Research on Countermeasures of Intelligent Manufacturing Training Base Serving Local Industry Collaborative "Three Chains" Innovation

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Abstract: With the needs of the transformation and upgrading of the manufacturing industry and the continuous iteration of high-end technology, the service transformation of enterprises and the service of local industries by higher vocational colleges are strategic challenges that schools and enterprises need to face together. Research has found that technological innovation and school-enterprise cooperation model innovation can promote service-oriented transformation, but there is currently a lack of in-depth interpretation of the synergistic interaction between the two. This article takes the intelligent manufacturing training base of higher vocational colleges serving local industries in Liaoshen as an example to study the dynamic interaction mechanism of the deep integration of schools and enterprises under the background of manufacturing technology and service transformation. The author puts forward the process mechanism of school-enterprise cooperation on the industrial chain of local industries and other "three chains" collaborative integration and innovation. The research result of this paper is to find that the mode of intelligent manufacturing training base is the key to the transformation and upgrading of manufacturing enterprises to serve local industries. At the same time, the author finds that the transformation process of manufacturing enterprises is a process of industrial chain collaboration, integration and innovation.

1. Introduction
In the construction of higher vocational colleges in Liaoshen area to serve local industrial clusters, the construction of intelligent manufacturing training bases is not only the top priority of industrial services, but also an important position for training high-skilled talents. They have the function of promoting local technological innovation and accelerating economic development and social progress. Making full use of the intellectual resources of colleges and universities is conducive to continuously improving the technology and management level of relevant local industrial clusters and realizing the comprehensive revitalization of the old industrial base in Liaoshen area as soon as possible.

As one of the representatives of China's old industrial base, Shenyang's manufacturing transformation and upgrading play a vital role in its industrial development. In order to enhance the competitiveness of Shenyang in the ranking of Chinese cities and the attractiveness of talents, and to achieve the goal of industrial revitalization, we need to integrate industrial transformation and upgrading with the development foundation and strategic positioning of Shenyang's manufacturing industry. In addition, we also need to solve the dilemma of the coordinated development of the manufacturing industry chain, innovation chain, talent chain, and capital chain. On this basis, practically providing technical, talent, and financial support for localities through the construction of college training bases is conducive to promoting industrial upgrading. Meanwhile, this is also of great significance for promoting the high-quality development of manufacturing in Shenyang and enhancing the activity and sharing of economic development.
2. Intelligent Manufacturing Training Base Construction and Serving Local Industries

With the rapid development of society and economy, there is an urgent need for high-quality technical and skilled personnel, and with the support of national macro policies, China's vocational education has developed rapidly. Vocational colleges deeply realize the importance of the construction of the training base in the school in the development of connotation [1]. The construction of the intelligent manufacturing training base plays an important role in improving the service capabilities of the training base of higher vocational colleges in teaching, production, scientific research, etc. It is an important way to serve the transformation and upgrading of the equipment manufacturing industry.

2.1 Basic Ideas for the Construction of Intelligent Manufacturing Training Base

The construction concept of the intelligent manufacturing training base needs to match the new needs of regional industrial upgrading. The upgrading of equipment manufacturing industry has continuously improved the degree of automation, intelligence, and integration of the manufacturing process. In the mean time, it also has higher and higher requirements for the professional abilities of technical personnel, prompting the urgent need to improve the level of practical teaching equipment in higher vocational colleges. According to the "Shenyang City National Big Data Comprehensive Experimental Zone Construction Three-year Action Plan (2018-2020)”, Shenyang will strengthen technological research, create "Shenyang Intelligent Manufacturing·Industry Model", and build "Internet + "Advanced manufacturing" smart factory, as shown in Table 1. The construction of an intelligent manufacturing training base is a process of matching the needs of regional industrial upgrading. During construction, we should fully investigate the regional industrial structure and job requirements to ensure the number and scale of training bases so that the construction of the training bases can meet the needs of professional skills teaching, industry enterprise training, and technology upgrade services. Furthermore, we also need to plan the seamless connection between intelligent manufacturing training equipment and new technologies.

