Research on the Construction of Electromechanical Specialty under the 3+4 Cooperative Training System of Vocational Education—The Direction of Industrial Robot

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Abstract. Aiming at the uniqueness of the 3+4 electromechanical profession in the vocational education system, a system for applying talents suitable for the direction of electromechanical industrial robots is proposed. School-enterprise cooperation is the foundation of laboratory construction. The combination of engineering and learning is the entry point for talent training reform. It is equipped with high-quality teachers and real enterprise practice projects to build a first-class industrial robot teaching and training system. It can support the first and second classroom teaching of industrial robot courses, can have the industrial assessment function of industrial robots, can cultivate students' professional qualities and other functions. At the same time, it aims at the social needs of the 3+4 electromechanical profession of the vocational education system, from the aspect of industrial robot laboratory configuration, practice teaching reform implementation, and teacher team allocation, the professional construction plan is proposed to achieve the purpose of high-quality applied talent training.

1. Introduction
In order to effectively integrate the teaching resources of Jiangsu education, give full play to the respective advantages of secondary vocational education and applied undergraduate education, adopt the secondary vocational and undergraduate division to train undergraduate-level applied high-end skilled talents (professional education 3+4), vocational education 3+ 4 Cooperative training system is conducive to the cultivation of high-level professional and technical personnel, which is conducive to the scientific development of vocational education. At the same time, in the context of China's manufacturing 2025, the application of industrial robots is still expanding, and has been promoted from the automobile manufacturing industry to other manufacturing industries. Therefore, it is urgent to cultivate the application technology talents in the direction of industrial robots in order to cope with the large demand of application technology talents driven by technological advancement and industrial upgrading of the Chinese manufacturing industry[1].

In view of the above situation, the curriculum and laboratory construction of industrial robots under the vocational education 3+4 cooperative training system is extremely urgent. The curriculum and teaching materials under the traditional disciplinary system are not suitable for students under the vocational education 3+4 system. At the same time, with the deep development of school-enterprise cooperation, the school-enterprise joint construction of industrial robot laboratory will become the main development direction. The school-enterprise co-construction laboratory model has brought about innovative changes to the industrial robot laboratory construction direction and laboratory
management concept; it has provided convenience for industrial robot technology update and teacher capacity improvement; and applied undergraduate talent training for industrial robots. Providing precise direction and clear goals to fully meet the needs of corporate talent\textsuperscript{[2]}.

2. School-enterprise joint construction of industrial robot laboratory

Taking the joint construction of experimental bases by enterprises and schools as the guiding ideology, the experimental equipment was jointly invested. The joint construction of schools and enterprises is conducive to enterprises to help schools provide support for the practice of professional development, management reform, technology renewal, and teacher capacity improvement. It is conducive to the school to accurately cultivate the urgently needed talents of the society and serve the local economic development; It is conducive to arranging laboratories according to the factory pattern of the enterprise, and setting up relevant positions for industrial robots according to the needs of the enterprise; It is conducive to the rational use of the base area to build a series of industrial robots, to achieve progressive progress of experimental equipment from basic knowledge, skills training to comprehensive application.

As shown in Figure 1, the basic knowledge laboratory construction includes the recognition of industrial robot machinery and electrical systems, the basic operation programming of industrial robots, and the development history of industrial robots (Smart Learning Factory). The skills training laboratory construction includes industrial robot technology (welding, palletizing, grinding), virtual simulation (FANUC ROBOGUIDE). The integrated application laboratory has a smart assembly production line (integrated development). Through the construction of the hierarchical laboratory, the whole set of practical teaching links from basic programming operation to integrated development and application can be realized, and the system can cultivate the application talents of industrial robots\textsuperscript{[3]}.

