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Construction of Practical Teaching System for Industrial Internet Specialty Groups in Higher Vocational Colleges*

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Abstract—**After the global financial crisis, the intelligent manufacturing industry is widely emerging on a global scale. Many countries in the world have introduced national strategies and action plans for intelligent manufacturing, aiming to revitalize their economies and enhance the strength of the manufacturing industry through intelligent manufacturing. This paper analyzes the training objectives and characteristics of industrial internet professionals in intelligent manufacturing, and elaborates on the practical teaching system of the specialty groups in vocational colleges. From the industrial internet system architecture, industrial internet specialty groups and shared specialty groups training base, this paper gives some corresponding suggestions for the construction of the practical teaching system of the specialty groups in higher vocational colleges.**

Keywords: industrial internet, practical teaching system, higher vocational colleges, specialty groups

I. INTRODUCTION

Manufacturing industry is the main body of a country's economy, and also it is the foundation of a nation and the foundation of a strong country. In recent years, many advanced manufacturing technologies, such as computer information technology and automation technology, have penetrated into all aspects of the national economy. In the field of industrial manufacturing, traditional manufacturing has gradually evolved from automation, digitization, and informatization to intelligence. As a cross-fusion of the integration of industrialization and informatization, intelligent manufacturing has been set off in various countries, and using the industrial internet to promote the transformation and upgrading of economic growth methods, some countries have raised the industrial internet to the strategic level of national economic development, aiming to improve the international competitiveness of domestic

enterprises and the overall level of the manufacturing industry through the industrial internet. [1]

In 2015, the Chinese government released the first ten-year program document "Made in China 2025", and the industrial internet has become the future development direction of the manufacturing industry. Facing the country's strategic needs, insufficient supply of high-quality technical and skilled personnel is an important shortcoming that restricts the development of industrial internet. By 2025, the relevant talent gap in the Yangtze River Delta will be more than 9.5 million. By the end of 2019, there are 1,418 higher vocational colleges in China. As a key position for the cultivation of high-quality talents in the field of industrial internet, higher vocational colleges need to further improve the quality of professional talents and build the practical teaching system of specialty groups based on the industrial internet.

II. GLOBAL DEVELOPMENT TREND OF INDUSTRIAL INTERNET

A. The connotation of intelligent manufacturing and industrial internet

Intelligent manufacturing is supported by information technology, Internet of things technology and automation technology. It is a man-machine integrated system composed of intelligent equipment and intelligent systems, runs through manufacturing activities such as design, production, management, and service of manufacturing enterprises. It is a general term for advanced manufacturing technologies, processes, models, and systems that can perform functions such as automatic sensing, automatic decision-making, and automatic execution. Intelligent manufacturing is the result of the application, practice and development of advanced technology in the manufacturing field. As the core technology of intelligent manufacturing, the industrial internet is the result of the integration of global industrial systems with advanced computing, analysis, sensing technology, and Internet connections. It is supported by information technology, and ultimately realizes human-machine connections through intelligent machine

connections. The information management system and platform serve as the carrier to intelligently control the various information and data in the manufacturing process. From the content, it covers the entire process of internal manufacturing and the external service and supply chain of the entire product. [2]

B. Industrial internet development strategies in countries around the world

The international financial crisis has caused a fatal impact on the virtual economy industry. In order to rejuvenate their economies and improve the level and strength of their manufacturing industries, many developed countries have proposed "re-industrialization strategies" and issued and implemented a series national strategy for revitalizing entities economic. Since 1995, EU countries have launched the "Intelligent Manufacturing System" program, and by 2005 a total of 482 companies and organizations participated in this program. In 2010, the European Union launched the "IMS2020" roadmap project, focusing on the development of advanced manufacturing industries represented by new energy, information, and intelligent manufacturing in areas such as energy-saving manufacturing, key manufacturing technologies, standardization, innovative training, and sustainable production. In February 2012, the United States took the lead in promulgating the National Strategic Plan for Advanced Manufacturing. In April 2013, Germany proposed the "Industry 4.0" plan for the fourth industrial revolution in the "German 2020 High-Tech Strategy". In December 2016, Japan officially released the Industrial Value Chain Reference Framework. [3]

