RESEARCH ARTICLE

Exploration and Reflection on the Construction of Intelligent Manufacturing Professional Clusters for Industrial Internet

Min Yang[*,1], **Longyu Cai**[1] , **Cuiping Zhang** [1] , **Li Wang**[1] & **Youchao Chen**[1]
[1]*Nanjing University of Science and Technology ZiJin College, China*

Abstract: In the trend of the transformation of the manufacturing industry towards intelligence promoted by industrial internet technology, the traditional curriculum system related to the manufacturing industry cannot meet the requirements of society and industry for talent knowledge structure and skill training, which puts forward new requirements for undergraduate major construction and development. This article relies on the advantages of the industrial internet location in the Yangtze River Delta region, combined with the needs of regional industrial development, and the problems in the current process of intelligent manufacturing professional construction. Taking the construction of the intelligent manufacturing major cluster at the Nanjing University of Science and Technology ZiJin College as an example, in response to the needs of the development of the intelligent manufacturing industry and the problems in the current process of cultivating intelligent manufacturing talents, this article focuses on the construction of the teaching staff, revision of the curriculum system, construction of scientific research and virtual simulation teaching platforms, multi-disciplinary and multi-angle collaborative education models, providing reference for the reform of applied engineering and technology talent cultivation models in the manufacturing industry in the era of industrial internet.

Keywords: intelligent manufacturing;professional cluster;speciality constriction

The manufacturing industry is the foundation of a country, the tool of a country, the basis of a strong country, and the economic foundation of a country, and is vital to the sustainable development and continuous growth of the economy (Zhang, 2014). Industrial Internet has become a major industrial country to seize the high point of international manufacturing competition, intelligent manufacturing and industrial Internet has a close connection with the deep integration of a new generation of information technology, triggering a new round of industrial change and technological revolution. The core of this change is intelligent, networked, and manufacturing digitalization (Zhou, 2015). In this paper, we start from the social demand of enterprises for manufacturing talents in the context of the industrial Internet, discover the characteristics of the demand for talents in the intelligent manufacturing industry, combine with the development status quo of applied undergraduate intelligent manufacturing majors, analyze the positioning of professional applied talents in different professional perspectives related to the manufacturing industry, and explore the construction of intelligent manufacturing professional clusters from the supply side of talent cultivation.

1. The Current Situation of Intelligent Manufacturing-related Professional Construction

Intelligent manufacturing and the industrial Internet are interrelated and mutually reinforcing, and both are important means and technologies to promote the intelligent and digital transformation of manufacturing. With the traction of the demand of the intelligent manufacturing industry, it is urgent to cultivate high-quality and innovative talents specialized in intelligent manufacturing engineering (Chen et al., 2014). Manufacturing enterprises need

Corresponding Author: Min Yang
Nanjing University of Science and Technology ZiJin College, China
Email:yangmin082@njust.edu.cn

not only engineers and technicians in the production and manufacturing process but also applied talents who understand both equipment and technology and have industry experience (Dong et al., 2014). At present, the enthusiasm of students to choose manufacturing majors is not high, and the shortage of use-type talents is the dilemma of the development of intelligent manufacturing in China, which does not match with the development trend of China's progress from a large manufacturing country to a manufacturing power. The problem is related to both the transformation of talent skills demand brought about by industrial transformation or upgrading development, and also to the insufficiently perfect cultivation of composite talents for intelligent manufacturing. Therefore, grasping the characteristics of the manufacturing industry's demand for applied talents, integrating related majors to form clusters, updating the knowledge and skill cultivation mode, expanding the horizons of applied undergraduate students, and establishing a comprehensive engineering thought system are useful explorations for cultivating applied undergraduate talents in line with the development of the intelligent manufacturing industry.

Under the environment of "Internet+", applied undergraduate colleges and universities undertake the task of providing high-quality talents for the development of China's industry, and they should carry out the construction of intelligent manufacturing engineering technology clusters based on the cross-discipline of disciplines through the research and analysis of the demand for industrial development. Applied undergraduate talent training and regional manufacturing enterprises to match the actual demand for jobs, according to the advantages of regional industrial agglomeration to set up professional and professional direction, manufacturing professional settings should be matched with the development of the intelligent manufacturing industry, industry, according to the market demand for dynamic adjustment of the course structure to achieve the intensive development of professional construction (Chen & Zhang, 2022).

