RESEARCH ON THE CONSTRUCTION OF INTELLIGENT MANUFACTURING ENGINEERING MAJOR IN APPLICATION-ORIENTED UNIVERSITIES

WANG Wang-ping, LIU Cheng, SONG Shao-yun, YIN Qiang, YANG Hong-jun

Wuhan Polytechinc University, Wuhan, Hubei Province 430000

Keywords: Intelligent manufacturing engineering, Professional construction, Emerging engineering education, Engineering education accreditation

Abstract: Intelligent manufacturing engineering is a typical representative of emerging engineering education. The construction of intelligent manufacturing engineering is the need of future manufacturing development and the inevitable requirement of current social industrial upgrading and development. Based on the concept of emerging engineering education construction and engineering education accreditation, this paper illustrates the necessity and prospect of setting up intelligent manufacturing engineering major. Based on the engineering education accreditation, this paper puts forward the construction requirements of talent training scheme for intelligent manufacturing engineering. Finally, the construction of intelligent manufacturing engineering major is discussed from the aspects of curriculum system construction, teaching staff construction, teaching materials construction and practice and training base construction.

1 INTRODUCTION

In 2017, the Ministry of Education started work on the development of emerging engineering education, forming a series of documents such as "Fudan Consensus", "Tianda Action" and "Beijing Guide" for emerging engineering education construction [1-3]. On the one hand, emerging engineering education construction promotes the reform and innovation of existing engineering majors; on the other hand, it takes the initiative to set up and develop a number of new engineering majors, construct a new structure of discipline combining new engineering with traditional engineering, and explore a new mode of engineering education personnel training.

In recent years, new generation of information technologies represented by mobile Internet, Internet of Things, big data and cloud computing and new manufacturing technologies represented by 3D printing, robotics and man-machine collaboration have presented multi-point breakthroughs and cross-integration with new energy, new materials and biotechnology, and new breakthroughs have been made in intelligent manufacturing [4-5]. There is no doubt that intelligent manufacturing engineering is a typical representative of emerging engineering education. The construction of intelligent manufacturing engineering emerging engineering major is the need of the new development of the future manufacturing field and the inevitable requirement of the current social industrial upgrading and development.

In 2018, five universities -- Tongji University, Shanghai University, Shanghai Polytechnic University, Shantou University and University of South China-- were approved for the first time as
smart Manufacturing engineering majors. In 2019, a total of 50 colleges and universities across the country were approved to major in intelligent manufacturing engineering. In March 2020, according to the Circular of the Ministry of Education on the Publication of 2019 Annual Record and Approval Results of Undergraduate Majors in Ordinary Institutions of Higher Learning, 80 colleges and universities in China were approved as intelligent Manufacturing engineering majors. Wuhan Polytechnic University, as a local application-oriented undergraduate university, started the construction and preparation of the emerging engineering education major of intelligent manufacturing engineering in May this year.

1.1 The necessity and prospect of setting up intelligent Manufacturing Engineering major

At present, China is implementing the innovation-driven development strategy and a series of major development strategies such as "Made in China 2025", "Internet Plus" and "Cyber Power". In 2015, the State Council issued made in China 2025, realizing the strategic goal of becoming a manufacturing power through "three steps" [6]. In 2016, the Intelligent Manufacturing Development Plan (2016-2020) was officially released and implemented, which will coordinate the development of domestic intelligent manufacturing and accelerate the formation of a working pattern of comprehensively promoting the intelligent transformation of the manufacturing industry. In 2017, when the Ministry of Industry and Information Technology issued and promoted the implementation of "Made in China 2025", it mentioned to strengthen the implementation of intelligent manufacturing, expand intelligent guidance and cooperation, and take the development of intelligent manufacturing as the main direction [7]. In October 2018, the World Intelligent Manufacturing Summit 2018 was held in Nanjing, during which the Guideline for the Construction of National Intelligent Manufacturing Standard System (2018 edition) was officially released. Driven by the national strategy, the social demand for intelligent manufacturing professionals surges. Therefore, it is imperative for colleges and universities, especially application-oriented colleges and universities, to set up intelligent manufacturing majors and train professionals in intelligent manufacturing industry.

