Research on the Reform of Industrial Engineering Talents Training Mode for Intelligent Manufacturing

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Abstract: Industrial Engineering, as a discipline of improvement and optimization, has been applied to many industries in China. In the context of the scientific and technological revolution and industrial upgrading in the intelligent era, the knowledge, abilities, and professional qualities of Industrial Engineering professionals are required to be changed accordingly, and the talent cultivation mode of this specialty will inevitably be reformed and optimized. Based on the knowledge map of the core courses of the major of Industrial Engineering, and the relationship between the curriculum theory and practical application, as well as the relationship between professional skills and practical operation, a set of dynamic courses with the definition of IE knowledge system as the core are formed. Relying on school-enterprise cooperation projects, the production and teaching digital intelligence cloud platform and production and teaching digital intelligence experiment practice platform for Industrial Engineering majors have been effectively developed. Through the cross integration of mechanical engineering, management science, and information science disciplines, the "intelligence+" talent training system for Industrial Engineering majors has been studied and formed. The "intelligent+" talent cultivation system for Industrial Engineering majors has been developed in this project, which can cultivate high-level composite innovative talents to solve complex engineering problems in multiple disciplines, effectively address the demand for talents in the emerging fields of intelligent management and intelligent manufacturing, and provide a new system and mode for the cultivation of composite talents in new engineering disciplines.

Keywords: Intelligent Manufacturing; Industrial Engineering; Talent Training Mode; Production and Teaching Data Cloud Platform

1. Introduction

At present, the world is entering a new round of active scientific and technological innovation and industrial revolution. Competition between countries in science and technology is becoming fiercer. The integration of the Internet, intelligence and social and economic activities is accelerating, driving the formation and development of new economy [1]. Germany's "Industry 4.0 [2], China's "Made in China 2025" [3] Etc. To promote and implement the strategy of "three high and four new" leading the regional economic development of Hunan Province [4]. It can be seen that in the context of the development of the new economy, the social demand for compound talents has risen sharply. Based on the perspective of "new engineering", the concept of engineering education is gradually discussed [5-9] Finally, "Beijing Guide" was formed to guide the new engineering education [10]. Therefore, Based on the national innovation-driven new economic development strategy, the rising market demand for interdisciplinary talents and the concept of new engineering education, the education mode of colleges and universities is bound to change.

Industrial Engineering is an interdisciplinary subject with strong practical and systematic characteristics. Industrial upgrading under the background of intelligent era drives the demand for knowledge, ability and quality of Industrial Engineering talents oriented towards intelligent manufacturing, forcing the connotation and extension of Industrial Engineering major to undergo fundamental changes. It is necessary to study the objectives and specifications of talent training. Pay more attention to the advanced and practical teaching methods, to meet the needs of

curriculum design, graduation design, thesis demonstration and other experimental or practical links. Therefore, through the research of a set of Industrial Engineering professional integration of production and education, can be implemented in the implementation of digital intelligent innovation laboratory program, can improve the professional practical ability of students.

Therefore, based on the new engineering education concept, it is very necessary to reform the training mode of Industrial Engineering talents for intelligent manufacturing, which can effectively solve the demand for compound talents for industrial upgrading in the new field of intelligent manufacturing.

2. Analysis of the Current Research Situation at Home and Abroad

After over 20 years of development, Industrial Engineering major in China has accumulated rich experience in the training of Industrial Engineering talents. It has laid a solid foundation for exploring the reform and exploration of the training mode of Industrial Engineering talents under intelligent manufacturing. it provides a guarantee for exploring the collaborative training of Industrial Engineering talents through production and education under the background of intelligent manufacturing.The following will analyze the domestic and foreign research status of this project.

2.1 Intelligent Manufacturing is the Main Direction and Core Content of "Made in China 2025" Strategy

In 2015, "Made in China 2025" was released and implemented, which determined the overall strategy of building a manufacturing powerhouse in the next 30 years at the national level. In the guiding ideology of "Made in China 2025", it was clearly stated that the deep integration of the new generation of information technology and the manufacturing industry should be the main line, and the promotion of intelligent manufacturing should be the main direction, so as to realize the historical leap of the manufacturing industry from large to strong.In addition, intelligent manufacturing is also the main content of the "three high and four new" development

strategy of Hunan Province.