2. Intelligent Manufacturing Professional Clusters for the Industrial Internet

2.1 The connotation of professional cluster construction

In 2015, the "Guiding Opinions on Guiding Some Local General Undergraduate Colleges and Universities to Transform into Application-oriented" put forward professional clusters as an important direction for the transformation and development of regional colleges and universities. On the one hand, professional clusters come from industrial clusters to enhance the ability of higher education to serve industrial clusters, and run majors around industrial clusters; on the other hand, professional clusters are also a method of professional construction, which draws on the concepts, modes, and methods of industrial clusters to enhance the connotation of higher education, and to realize complementarity of strengths between majors, resource sharing and intensive development. It can be seen that professional clustering is an important way for the optimization and upgrading of applied undergraduate colleges and universities.

Intelligent manufacturing is a systematic and open advanced manufacturing system, which in the design process according to the corresponding module of the research and development, design, production, sales, and after-sales links from the overall fine separation, play the advantages of modularization, abandon the traditional manufacturing industry, big and complete development of the idea (Huang et al., 2023). This requires the planning and construction of professional clusters, giving full consideration to the advantages of each professional talent training (Yin et al., 2022), around the industrial cluster platform and other professional synergies, breaking the barriers between the professions, and playing the utility of disciplinary cross-fertilization.

2.2 The positioning of professional clusters thinking

In the summer of 2023, at the High-level Forum on the Integrated Development of the Yangtze River Delta, the goal of the Yangtze River Delta region was set to create a world-class industrial cluster of new energy vehicles, and the School of Intelligent Manufacturing of Zijin College of Nanjing University of Science and Technology accordingly formulated measures for the construction of the

applied undergraduate intelligent manufacturing professional clusters, and successively built new majors such as intelligent vehicle engineering, intelligent perception engineering, and intelligent manufacturing engineering, to form a cluster of specialties with the original mechanical engineering, vehicle engineering, Test and Control Technology and Industrial Engineering.

The talent training objectives of the new majors are set around the regional industrial clusters. Intelligent vehicle engineering is to cultivate high-quality applied talents with the ability of design and development, performance analysis, intelligent system assembly and testing technology, and the ability to analyze and solve complex engineering problems of vehicle systems (Cai et al., 2023). Intelligent perception engineering trains applied engineering and technical personnel with the design and production of intelligent sensors, the design and manufacture of intelligent perception systems, application maintenance, operation and management, and other basic capabilities (Zhang & Liu, 2023). Intelligent manufacturing engineering cultivates high-quality applied engineering and technical talents in the field of intelligent manufacturing engineering who are engaged in the design of intelligent products and equipment, research and development of production lines, and the assembly, manufacture, application, and maintenance of intelligent equipment (Zhao et al., 2022). Industrial engineering, on the other hand, undertakes the cultivation of data management and analysis talents, who can grow up to become data analysis engineers, data mining engineers, data management engineers data product managers, etc (Zhou & Wei, 2022).
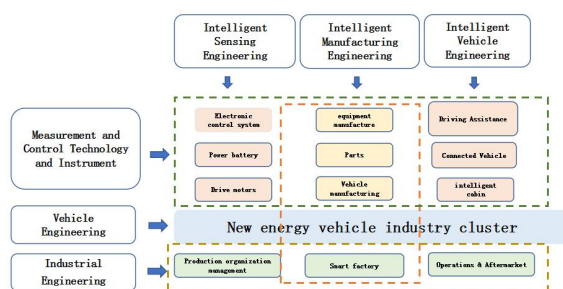

Figure 1.Building professional clusters around new energy automobile industry clusters

2.3 The main line of digitalization technology of professional clusters

The digitalization of the product life cycle is one of the main lines of intelligent manufacturing, and it is also the main basis for the industrial Internet to realize the transmission of data and digital management. Digitalization as the main line of the professional cluster courses, not only reflects the industry cluster-based professional cluster course system vein, but also a new generation of information technology applied to the intelligent manufacturing engineering professional courses in the teaching, the use of a virtual and real combination of teaching means, is not only conducive to improving the professional fit so that the students in the product design, performance analysis and other aspects of the digital twins to master the digital simulation technology, but also be able to Improve students' understanding and awareness of knowledge.