In addition, the development of intelligent manufacturing has brought about the transformation of production mode. Many production lines of traditional manufacturing enterprises have been gradually replaced by intelligent production equipment based on industrial robots. This situation has led to a sharp increase in the social demand for intelligent manufacturing engineering professionals. According to a recruitment website, the demand for talents in the intelligent manufacturing industry will increase by more than 10% in 2019 compared with 2018. What’s more, according to the Research Report on Investment Prospects of China's Intelligent Manufacturing Industry in 2020 released by askci corporation in 2019, China's intelligent manufacturing industry shows a relatively fast growth trend, and it is estimated that the output value of intelligent manufacturing will reach 2.7 trillion yuan in 2020. It can be predicted that the employment prospects of the specialized talents in the intelligent manufacturing industry cultivated by universities will be very popular.
2 UNDER THE BACKGROUND OF ENGINEERING EDUCATION ACCREDITATION, THE CONSTRUCTION REQUIREMENTS OF TALENT TRAINING PROGRAM FOR INTELLIGENT MANUFACTURING ENGINEERING MAJOR

Chinese Higher Education has been participating in international engineering education accreditation, since 2006, and became a preparatory member of the Washington Agreement in 2013 and a full member in 2016. After nearly 15 years of engineering education accreditation, Chinese higher education has gradually implemented the three educational concepts of "student-centered, production-oriented and continuous improvement" [8-9]. The implementation of intelligent manufacturing strategy brings new challenges to Chinese higher education, and the engineering education professional accreditation provides an effective theoretical basis for colleges and universities to cultivate talents required for intelligent manufacturing. Under the background of engineering education accreditation, the training of intelligent manufacturing talents puts forward new requirements on traditional higher education concepts, talent training programs and graduate quality evaluation methods.

The design of professional talent training program mainly includes training objectives, graduation requirements and curriculum system. The three core concepts of engineering education accreditation include student-centered, production-oriented and continuous improvement. These three core concepts put forward higher requirements for the design of talent training program for intelligent manufacturing engineering.

One is to focus on students in teaching design, teaching process, and teaching evaluation, paying attention to what students learn, how they learn, and how learning results are. Therefore, the cultivation of intelligent manufacturing engineering professionals needs to establish a new curriculum system. Combining with the characteristics of intelligent manufacturing, it offers courses that reflect the characteristics of the school and conform to the market positioning.

Second, it is oriented by the demand of intelligent manufacturing talent market, which requires graduates to have the ability to be different from the traditional mechanical manufacturing graduates. Therefore, intelligent manufacturing engineering talents training should set high graduation requirements on cutting-edge information technologies such as cloud computing, big data and Internet of Things related to the intelligent manufacturing industry, and such requirements can be flexibly adjusted as the market demand changes.

The third is the requirement of continuous improvement mechanism in the whole cycle. In order to ensure the quality of teaching, it is necessary to establish a continuous improvement mechanism throughout the whole cycle from students entering the school to their graduation. For example, continuously improve and optimize the teaching process according to the feedback from daily supervisors, timely adjust and optimize the teaching content according to the achievement evaluation results of graduation requirements, etc.

3 IDEAS AND MEASURES FOR THE CONSTRUCTION OF INTELLIGENT MANUFACTURING ENGINEERING
3.1 Construction ideas

Intelligent manufacturing and traditional machine manufacturing are two completely different concepts, and intelligent manufacturing technology is a typical interdisciplinary technology. Intelligent manufacturing units generally include CNC machine tools, industrial robots, intelligent logistics, storage systems and so on. The current demand for intelligent manufacturing talents mainly focuses on the installation, commissioning, control and maintenance of intelligent manufacturing units. The professional skills required for intelligent manufacturing include digital design and manufacturing, modern control, robot application, computer control, industrial Internet communication control and other skills. Therefore, the basic idea for the construction of intelligent manufacturing engineering is to build around the cultivation of the above abilities. In combination with the requirements of engineering education accreditation, the overall idea of the major construction is shown in Figure 1. The purpose is to cultivate intelligent manufacturing high-end talents for national, social and local manufacturing industries, the way is the integration of production, education and research, and the means is the focus on mechanical and electrical integration.