Table 1 The Equipment Manufacturing Industry Construction Plan in "Shenyang Intelligent Manufacturing·Industrial Model"

| Construction Planning | Planning Content | Planning Objectives |
|-----------------------|------------------|--------------------|
| Demonstration Project | Build an "Internet + Advanced Manufacturing" Smart Factory | Promote the construction of 10 smart factories, 20 digital workshops, and complete the upgrade and transformation of 100 smart production lines. |
| Enterprise Cloud | Formulate Enterprise Cloud Support Policies, Promote the Development of E-commerce in the Industrial Field | Promote 200 industrial enterprises to implement digital, networked, and intelligent upgrades, and drive 300 enterprises to go to the cloud. |
| Lean Management Cloud Platform | Building A User-specific Information Platform and A Personalized Customized Service Platform | Support the construction of no less than 30 application pilot projects and build more than 10 national pilot demonstration projects. Encourage leading companies to formulate basic commonality and industry application standards for the industrial Internet. |

Note: Data Source: "Shenyang City National Big Data Comprehensive Experimental Zone Construction Three-year Action Plan (2018-2020)".

2.2 Research on the Model of Intelligent Manufacturing Training Base Serving Local Industries

The intelligent manufacturing training base is a manifestation of professional resources, and the accurate connection of professional resources and enterprise needs is an important way to serve local industries [2]. In the construction, promote school-enterprise information exchange, mutual recruitment of personnel, and resource sharing, attract enterprises to participate in the whole process, and jointly build a high-level intelligent manufacturing training base [3]. Incorporate school-enterprise
cooperation into the whole process of talent training, realize that the training base can play a role in skills teaching and technology promotion, and it needs to be improved in terms of technology research and development services and achievement transformation. As shown in Figure 1, the cooperation of faculty resources in the cycle will help teachers and enterprise personnel to quickly improve their business capabilities and technical levels. Accelerating the technological innovation of enterprises through technological innovation cooperation can improve teachers' practical ability. In addition, equipment resource cooperation enables schools and enterprises to save production and operation costs and improve equipment utilization, which will play a greater role in the life of the equipment. Technical resource cooperation refers to the integration of all their technical resources for schools and enterprises to carry out in-depth and long-term cooperation. In the end, it comes down to the cultivation of talents for students, forming a superior circle of school-enterprise cooperation that connects enterprises to serve local industries.

![Figure 1 The Ecological Chain of the Training Base Serving Local Industry Models](image)

3. Analysis of Manufacturing Industry Chain and "Three Chains" Integration and Innovation

3.1 Status Quo of Manufacturing Industry Chain in Liaoshen Region

In the context of intelligent manufacturing, the structure of corporate value transfer has gradually developed from a chain to a networked and non-directional direction. The cross-border organization formed by the reduction of computing and communication costs has fundamentally changed the way enterprises, suppliers, and users interact. The changes in the internal and external environment of the organization have opened up new horizons for the research on the industrial chain of manufacturing enterprises. Many enterprises have formed a service-oriented business model by integrating resources such as smart factories, digital workshops, and networked smart interconnected equipment. This not only creates a core competitive advantage for the enterprise, but also creates a new economic growth point [4]. UNIS Industrial Service Co., Ltd. was established in Shanghai in 2013, which transformed Shenyang Machine Tool from a traditional machine tool manufacturer to an industrial service provider. Shenyang Machine Tool successfully launched the i5 series of intelligent machine tools in the world through intelligent control technology in 2014, enabling intelligent manufacturing to help the transformation and upgrading of manufacturing enterprises. In 2017, the world's first industrial operating system i5OS was released globally.