2.2 Intelligent Manufacturing is in Urgent Need of Industrial Engineering Professionals

Intelligent manufacturing has put forward severe challenges and higher requirements for the training of composite application-oriented professional talents in colleges and universities. It is more necessary to highlight the cultivation of students' practical ability, professional ability and innovation quality, so that students can master the integration and application of modern cutting-edge technology, and better adapt to and serve in the industry 4.0 era. According to incomplete statistics, the gap of domestic lean talents (Industrial Engineering professionals) is about 7 million, mainly distributed in intelligent manufacturing, intelligent logistics, intelligent building, intelligent service, intelligent medical and other industries.

2.3 Intelligent Manufacturing Puts Forward Higher Requirements for the Training Specifications of Industrial Engineering Professionals

Industrial Engineering is a science about the effective operation of complex systems. It combines engineering technology with management science to quantitatively analyze, optimize and design actual engineering and management problems in enterprises or organizations such as manufacturing and service industries from a systematic perspective. It is an independent engineering discipline aiming at system efficiency and benefit.In recent years, the rise of a new round of industrial revolution, its fundamental driving force lies in a new round of scientific and technological revolution.The exponential growth of information technology, digitalization, widespread application of the Internet and integrated intelligent innovation are the three driving forces behind this industrial revolution.These three driving forces just point out the three core thinking of intelligent manufacturing talents in the new era: information digitization thinking, data value thinking and system integration thinking, which drives the competitiveness of industrial talents has three core requirements: the ability of information conversion, data mining and integrated innovation.In the context of

intelligent manufacturing, the research object of Industrial Engineering is intelligent manufacturing system, which is based on emerging technologies such as artificial intelligence, big data, cloud computing, block chain and 5G, which requires profound changes in the connotation of Industrial Engineering.

To sum up, in order to meet the development demand for Industrial Engineering talents from "Made in China 2025", it is urgent to explore the training mode of industrial engineering talents oriented to intelligent manufacturing.

3. Research Methods

During the research process of this project, the method of combining literature analysis and survey research were used to analyze and summarize the successful experience and existing problems of domestic and foreign Industrial Engineering talent cultivation models; The method of combining experience summary and comprehensive analysis were used to analyze and summarize the training modes and characteristics of Industrial Engineering majors in different universities, the functions, mechanisms, and degrees of influence of various elements in the training modes of Industrial Engineering majors in different universities have been well clarified; Based on a combination of theoretical and experimental research methods, the internal needs, driving forces, and promotion mechanisms for the development of Industrial Engineering majors in different universities were studied; Through the use of a systematic research approach, the internal and external systems of different institutions and the various elements of their interaction were comprehensively studied.

3.1 A Combination of Literature Analysis and Investigation

By referring to relevant research monographs, academic papers, policy documents and newspaper materials at home and abroad, this paper analyzes and summarizes the successful experience and existing problems of Industrial Engineering talent training mode in various countries in the world under the background of intelligent manufacturing at home and abroad. Using interview, field investigation, questionnaire and other investigation and research methods, investigate and analyze the needs, aspirations and training modes of leaders and teachers and students of Industrial Engineering in different universities.

3.2 Combined Experience Summary and Comprehensive Analysis Method

Using the method of experience summary, summarize the members of the research group for a long time to carry out the practice of industry-university-research cooperation and professional teaching and management practice experience, analyze the existing problems. By the comprehensive analysis method, the training modes and characteristics of Industrial Engineering majors in different colleges and universities are summarized, and their adaptability is analyzed. Clarify the training mode of Industrial Engineering in different colleges and universities and explore the function, mechanism and influence degree of each element in this movement system.