2.4 Specialty cluster comprehensive practice platform construction

Adopting the "combination of virtual and real" multi-angle and hierarchical means to complete the product and production line design, production, management, and other aspects of the training of students in the necessary professional competence. Utilizing IOA virtual reality manufacturing software, the virtual simulation of professional content is completed from different perspectives of the profession according to the requirements of machinery, electronics, big data analysis, manufacturing execution, factory automation, process engineering, and other aspects. In the practice process, starting from the cognitive internship of the manual production line, through the software virtual reality scene modeling and simulation, with the help of a digital twin lab bench to complete the local verification, and finally through the debugging of the physical system. Outstanding student teams can carry out innovative practices on the comprehensive laboratory platform and participate in disciplinary competitions and innovation and entrepreneurship competitions. Form a "student-centered" knowledge + quality + ability training system.

3. Reflections on the Construction of Professional Clusters

3.1 Modularization of curriculum system

Intelligent manufacturing professional cluster is a multi-scientific cross-fertilization of the whole, covering a wide range of knowledge, the amount of knowledge. Therefore, the intelligent manufacturing majors of applied colleges and universities should continuously optimize the reasonable professional curriculum system by combining the feedback from alumni, social development needs, and the division of responsibilities of technical positions in enterprises in the industry cluster. Through the teaching practice of the comprehensive practice platform, students' learning interests are explored, and the demand of enterprises for professional talents is understood through the continuous tracking of alumni, according to which the professional curriculum system is set up in a more humanized and personalized way, to mobilize students' learning enthusiasm more fully and realize the relative connection between students' professional abilities and the diversified talents demand of enterprises. Therefore, the modularization of course combinations in the cluster of intelligent manufacturing majors facing the industrial Internet, through the construction of course combination modules matching the employment positions, allows students to make clear the connection between each professional course and the employment positions, so that students can focus on learning the professional courses that are in line with their career planning. Ensure that each student can not only study all the courses in intelligent manufacturing to have the same professional knowledge background but also focus on the professional knowledge they are interested in within a limited number of hours to have a certain professional expertise.

3.2 Mutual promotion of faculty and research team

In the context of the globalization of the industrial Internet, it is necessary to organically combine research and teaching. On the one hand, scientific research is the source of brand-new teaching content, which constantly injects new vitality into the teaching content; on the other hand, teaching, as a purposeful and planned training of human activities, will provide inexhaustible human resources for scientific research. If teachers simply teach the existing scientific research cases in the classroom, it is easy to contradict the content of the main teaching line, and it is difficult for students to appreciate the status of the knowledge content involved in the cases in the intelligent manufacturing system, resulting in a disconnect between scientific research and teaching content. In the scientific research cluster, the scientific research team ensures consistency between the transformation of scientific research content and teaching objectives through seminars and exchanges.

For this reason, in the construction of an intelligent manufacturing professional cluster, the idea of building a scientific research cluster is proposed, i.e., the lecturers of different professional courses are encouraged to realize the consistency of scientific research direction with the content of the courses they teach. Teachers of different majors will form substantive cooperation in scientific research and carry out scientific research around the same project in the field of intelligent manufacturing. On the one hand, teachers can truly integrate scientific research dynamics with teaching content in classroom teaching, enrich teaching content continuously, and subconsciously make connections with other course content in teaching, thus strengthening "mainline thinking" and promoting the construction of specialties; on the other hand, the intersection of disciplines is conducive to the teacher's ability to give full play to their advantages in the new field of intelligent manufacturing products and to the development of new technologies. On the other hand, the intersection of disciplines is conducive to the teachers to utilize their advantages in new fields, and to form a cluster effect in different fields of intelligent manufacturing, such as products and business.