In 2015, the State Council of China issued the "Made in China 2025" strategy; in 2016, the Ministry of Industry and Information Technology officially released the "Intelligent Manufacturing Development Plan (2016-2020)"; in July 2018, the Ministry of Industry and Information Technology issued Promotion Guide and Evaluation Method of industrial internet Platform; On January 18, 2019, the Ministry of Industry and Information Technology issued the "Guide to the Construction and Promotion of the industrial internet Network"; in March 2019, the "Industrial Internet" was written into the "State Council Government Work Report 2019". These plans all take intelligent manufacturing and Industrial Internet as the core, and accelerate the development of intelligent manufacturing technology at the national level. The objectives are to promote the transformation and upgrading of the manufacturing industry, improve the core equipment and production technology level in the intelligent manufacturing field, and thereby enhance enterprises core competitiveness and the level of intelligent manufacturing across the country.

III. CONSTRUCTION OF INDUSTRIAL INTERNET SPECIALTY GROUPS IN HIGHER VOCATIONAL COLLEGES

A. The development direction of the industrial internet

Most Chinese enterprises have started late in the construction of CAD software, industrial software, and management information systems. From a regional perspective, due to the relatively developed economy in the eastern region, some companies have gradually moved from digitalization to automation, networking, and intelligence. The pilot companies have relatively high levels of intelligent manufacturing, while the western region has generally lower manufacturing levels. It is at the stage of transition from mechanization to digitalization and automation. In order to give full play to the advantages of the industrial internet, countries must make every effort to promote the widespread application of the industrial internet in manufacturing.

The first is constructing a top-level architecture system for intelligent manufacturing and formulating a policy system for the entire industry chain. The industrial internet is complex system engineering, including intelligent product design, intelligent equipment, intelligent production, and intelligent management and services. It is need to collaborate with industry associations, manufacturing companies and infrastructure suppliers to play the role of top-level government design, establish a corresponding standard system for various contents of the industrial internet, and also improve the design of basic common technical standards, and give play to the guiding and supporting role of each standard system in the process of enterprise intelligent manufacturing. For example: formulating intelligent factory construction standards, intelligent workshop construction standards, smart factory master planning standards, and industrial internet standard system construction guidelines.

The second is constructing a key technological innovation system. The industrial internet is supported by infrastructure such as high-tech manufacturing technology, the Internet of Things, big data, cloud computing and other new-generation Internet technologies. It is necessary to integrate key technological innovation and service innovation into the entire process of manufacturing. The government through the technological innovation of the industrial capital and the drive of integrated intelligent technological innovation, enables enterprises to more quickly, conveniently and cheaply obtain digital, information and networked resources, so that information is more effectively integrated into the entire process of manufacturing, reconstruct the value chain between manufacturing enterprises, and realize the innovation of industrial Internet technology and business model. For example: the establishment of industrial cloud and big data technology research and development centers, future industrial research centers, new supply chain collaborative innovation centers.

The third is forming an industrial internet alliance. In terms of the major emerging technologies of the industrial internet, the government needs to work with intelligent equipment companies, IT companies, manufacturing companies, universities, research institutes, and industry

associations to form an industrial internet Industry development alliance to develop an industrial Internet system platform. At the same time, through the national manufacturing innovation center to integrate industrial Internet systems with key technologies such as sensors, software systems, and advanced manufacturing technologies, it provides enterprises with industrial-grade applications of various industrial Internet systems and provides enterprises with reliable software and hard resources and systems and solution to reduce the application cost of enterprise intelligent manufacturing systems. For example, the establishment of the industrial internet development alliance, the industrial internet production and education integration development alliance at all levels.