Through the analysis of related industries in the manufacturing industry in Liaoning Province, we have studied the industrial chain formed around various industries. Among them, the average number of related industries in the manufacturing industry is 13 nationwide, and 10 in Liaoning Province. The
number of related industries in 9 industries including general equipment manufacturing is less than the national average. As a whole, the extension capacity of the manufacturing industry in Liaoning Province has much room for improvement, from the perspective of industrial spatial agglomeration. Most manufacturing industries and related industries in Liaoning Province have not yet formed obvious spatial agglomeration characteristics [5]. In the comparison of the amount of manufacturing industry chain connections, the total amount of manufacturing industry chain connections between Shenyang and other cities in Liaoning Province is relatively high. As my country's manufacturing industry upgrades, the dependence of economic growth on traditional resource and capital-intensive industries will inevitably weaken. The competitiveness of economic growth also formed by technological innovation will become a new engine of economic growth.

3.2 Analysis of the Problems Existing in the Manufacturing Industry Chain and its "Three Chains" Integration

The problems of the manufacturing industry chain are concentrated in the insufficient possession of China's high-tech industry chain and high value-added industrial links, and the basic industrial capacity and the modernization level of the industrial chain need to be improved. In the field of advanced manufacturing, China has a total of 287 core components (components), 268 key basic raw materials, 81 advanced basic processes, and 46 industrial technological foundations that urgently need to be broken through. These have greatly affected the safety and stability of the industrial supply chain [6].

The core issue facing the industrial chain due to the transformation and upgrading of the manufacturing industry is the "connection mechanism" between the industrial chain and the internal value chain, enterprise chain, supply and demand chain, and space chain, as shown in Table 2. This docking mechanism directly affects the internal connections between the structure of the enterprise group, and affects the upstream and downstream relationships of the industrial chain and the exchange of mutual values.

| Docking Level | Effect | Docking Content | Details | Docking Core |
|---------------|--------|-----------------|---------|--------------|
| Macro Level   | Guide  | Value Chain and Enterprise Chain | Industry Distribution |
|               |        | Value Chain and Supply Chain      |         |              |
|               |        | Value Chain and Space Chain       |         |              |
| Region        | Main Body | Value Chain and Supply Chain     |         |              |
|               |        | Enterprise Chain and Demand Chain|         | Product Technical |
|               |        | Enterprise Chain and Technology Chain|  |
|               |        | Enterprise Chain and Supply Chain|         | Standard Production |
|               |        | Value Chain and Space Chain       |         | Factors      |
| Micro Level   | Basis  | Docking in the Supply Chain       |         | Matching Radius |
|               |        | Docking in the Enterprise Chain   |         |              |
|               |        | Docking in the Space Chain        |         |              |
|               |        | Demand Chain and Technology Chain|         | Technological Innovation |
|               |        | Demand Chain and Supply Chain     |         | Division of Labor |
|               |        | Value Chain and Space Chain       |         | Transactions, |
|               |        | Enterprise Chain and Demand Chain|         | Market Competition |
|               |        | Enterprise Chain and Technology Chain|  |
|               |        | Enterprise Chain and Supply Chain|         | Structure |
|               |        | Value Chain and Space Chain       |         | Regional Economy |

Enterprise development needs to solve the integration and innovation of manufacturing industry chain and innovation chain, talent chain and capital chain. In recent years, Shenyang has continuously promoted the transformation of the manufacturing industry, cultivating and expanding the 100 billion industrial chain of automobiles and parts, robots and intelligent manufacturing equipment. In the process of industrial transformation and upgrading, the equipment manufacturing industry needs to be high-end, intelligent, and service-oriented. Unblocking the manufacturing industry chain is an important part of stabilizing market players. The manufacturing industry chain group needs to solve
how to speed up technological innovation and product innovation in the construction of a strong manufacturing country, and connect with the innovation chain. How to retain and introduce talents, how to connect with the talent chain, how to guide capital to connect with real enterprises, and how to make the "financial water" directly reach the main body of the industry chain, etc. have yet to be resolved. The essence of the integration and innovation of the industrial chain and other "three chains" is also the integration and innovation of the internal value chain of the industrial chain, the innovation chain, the talent chain, and the capital chain, as shown in Table 3.