3.3 The Method of Combining Theoretical Research with Experimental Research

With the theory of higher education, the theory of demand determination, the theory of complex adaptation system, and the theory of sustainable development, this paper studied the internal demand and motivation mechanism, the promotion and guarantee mechanism, the incentive and constraint mechanism, the adaptation and adjustment mechanism, the mechanism of school-enterprise co-construction of faculty and teaching resources, the mechanism of school-enterprise joint evaluation and examination, the supervision and guidance mechanism of industrial organizations, and the society Association evaluation mechanism and so on. The theoretical research results will be materialized into a practical plan, and the Industrial Engineering major of the school where the research group members belong will be taken as the experimental object to conduct sufficient experimental research, test and evaluate the experimental results, correct the deviation, improve the specific practical operation mechanism, and finally form a theory that can guide practice.

3.4 Systematic Research Method

The research object of this study involves the internal and external systems of different colleges and universities, and involves the various elements of the interaction between the

internal and external systems. It is necessary to use the theories and methods of the system to conduct a comprehensive and systematic study on it.

4. Objectives, Content, and Key Issues to be Addressed for Project Research and Reform

4.1 Objectives of Project Research and Reform

The project plans to explore the training mode of Industrial Engineering talents suitable for the development of intelligent manufacturing, and form IE Plus training program, curriculum system, teaching mode, collaborative education mechanism, production -education integration path, digital intelligent application platform, etc. At the same time, it will explore the construction mode of "new engineering" for Industrial Engineering majors, and build the training system of "intelligent +" Industrial Engineering talents. Cultivate high-level composite innovative talents with the ability to solve complex multidisciplinary engineering problems, and solve the demand for talents in short supply in the emerging fields of intelligent management and intelligent manufacturing.

4.2 Content of Project Research and Reform
Content of Project Research and Reform
Under the guidance of the current 5G+technology, emerging industries based on Internet technology such as the Internet of Things, artificial intelligence, and big data have achieved rapid growth, which has led to the rapid development of intelligent manufacturing logistics, intelligent transportation construction, and intelligent medical services. Therefore, the demand for talents in the intelligent manufacturing industry is constantly increasing, especially the talent gap in industrial engineering reaches around 7 million. In order to effectively meet the needs of the talent market, this project aims to revise the industrial engineering talent cultivation plan from three aspects: quality structure, knowledge structure, and ability structure. By establishing a cloud platform and practice platform for the integration of industry and education in industrial engineering, it provides guarantee for the cultivation of computer skills, engineering reasoning and problem-solving abilities, as well as professional and technical abilities of industrial engineering students. See Figure 1 for details.
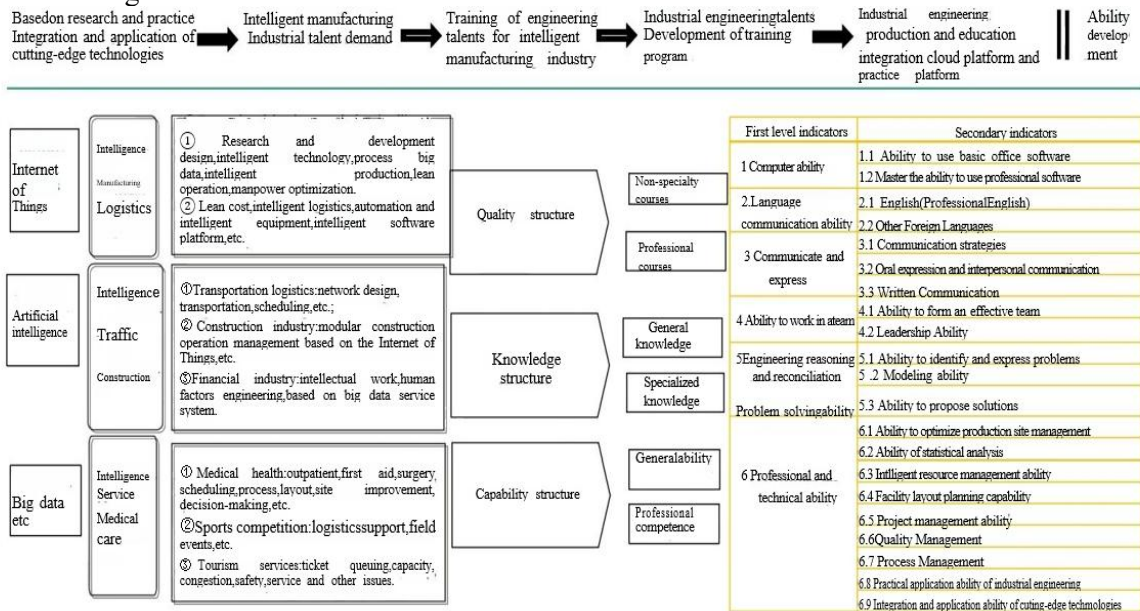