The fourth is promoting the application of the industrial internet platform for SMEs in an all-round way, and building an industrial internet industry ecosystem. SMEs are the main body of China's industry, and their number accounts for about 99% of national industrial enterprises. The construction of industrial Internet systems for SMEs is a key content of the construction of an industrial Internet industry ecosystem. The government must play a role in unblocking SMEs' industrial Internet technology solution channels, and promote their construction of infrastructure, software systems, management platforms, and technical services. At the same time, through government special subsidies, tax reduction and exemption, financing loans and other forms, it supports the informationization and intelligent transformation of small and medium-sized enterprises, so as to build the ecological foundation of the entire industrial internet industry.

B. Industrial internet architecture

The industrial internet builds a network, platform and security system, and creates a new network infrastructure that is fully interconnected with people, machines, and things, and forms an emerging business format and application model for intelligent development. The industrial internet architecture is shown in "Fig. 1" below. [4]
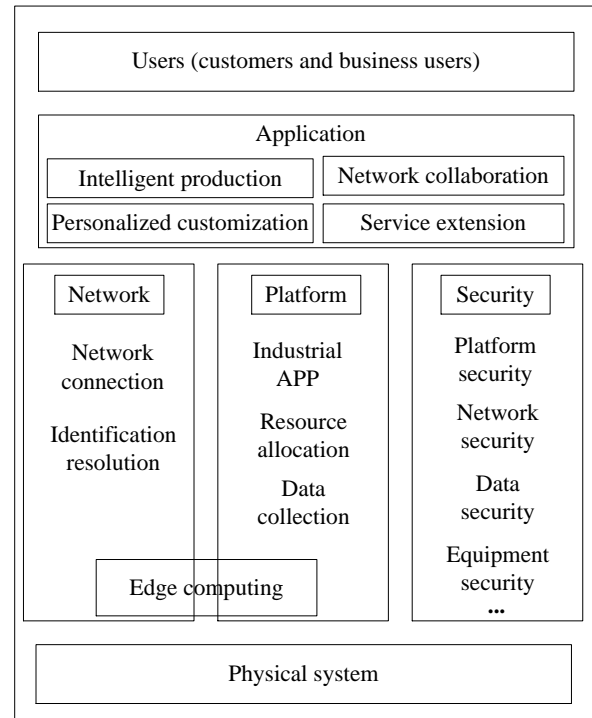

Fig. 1. Industrial internet architecture.

Among them, the network is the foundation of the industrial internet. It extends the connected objects to the entire industrial system, the entire industrial chain, and the entire value chain. It can realize the ubiquitous and deep interconnection of all elements such as people, goods, machines, workshops, and enterprises, as well as design, research and development, production, management, and service [5]. It includes key technologies such as network connectivity, identity analysis, and edge computing. The platform is the core of the industrial internet. It is oriented to the digital, networked, and intelligent needs of the manufacturing industry. It builds a service system based on massive data collection, aggregation, and analysis. And also the APP technology is the key to the industrial internet platform [6]. The security system is the guarantee of the industrial internet. By building a security protection system covering the entire industrial system, it enhances the security assurance capabilities of equipment, networks, controls, applications and data, identifies and defends against security threats, resolves various security risks, and builds industrial intelligence for the development of a safe and trusted environment to ensure the realization of industrial intelligence.

C. Industrial internet specialty groups in higher vocational colleges

As an important training base for high-skilled and high-quality professional talents of the industrial internet, higher vocational colleges should focus on the corresponding relationship between the specialty group and the industrial internet industry chain and focus on the "Physical System + Network + Platform + Security + Application" system

architecture of the industrial internet. Establish the internal logical relationship between the specialties in the specialty group, and establish corresponding specialty groups based on some key positions and core technologies of the industrial internet. For example, intelligent equipment specialty group, industrial network specialty group, information security specialty group, industrial APP software specialty group, enterprise management specialty group, etc., as shown in "Fig. 2" below. It also forms a seamless connection between the specialty group and the entire industrial internet industrial chain, and trains specialized technical personnel in the industrial internet field.