3.3 Professional teaching resources cluster

Construction of curriculum resources for industry-teaching integration. Offer courses for the industries or enterprises in the professional clusters, attract industry experts and enterprise technology and management personnel to participate in the construction of courses in-depth, and integrate the professional courses with the skill requirements of the enterprises by the principle of "on-site, on-site, on-site, on-site, on-site, and on-site"; and integrate the six aspects of the course construction

(construction of the hardware environment, construction of the virtual software environment, design of teaching methods, development of teaching materials, digitalization of teaching resources, etc.), The six aspects of curriculum construction (hardware environment construction, virtual software environment construction, teaching method design, teaching material development, digital teaching resources development, teacher training) are highly integrated; teachers are encouraged to write school-based teaching materials, school-enterprise cooperation teaching materials, organically integrate professional skills, industry standards, technical specifications into teaching materials, supporting students' work flipcharts, high-quality video resources, a full set of PowerPoint courseware, and so on, and to promote the use of information-based teaching methods and "integrated" teaching mode. Promote the use of informationized teaching methods and the "integrated" teaching mode, and promote the communication and interaction of students within the professional cluster.

Expand the construction of practice teaching platform resources. Build off-campus internship bases for combining engineering and learning and integrating production and learning, and create an engineering center for cultivating talents in the whole process of intelligent manufacturing that integrates teaching, training, certification, scientific research, and production and integration; set up studios for industrial enterprises, encourage the professional clusters to introduce enterprise resources, absorb experts from industrial enterprises, and innovate the applied talent cultivation mode and mechanism of "school-enterprise-school synergy and industry-teaching integration", and explore the research and development of the "integrated" teaching mode and mechanism. It also encourages professional clusters to introduce enterprise resources, absorb experts from industrial enterprises, innovate the applied talent cultivation mode and mechanism of "school-enterprise-university collaboration and industry-teaching integration", and explore the resources of research colleges and higher vocational colleges and universities
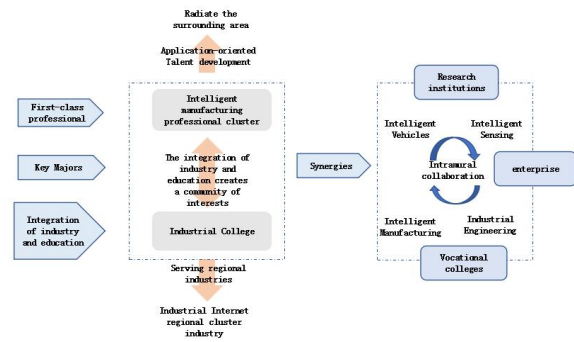

Figure2.Industrial colleges under the school-enterprise-school synergy model

3.4 Actively promoting the construction of industrial colleges

Taking the demand for transformation, upgrading, and structural adjustment of service industry clusters as the guide, and the professional groups serving regional industry clusters as the link, it realizes the in-depth integration of industrial chain (cluster), professional chain (cluster), and talent chain. Comply with the logic of training applied engineering and technical talents, the logic of industry, and the logic of innovation, systematically consider the logical relationship between disciplines and specialties, break the barriers between disciplines and specialties, according to the development direction and service orientation of the specific needs of the industry chain and innovation chain, closely around the industry chain and innovation chain of the service, to find the combination point of the demand and training of the applied talents in the industrial clusters, and create special specialty clusters through the high degree of integration and compound of different disciplines and specialties. Integration and composite, to create a characteristic professional group, through the mutual integration, collision, and derivation between related disciplines and majors, to realize the division of labor specific and detailed, and accordingly reform the professional talent training program, curriculum system, teaching system, teaching organization mode, faculty construction and other aspects of the formation of industrial colleges, to create a high-quality, composite, innovative talent training system to accurately and effectively meet the needs of talents for industrial clustering and innovative development. the demand for talents in industrial agglomeration and innovative development.

Conclusion

From the perspective of the development process of industry-teaching integration and school-enterprise cooperation, the construction of intelligent manufacturing professional clusters for the industrial Internet is an inevitable process of the development of traditional professional construction, and in the future, it needs to be deeply integrated. For society, the construction of professional clusters helps to dock the industrial development of the regional economy and realize the mutual coherence between traditional and newly built professions; for enterprises, it helps to provide intellectual guarantee and talent support for the independent innovation, transformation, and upgrading of enterprises; for schools, it helps them to further refine the construction plan of professional clusters, make precise efforts, and form a group of characteristic backbone and demonstration professions, to enhance the school's Influence. On this basis, the construction of intelligent manufacturing professional clusters should also consolidate the traditional majors step by step, highlight the characteristic advantages of combining the training of applied undergraduates with the regional industrial clusters, and provide the pillars for the transformation and upgrading of the national manufacturing industry.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

Acknowledgement

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