From the macro level, the value chain and the enterprise chain, the value chain and the supply and demand chain, the value chain and the space chain are all determined by the industrial chain, and the industrial chain is the main docking relationship. From a regional perspective, in the supporting space chain, the technology chain and the talent chain are important supports for the docking core. From a micro perspective, the docking of various innovation chains requires the support of the capital chain.

Table 3 Industrial Chain and Three-chain Docking Mechanism

| Docking Level | Docking Content | Docking Core | Main Docking Relationship |
|---------------|----------------|--------------|--------------------------|
| Macro Level   | Value Chain and Enterprise Chain | Industry Distribution | Enterprise Chain |
|               | Value Chain and Supply Chain |             |                          |
|               | Value Chain and Space Chain |             |                          |
| Region        | Enterprise Chain and Demand Chain | Product | Technology Chain |
|               | Enterprise Chain and Technology Chain | Technical Standard | Talent Chain |
|               | Enterprise Chain and Supply Chain | Production Factors | |
| Micro Level   | Docking in the Supply Chain | Matching Radius | Capital Chain |
|               | Docking in the Enterprise Chain |             |                          |
|               | Docking in the Space Chain |             |                          |

4. Smart Manufacturing Training Base Serving Local Industry Collaboration "Three Chains" Integration and Innovation Countermeasure Suggestions

First of all, accelerating the improvement of technological and industrial innovation systems and mechanisms is conducive to improving financial services to the real economy and high-quality real economy supply. Second, accelerating the construction of a modern industrial system led by innovation and coordinated development is conducive to creating an environment for innovation. Besides, increasing support for the development of the industrial Internet is conducive to actively seeking national support for big data pilot projects. Third, the gradual establishment of a diversified investment and financing system for manufacturing industry led by the government, with enterprises as the main body, and extensive participation by the society can encourage enterprises to set up intelligent manufacturing technology research and development institutions, and encourage school-enterprise cooperation to jointly carry out technological innovation and overcome technical problems. This is conducive to enabling manufacturing enterprises to have core technologies in innovation while shifting to products and personalized services. Simultaneously, this is also conducive to promoting the effective integration of the industrial chain, technology chain, and capital chain.

The construction of an intelligent manufacturing training base is conducive to promoting the industrial chain and the three-chain interaction mechanism, and creating an interactive mechanism of deep integration between schools and enterprises. In the intelligent manufacturing innovative talent training model, the joint construction of training bases and technology research institutes with enterprises is conducive to cultivating technical talents with high-end technology and equipment, and cultivating professional teachers for applied technology research and on-site problem solving. At the same time, cultivating scientists and innovation leaders who can break through key technologies in technological innovation can provide support for various talent needs in the industry chain. The construction of the intelligent manufacturing training base is conducive to realizing the effective supporting role of the school-enterprise cooperation of higher vocational colleges and the industrial
chain. Moreover, it can also provide a docking effect on the technology chain and the talent chain. In the capital chain, we can use the advanced equipment resources of colleges and universities to save corporate funds, so as to help the capital chain.

Through the construction of intelligent manufacturing training base, it will help to innovate and customize business models and promote the coverage of raw materials, technologies, products, and services across the entire manufacturing industry chain. This will promote the effective connection of the manufacturing industry chain with the innovation chain, talent chain, and capital chain. The rapid development of technologies such as the Internet, big data, information and communications and the trend of personalized products and needs have promoted the strategic orientation of smart manufacturing platforms. Through innovating business models and implementing smart product upgrades, it is conducive to the strategic transformation from industrial manufacturing to providing comprehensive solutions for smart manufacturing. In the mean time, promoting and supporting upstream and downstream enterprises to strengthen industrial coordination and technological cooperation to tackle key problems will help strengthen the resilience of the industrial chain and improve the level of the manufacturing industry chain. Otherwise, this will also help to form a more innovative and higher value-added manufacturing industry chain in open cooperation. The personalized business needs and technological innovation that smart manufacturing meets will promote the industrial chain, which will attract the coordination and linkage of the innovation chain, the talent chain, and the capital chain to promote mutual progress.

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