Figure 1. Research Content of Industrial Engineering Talent Training Reform for Intelligent Manufacturing

4.2.1 Research on training objectives and training specifications of Industrial Engineering talents to meet the needs of intelligent manufacturing
Implement the concept of OBE, take the

seamless connection of industrial chain, education chain and innovation chain as the starting point, comprehensively and systematically investigate the development needs of intelligent manufacturing industry,

study the training objectives and knowledge, ability and quality requirements of Industrial Engineering professionals, and map the training objectives to graduation requirements. Focusing on the intelligent manufacturing development of Changzhutan economic circle as the object, on the basis of fully studying the national strategic planning and regional development planning (especially the "three high and four new" strategy of Hunan Province and "Changzhutan Metropolitan Circle Development planning"), the intelligent manufacturing needs of typical industries are investigated, combined with the connotation of intelligent manufacturing, Form the training objectives and graduation requirements of Industrial Engineering talents oriented to intelligent manufacturing.

4.2.2 Develop training programs for Industrial Engineering talents oriented to intelligent manufacturing

According to the guidance of the construction of "new engineering", and integrating intelligent manufacturing technology, big data, cloud computing, artificial intelligence, 5G technology, block chain and other technologies, restructure the training program for Industrial Engineering professionals. In the reconstruction training program, training objectives, curriculum system and teaching content are defined in accordance with the specific needs of intelligent manufacturing for applied technical talents, innovative technical talents and management talents, and in combination with the orientation of the school. Through the integration and reorganization of frontier technology and professional courses, the setting of general courses and interdisciplinary elective courses is effectively promoted, so as to construct the Industrial Engineering multidisciplinary general curriculum system integrating "intelligence +" elements.

4.2.3 Reform of teaching content and teaching methods

In terms of teaching content, it is capability-oriented and reflects the latest ideas, methods, technologies and tools of intelligent manufacturing. To promote the reform of teaching methods and teaching means with PBL, case teaching, CDIO and the teaching organization model of interdisciplinary integration as the main contents. Considering the duplication of course content, this project will optimize course resources and form a new course system, such as integrating "Mechanical Design" and "Interchangeability and Measurement Technology" into "Mechanical Design Basis", and integrating "Facility Planning and Logistics Analysis" and "Logistics and Supply Chain Management" into "Intelligent Logistics and Supply Chain Management". Engineering Economics, Cost Control and Production Planning and Control will be integrated into Production Planning Control and Management. For example, artificial intelligence technology and application, intelligent scheduling and optimization, intelligent production system, intelligent operation and health management, big data analysis technology and application, intelligent factory management and other cutting-edge technology applications will be added.

4.2.4 Construction of new form teaching materials

Study the intelligent knowledge map of core courses of Industrial Engineering under the mode of intelligent manufacturing, and form a set of dynamic course with knowledge point definition as the core according to the relationship between courses and course application, knowledge point and knowledge point application, including industrial application case base, knowledge point application scenario, knowledge understanding and application classification question bank, such as picture mode, video mode, audio mode, etc. To build new intelligent teaching materials and tutorials based on IE+AI.

4.2.5 Research and practice of collaborative education model oriented by the cultivation of students' practical and innovative ability

Take intelligent manufacturing ecosystem as the main line, fully integrate the industry-university-research resources of the whole society, and realize the collaborative education mechanism of production-education integration, science-education integration and school-school cooperation.

4.2.6 Reform of training mode for practical and innovative ability of Industrial Engineering students

Relying on professional manufacturers of Industrial Engineering, to carry out collaborative education, jointly developed

Industrial Engineering production and teaching data intelligence cloud platform and production and teaching data intelligence experimental practice platform, to build a four-year continuous line of practical teaching system, so that freshmen students know the factory; Sophomores cognitive management; Junior students' experimental practice and course design, competition drill, etc.; Senior students practice and graduation design, practical teaching results bottoming out.