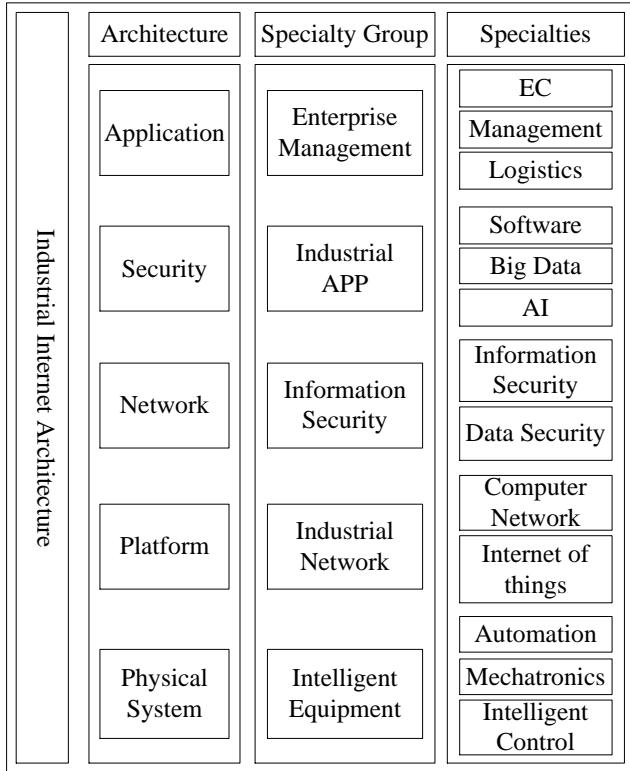| Architecture	Specialty Group	Specialties
		EC
Application	Enterprise Management	Management
		Logistics
		Software
Security	Industrial APP	Big Data
		AI
		Information Security
Network	Information Security	Data Security
		Computer Network
Platform	Industrial Network	Internet of things
		Automation
		Mechatronics
Physical System	Intelligent Equipment	Intelligent Control

(Industrial Internet Architecture)

Fig. 2. Industrial internet specialty groups.

The industrial internet specialty groups in higher vocational colleges should aim at the industrial internet industry chain, rely on national and regional economic development, innovate the collaborative education mechanism of production and education, innovate modular teaching and "Internet + education" teaching methods, and focus on key elements such as the training model, teaching resources, curriculum system, practical teaching system, teacher team, integration of production and education, service capabilities, and international influence, the quality of professional talents training will be comprehensively improved.

IV. PRACTICAL TEACHING SYSTEM OF INDUSTRIAL INTERNET SPECIALTY GROUPS IN HIGHER VOCATIONAL COLLEGES

A. Training objectives and specifications of the practical teaching system for the industrial internet specialty groups in higher vocational colleges

Compared with the development of intelligent manufacturing in developed countries around the world, most of China's industrial enterprises are in the stages of "Industry 2.0" and "Industry 3.0". The existing industrial industry has a weaker level of intelligence and manufacturing bases, and must make every effort to promote the industrial internet Technology, new formats, new industries and new models, strengthen the training of industrial internet professionals at higher vocational levels, and bring greater business opportunities and development opportunities to the manufacturing industry in the new era. The industrial internet specialty groups in higher vocational colleges is positioned to meet the needs of the industrial internet industry chain, to meet the needs of the national advanced manufacturing industry's transformation and upgrading, and to cultivate the physical, network, platform, security, and management areas in the industrial internet architecture urgently needed talents, so that students have a solid basic knowledge of the industrial internet, and also they can possess the basic ability and basic skills of practical work such as intelligent equipment installation and commissioning, industrial network establishment and maintenance, information security risk prevention and management, industrial data analysis and application, industrial APP development, and enterprise management platform application. And also make the student become as a composite technical talent with high professional literacy, cooperative innovation consciousness and international vision, and meet the professional skills requirements of the industrial internet industry. [7]

B. Contents of practical teaching system of industrial internet specialty group in higher vocational colleges

The industrial internet specialty groups in higher vocational colleges needs to track the technological progress of enterprises according to the actual requirements of corporate posts, establish public technology training centers, basic skills training centers, special skill training centers, and comprehensive skill training centers for specialty groups, and establish a specialty group four-level practical teaching system of " specialties sharing", as shown in "Fig. 3" below. [8]