![Figure 1. Industrial robot laboratory construction](image)

In 2017, the School of Applied Technology of Soochow University combined with the Ministry of Education's "Internet + Made in China 2025" production and education integration and innovation promotion plan. The joint Shanghai FANUC Co., Ltd. and Beijing Huacheng Jingshi Information Technology Co., Ltd. successfully built the Ministry of Education's production and education integration and innovation base. It creates an intelligent manufacturing application innovation base that integrates intelligent manufacturing talent cultivation, technological innovation, and industrial services. The base provides a platform for schools to cultivate talents for application of industrial robots, and also provides a stage for the application and development of industrial robot technology, accelerating the pace of local manufacturing to intelligent reform\textsuperscript{[4]}.

3. Experimental practice teaching reform

Because the curriculum and teaching materials under the traditional disciplinary system can not meet the application-oriented talent training mode, the experimental practice curriculum and teaching materials are deconstructed and reconstructed according to the systematic action system of the work process. The development of the course of the action system is based on the real environment, the true learning, and the requirements of the true skills.
As shown in Figure 2, the discipline structure system is deconstructed and reorganized into a work process system. The action system project curriculum can better improve the cognitive knowledge of students and realize the cognitive cycle of practice. It fully embodies the characteristics of action teaching in learning to do, doing to learn, learning and doing together. Realize the curriculum model with the action content of practice as the main part and the subject content of theory as the supplement[4].

Figure 2. Traditional Discipline System and Action System Course

Taking the course of “Mechatronics Integrated Practice” as an example, through the construction of action system, the course of practice has been turned into an applied course based on ability training, situation as the main body and project as the center. The construction of practical courses takes robots as carriers to construct learning situations, work processes to construct learning fields, knowledge system to action system, setting situations from easy to difficult, learning content step by step, and ability requirements gradually improve. As shown in Figure 3, the subject system of integrated practice course of Mechatronics is deconstructed and reconstructed into action system. Five contexts are set up, and the situation is implemented from simple to complex, from single to comprehensive. It embodies the characteristics of repetition of knowledge points and non-repetition of learning content in the process of work, and gradually incorporates the ability module in the process of repetition[5].

Figure 3. "Mechatronics Integrated Practice" course action system
In the process of constructing the experimental practice teaching course, the teaching process evaluation is adopted, and the process evaluation is used to evaluate the students' practical learning, which is conducive to the mastery and analysis of the students' learning. For the industrial robot course, the process assessment content can include: whether it can independently program and realize the basic actions and requirements of the robot (50%); whether it can solve the industrial robot failure independently (20%); whether it can improve the project design and have innovation points (20%); design report completion (10%). At the same time, through the Blue Ink Cloud APP, we publish information such as extracurricular assignments, problem discussions, and self-study videos for students outside the classroom; communicate with other students through the Blue Ink Cloud channel; teachers publish more cases and situational applications in the Blue Ink Cloud curriculum resources. Provide students with case studies to help students better understand.

In the construction process of experimental and practical teaching courses, real enterprise projects are adopted to implement teaching. Enterprise courses are created through the integration of production and teaching projects. The courses in the teaching plan are carried out by relying on enterprise resources. The content of the lecture is the real practice project of the enterprise, and the teaching is implemented according to the specific requirements of the enterprise. At the same time, it combined with the enterprise project and the enterprise staff to write the direction of the industrial robot teaching materials or experimental practice instructions. Realize the integration of university and enterprise to cultivate applied talents. Finally, enterprise courses (practical cases) are introduced into the classroom in a project-driven way, so that students have good professional knowledge, enterprise-level professional quality and strong professional skills.

4. Cross-building of Teachers

Establish a long-term school-enterprise cooperation mechanism, through the establishment of a talent training base between the school and the enterprise, to jointly develop a talent training program, jointly implement professional standards construction, curriculum system construction, teaching content reform, teaching organization management and vocational education research work. Exchange teachers and technicians to serve as instructors and internship instructors, participate in student management, and jointly assessment and evaluation of students. Students learn in the real situation of the enterprise, not only can improve practical skills and professional qualities, but also can acquire work process knowledge and related tacit knowledge to promote employment.