4.3 Key Issues to be Addressed in Project Research and Reform

4.3.1 Compile a knowledge map of Industrial Engineering, and develop a dynamic course of Industrial Engineering

Based on the research on the knowledge map of the core courses of Industrial Engineering, a dynamic curriculum with the definition of knowledge points as the core is ultimately formed according to the relationship between theoretical courses and practical applications, as well as the relationship between professional skills and practical operation training.

4.3.2 Research and develop the cloud platform for producing and teaching data wisdom and the experimental practice platform for producing and teaching data wisdom of Industrial Engineering

Relying on school-enterprise cooperation, through collaborative education projects between enterprises and schools in the field of Industrial Engineering, the production and teaching digital intelligence cloud platform and production and teaching digital intelligence experimental practice platform for the field of Industrial Engineering have been effectively developed.

4.3.3 Develop "intelligent +" talent training system for Industrial Engineering

Through the cross integration of mechanical engineering disciplines, management science and engineering disciplines and information science disciplines, an "intelligent +" talent training system for Industrial Engineering majors is formed. The deep integration application of OT+IE+IT for intelligent manufacturing was shown in Figure 2.

As can be seen from Figure 2, the in-depth integration of OT+IE+IT talent cultivation curriculum system for intelligent manufacturing can more effectively broaden the knowledge range of Industrial Engineering students, enrich their business vision, and enhance their professional skills, thereby effectively meeting the demand for complex talents in the context of new engineering.
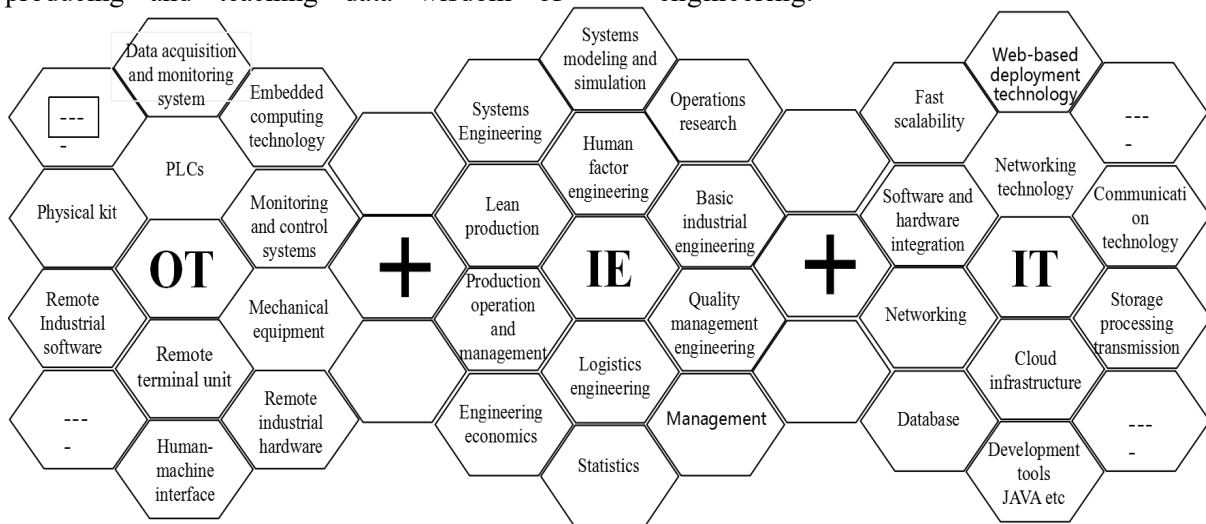