The public technology training center is to realize public practice projects among various specialty groups at the school level, training general basic technologies and skills of students in the field of industrial internet, such as the introduction of industrial internet, the application of internet of things technology [9]. The basic skills training center is to realize the sharing of professional basic courses and practical project groups of various majors in the specialty groups, and to cultivate the public and professional basic abilities in the

specialty group of students. The special skills training center mainly cultivates students' core technology application ability that is different from other specialties. The comprehensive skills training center cultivates the comprehensive technology and skills of the specialty group, realizes the comprehensive training of industrial internet technology skills, and cultivates the comprehensive technical skills within the students' specialty[10]. At the same time, the comprehensive skills training center can combine the school with enterprises to establish productive training bases to cultivate students' professional ability.
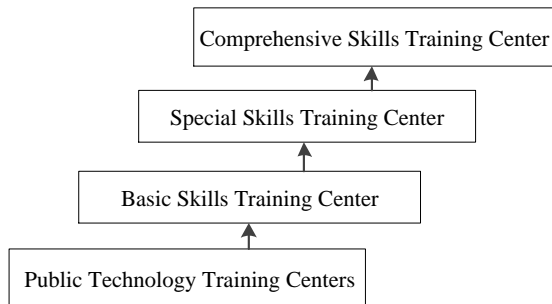

Fig. 3. Practical teaching system of industrial internet specialty.

In the process of cultivating talents in the industrial internet industry chain and the specialty group, the practice teaching system of the specialty group should realize the connection between the specialty group and the industrial chain, the connection between the specialty and vocational positions, and the connection between the content of professional courses and professional standards, the connection between teaching process and production process, connection between academic certificate and vocational qualification certificate, the connection between vocational education and lifelong learning. The connection between the teaching process and the production process refers to strengthening the combination of chemical engineering, strengthening the links of internship training, and training talents that meet industry standards. The docking of academic credentials and vocational qualification certificates refers to the "dual certificate" system of graduation certificates and skill level certificates to improve the pertinence of talent training. The integration of vocational education and lifelong learning means that according to the needs of industrial development and the growth of skilled talents, the channels for continuing learning are broadened to provide support for the sustainable development of talents. [11]

While constructing an on-campus practice teaching system, higher vocational colleges should rely on the integration of production and education to realize multi-subject education and expand off-campus training bases. In accordance with the principle of "resource sharing, mutual benefit and win"[12], select key industrial internet companies that have a high degree of relevance and fit with the specialty groups, and seek talents from schools in terms of enterprise employment needs, employee training, technology development, and product upgrade. The meeting point of training, co-construction of an off-campus training base, to

provide students with first-line training venues for enterprises to consolidate theoretical knowledge, enhance labor concepts, enhance practical ability, and cultivate comprehensive literacy. Through the implementation of a knowledge-and-exercise integration, task-based training model that integrates work with learning, and the establishment of a school-enterprise integration teacher team, the company uses real-time production in the enterprise through a variety of forms such as centralized teaching, corporate training, work-alternation, project training and job training work task practice in the environment forms a school-enterprise joint task training model.

V. CONCLUSION

Industrial internet is the development trend and direction of modern advanced manufacturing industry. The implementation of industrialization, informationization and intelligence of manufacturing industries is an important means to achieve national economic growth, and it is also an urgent need to enhance the level and strength of the manufacturing industry. As a key training base for high-quality technical and technical talents, higher vocational colleges need to seize the opportunities of the national industrial internet development strategy. By optimizing the setting of the industrial internet specialty groups and establishing a specialty group practice teaching system structure, it is necessary to create a high-level specialty group cluster that connects with the industrial internet industry chain. And cultivate more and better technical talents in the industrial internet field, solve the problem of shortage of high-quality technical and technical talents, and give full play to the transformation, upgrade and driving role of industrial internet in traditional manufacturing industries, so as to realize the leap-forward and innovative development of the intelligent manufacturing industry to improve the overall level and strength of the national manufacturing industry.

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