Taking the application technology of Suzhou University as an example, the current teaching staff of robotics is composed of colleges and enterprises, forming a teaching team with primary and secondary crosses. Main: Based on the theoretical knowledge of industrial robots, complete the theoretical teaching of related industrial robots. Auxiliary: Proficient in the programming and operation of robots, able to solve the difficult problems of robots and complete the experimental practice teaching of industrial robots. Realize a school-enterprise mixed faculty team. The teachers' teams learn from each other, learn from each other's strengths, and expand their abilities. They gradually form a faculty with equal emphasis on teaching and research.

As shown in Figure 4, the College takes its own teaching staff as the backbone, the part-time teaching staff of enterprises as the support, and the teaching staff of Soochow University as the supplement to carry out all kinds of teaching work. The teacher of full-time and part-time are combined with each other, age and title echelon structure is reasonable, teaching and scientific research are equally important, and theory and practice are coexistent. In the training of talents, the College of Applied Technology of Soochow University takes the full-time teachers of double-qualified teachers as the main force, and carries out the teaching tasks of most basic courses, professional courses and training courses; the part-time teachers of enterprises carry out the teaching tasks of enterprise courses to show the real teaching projects of enterprises. The construction of the mixed Faculty of schools and enterprises ensures the teaching quality and keeps the teaching content in step with the development of industry.
Figure 4. Examples of the Construction of Mixed Teachers in Schools and Enterprises

5. Supporting policy
The policy of opening industrial robotic laboratories after class is implemented. Through the policy of opening laboratories, we can support the construction of students' second classroom and realize the Multi-Certificate teaching and training mode. At the same time, students can obtain certificates of industrial robots industry (such as FANUC programmer certificate) through training in the second class of industrial robots, or obtain certificates of related skills through participating in university competition of related industrial robots.

Through the mode of integration of production and education, the management of industrial robot laboratory can be realized by both schools and enterprises. Establish a complete management system for industrial robot laboratories, and combine the 5S management concept of the enterprise to formulate safety operation codes for industrial robot laboratories, precautions for industrial robot laboratories, and management methods for industrial robot laboratories. Realize the joint management of laboratories by schools and enterprises.

Through the opening of the laboratory after class, the students in the industrial robot laboratory can assist in the management. Aiming at the problems of management, hygiene and safety of the laboratory after the first or second classroom, this paper puts forward the self-management mode of students, and realizes the cooperative management of students in industrial robot laboratory. Assist in the cleanliness and hygiene work of the laboratory, create a good environment for oneself and others, and cultivate students' professional quality imperceptibly.

6. Conclusion
It builds a cooperative training system with distinctive professional characteristics, taking industrial robots as the professional direction, effectively improving the teaching level of teachers, promoting the construction and connotation development of mechanical and electrical specialty in schools, and providing support for the optimization of local economic development. At the same time, it plays an exemplary role in the construction and implementation of other majors.

At the same time, through the construction of industrial robot laboratory, we can effectively promote the further development of school-enterprise cooperation and the innovation of management mode, the reform of practical teaching methods, the establishment of courses through School-enterprise cooperation, and the application of real industrial robot practice projects, which ensure the innovation of professional construction. The cross-construction of teachers guarantees the new vitality of industrial robotics laboratory. The innovation of laboratory management mode is conducive to the
experience of students' enterprise life and the development of students' second classroom activities. The mode of professional ability certificate is conducive to cultivating students' craftsmanship and achieving the goal of combining morality and technology.

This article is research results of the first batch of Suzhou Higher Vocational Education Teaching Reform Research Funding Project" Construction and Research of 3+4 Cooperative Training System for Vocational Education under the background of Made in China 2025--Case of Electromechanical Specialty " (subject number: SGJGB0101, subject leader: Lu Yaping).

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