Figure 2. Deep Integration Application of OT+IE+IT for Intelligent Manufacturing

5 Overall Implementation Plan for Project Research and Reform

5.1 Research Ideas of the Project

Based on the full study of national and provincial development strategies and related policies and documents such as *"Made in China 2025"*, Hunan Province's *"Three High and Four New" Strategy*, *Changzhuzhou-Xiangtan Metropolitan Area Development Plan*, in-depth research on intelligent manufacturing

and its demand for Industrial Engineering talents, and systematic summary of the problems existing in the training of Industrial Engineering talents. So as to form a talent training target for intelligent manufacturing; On this basis, the establishment of intelligent manufacturing oriented Industrial Engineering talent training program, the construction of new engineering, service intelligent manufacturing curriculum system; Further study the teaching content and teaching methods; At the same time explore collaborative education mode; Build a platform for cultivating practice and innovation ability.Finally, it was practiced in Hunan Institute of Engineering, and then extended to Industrial Engineering majors in colleges and universities in Hunan and the whole country. At the same time, give full play to the advantages of Changzhutan area, build a deep integration, interaction and collaboration platform for intelligent manufacturing industry, university and research, and create a talent training base and innovation highland for intelligent manufacturing.

5.2 Overall Implementation Plan for the Reform of the Project

Implementing the strategic plan of the Ministry of Education and the college for the integration of industry and education, and cooperation between schools and enterprises, and creating a shared platform product, fundamentally solving the teaching mode of "emphasizing theory, neglecting practice, emphasizing teaching, and neglecting training" in college education, in line with the actual needs of modern intelligent manufacturing enterprises for talent, and developing an IE talent cultivation mode that adapts to social needs.

5.2.1 A theoretical research group of Industrial Engineering core curriculum being set up

A special leading group for the project has been established, consisting of professors, associate professors, lecturers, industry experts, and other special committees. It is responsible for the demonstration, demand writing, data collation, and special meeting discussions of the project. It monitors the progress of the project throughout the process, and completes the phased summary and release of the project. School-enterprise cooperative enterprises provide relevant information and supporting

conditions for case application to ensure that the theory can be applied in the application scenario.

5.2.2 IE+AI+IT cutting-edge technology research and development team being established

A special leading group for the project has been established, consisting of professors, associate professors, lecturers, industry experts, AI technical experts, and other special committees. The committee is mainly responsible for the technical demonstration, demand writing, data collation, product algorithms, technical conference discussions, and curriculum resource construction of the project.

5.2.3 An Industrial Engineering experimental practice group being established

The special leading group for project practice was established, which is a special committee composed of professors, associate professors, lecturers, industry experts, and experimental specialists. The group is mainly responsible for the experimental practice research, demand writing, data collation, mode discussion, practical application, and enterprise recruitment demand seminars of the project, implementing the overall monitoring of the project progress, and doing a good job of summarizing and releasing the project in stages, Cooperate with the Industrial Engineering Branch of the Society of Mechanical Engineering to carry out industrial engineer qualification certification training and services, and cooperate with the Vocational Skills Appraisal and Guidance Center of the Mechanical Industry to carry out vocational and technical skills standard certification training and services for Industrial Engineering technicians, further consolidating the integration of industry and education.

5.2.4 The virtual teaching and research room being built relying on the society to achieve school-school collaboration

Relying on the Industrial Engineering Branch of the Society of Mechanical Engineering and the Higher Education Industrial Engineering Teaching Committee, we have participated in the establishment of a collaborative platform for Industrial Engineering professional teachers in universities in Hunan or Central China. The virtual teaching and research room has been constructed, which can effectively achieve the sharing of advantageous teaching

resources among colleges and universities.

6. Conclusion

In order to effectively solve the demand of compound talents for industrial upgrading in the new field of intelligent manufacturing, the reform of the training mode of Industrial Engineering talents oriented to intelligent manufacturing has been studied, and the following conclusions have been drawn:

(1). The training mode of Industrial Engineering talents adapted to the development of intelligent manufacturing has been explored, and the IE+ training program, curriculum system, teaching mode, collaborative education mechanism, production-education integration path, and application platform of digital intelligence have been developed.

(2). The construction mode of "new engineering" for Industrial Engineering major has been established, and the training system of "intelligent +" Industrial Engineering talents has been constructed;

(3). The deep integration and application training program of OT+IE+IT for intelligent manufacturing is designed, which can effectively train high-level composite innovative talents with the ability to solve complex multidisciplinary engineering problems, solve the demand for talents in short supply in the emerging fields of intelligent management and intelligent manufacturing.

Acknowledgements

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