + undergraduates" to realize the "comprehensive research" teaching model. In practice, some questions raised by undergraduates students can lead to further reflections of graduates. graduates can improve their professionalism in the process of solving problems. The cutting-edge knowledge and rich experience and experience of graduates can lead to curiosity and enlightenment of undergraduates students and play a positive guiding role. Through assisting tutors to guide undergraduates, master students have exercised their own leadership and teamwork skills, and at the same time have undermined undergraduates. The tutor's instructional efficiency has been effectively improved. Under the current situation where the student-teacher ratio is high, the tutor will reduce the problem of insufficient instruction for undergraduates, form a virtuous circle, and achieve a good command of teaching.

In the course of practice, each tutor is a tutor for master students and undergraduates, tutors guide graduates and undergraduates, and graduates can directly coach undergraduates. In the same practical project, the organic convergence of mentors, graduates and undergraduates is achieved. For the "2333" practice system, the research team practice project, the school and the company's mentor to guide the project topics, research content and practice plans to conduct checks, and literature search research, experimental guidance and data analysis, etc. by the graduates student specific guidance. At the same time, through the establishment of "project team", "competition team", "home of interest" and other diversified and personalized training groups. And often use multiple interactive teaching scenes, all participants learn from each other, thinking collision, and common incentives. Students from passive educators to active participants and contributors to the education process have effectively stimulated students' interest and enthusiasm for learning and innovation. Let undergraduates students take the initiative to understand the frontiers of international science and technology development in the field of energy and dynamics, integrate innovation training, and provide a rich practical platform for excellent graduates. Increased their guidance and exchange opportunities with domestic and foreign professors and enterprise engineers. In the interaction, the power of further innovation and the vitality of the struggle were further enhanced, and the interaction between teaching and learning of"teaching when doing,learning when doing, doing when learning" was effectively achieved.

In the "Integration of undergraduates and master students" teaching model, the tutor team plays a key role, and a high-quality tutor team is a guarantee of good teaching results. On the one hand, it strives to cultivate a team of teachers with engineering backgrounds, and selects teachers with high academic standards and strong scientific research strength. They have many years of engineering experience and rich engineering background. And to formulate relevant management methods to ensure that the employed instructors participate in the development of related enterprise projects. It has planned to arrange middle-aged and young teachers to study and exchange with famous universities at home and abroad, conduct on-site visits to famous domestic and foreign companies, exchange visits, and exercise in various ways to improve their own engineering practice. On the one hand, it strengthens the construction of enterprise guidance teams, and consists of four levels of teaching staff, including mainly line engineers, mainly instructing student internships. Corporate teaching teachers need to have a relatively

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strong background in engineering practice. Engineers with the university's academic history must combine the experience of engineering practice to teach students. The company's instructors should have a deep and broad background of engineering practice and have a comprehensive and systematic abilities to control engineering practice. They mainly guide students to carry out enterprise engineering practice and complete graduation project and thesis research. As well as corporate consultants, they should be technical experts, project management experts, or middle-level and senior leaders of enterprises, and participate in the formulation of decision-making plans for talent for excellent engineering, as well as decision-making on management and operation. The construction of the two mentor team has effectively guaranteed the quality of the "mentors + graduates + undergraduates" team, and the teaching effect of the "undergraduates and graduates integration" model.

4. the effectiveness of personnel training

After practice, students actively participate in internships and practice enthusiasm, engineering capabilities, innovation capabilities, and international capabilities continue to increase.

1)Since 2013, excellent students have won 4 special prizes in the national energy conservation and emission reduction competition, 8 first prizes, 4 first prizes in the national "Challenge Cup" scientific and technological works competition, and 2 gold prizes in the national "Challenge Cup" entrepreneurial plan competition. Among the excellent graduates, there have been one national excellent doctoral dissertation and one nomination award. There are 9 excellent posts in Jiangsu Province and 11 excellent winners. The excellent class undergraduates obtained 121 national patents.

2)The proportion of undergraduates students with overseas experience in the excellent class is 26%. The percentage of graduates participating in international academic conferences during their studies was 56%. Since 2011, this major has established joint student training plans with eight foreign universities, which has significantly improved students' international competitiveness. excellent students have won international competitions. Undergraduates have published their papers in international TOP journals such as "International Journal of Multiphase Flow" and "Applied Physics Letters" by their first author.

3)In the "National Energy and Power Education Steering Committee and Teaching Reform Seminar", organized by Jiangsu University in 2014, the theme of the conference for the training of excellent engineers in energy and power engineering was invited by the person in charge of this profession. It was fully affirmed by representatives from more than 100 universities in the country. Professor He Yaling, director of the Energy Dynamics Teaching Guidance Committee of the College of Higher Education of the Ministry of Education, highly praised the personnel training concept and effectiveness of the achievements.

4)The 9th National Competition for Energy Conservation and Emission Reduction Social Practice and Technology Works was organized by Jiangsu University in 2016. More than 20 accrediting experts from colleges and universities visited the students' practice venues such as the National Experimental Teaching Demonstration Center and the national-level scientific

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research platform, and fully affirmed the excellent personnel training practice model.

5)The long-term multi-diversity coordination mechanism and the deep cooperation mechanism between schools and enterprises have been innovated, a number of high-level practice platforms and the practice-based training system of "combination of research and development" have been established, and a strong team of practical guidance teachers have been formed. It has provided an important guarantee for the training of talent in energy and power engineering excellence.

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