![Figure 1: Construction idea of intelligent Manufacturing Engineering](image)

3.2 Curriculum system construction

As a typical representative of emerging engineering education, intelligent manufacturing engineering is bound to have new knowledge, including new technologies and new contents related to strategic emerging industries, so as to build a new knowledge system and curriculum system. To establish a new major of intelligent manufacturing engineering, the curriculum system and teaching content of the emerging engineering education major covering the basic knowledge of various disciplines must be reorganized and optimized. The curriculum system of the new engineering education major of intelligent manufacturing must take full account of the characteristics of the new interdisciplinary subjects, and based on the original mechanical engineering major, integrate the related courses of various interdisciplinary majors such as machinery, computer, automation, management and communication, etc.
To better integration of the interdisciplinary teaching content, it is necessary to analyze the quality of intelligent manufacturing engineering talents and clarify the ability system that graduates should have in engineering technology, information technology, economic management and other aspects, carry out the learning outcome oriented curriculum system reconstruction and establish the corresponding relationship between ability attainment and curriculum system. The following aspects are specifically considered in the construction of new major characteristic courses of intelligent manufacturing Engineering:

1. The importance of developing general education and strengthening the way of thinking is far greater than the importance of learning specific knowledge;

2. To strengthen the construction of major basic course group purposefully, to lay a solid foundation for the cultivation of innovation ability;

3. Integrating, elaborating and innovating specialized courses with emphasis, forming digital mechanical design course group and control course group with electromechanical combination; According to the demand of innovative and compound type talents in emerging interdisciplinary fields, new technology courses highlighting intelligence are added to cultivate students' ability to solve complex new engineering problems in the emerging interdisciplinary field of intelligent manufacturing engineering.

4. The whole course system is closely connected with robot, a typical carrier of intelligent manufacturing, to implement the construction of characteristic courses, and to realize the reform of teaching content and mode.

The course system block diagram of intelligent Manufacturing Engineering is shown in Figure 2.

![Course System Block Diagram]

Figure 2: The curriculum system diagram of intelligent Manufacturing Engineering

To solve the new problems of interdisciplinary engineering, students need to have a comprehensive understanding of various professional knowledge and a thorough understanding of the subject matter of the field. When students study various courses, if there is no main line or carrier, they cannot form the knowledge system from point to line and then to surface, then it is difficult for them to finally form the ability to solve complex new engineering problems in the field of intelligent manufacturing engineering. Robots are an important part of intelligent manufacturing technology, give full play to the leading and carrier role of robot technology in professional construction, with robot as the carrier set intelligent manufacturing engineering practice teaching contents of professional personnel training, not only improve students' interest in learning, to strengthen engineering students' practical ability, but also conducive to grasp the intelligent manufacturing of mechanical engineering,
control science and engineering, computer science and technology, materials science and engineering, cognitive science and technology problems, combining education with practice.

3.3 Construction of teaching staff

The construction of major must first pay attention to the construction of teaching staff. Without first-class teaching staff, all the major construction goals are empty talk. The construction of teaching staff in intelligent manufacturing engineering is an important link in the major construction. At present, most of the existing teachers' knowledge and skills are relatively simple, which cannot meet the needs of the major construction of intelligent manufacturing technology.

The teaching staff can be built through two channels: internal training and external introduction. The internal training mainly focuses on the existing teachers engaged in numerical control technology, industrial robots and other teaching. The way of sending out and inviting in is to make full use of the school's existing intelligent manufacturing teaching equipment and invite the enterprise's training personnel to carry out training for the relevant teachers. At the same time, the national platform for the training of highly skilled teachers is used to train the dispatched teachers in a planned way according to the teaching needs of the intelligent manufacturing specialty. In addition, we can also make use of the good conditions of intelligent manufacturing teaching equipment suppliers for school-enterprise cooperation training.

3.4 Construction of teaching material

Teaching materials are the most basic tools for the implementation of professional teaching and the continuation of the construction of professional curriculum system. The quality of teaching materials directly determines the quality of the training of skilled personnel. Therefore, the development of a set of professional teaching materials is the key to the construction of the whole profession. The construction of teaching materials for intelligent manufacturing technology mainly includes the development of teaching materials for professional skills and professional core skills. The teaching materials for professional skills are developed on the basis of the teaching materials of NC machining and electrical control majors of the university, and the two teaching materials for digital design and processing and network-based programmable control should be mainly developed. The professional core skills textbooks are developed on the basis of the technical application files of the training equipment, among which the four core skills textbooks are mainly developed, namely, industrial robot operation and programming, industrial Ethernet application, intelligent sensing application, and intelligent manufacturing unit application and maintenance. The above two kinds of teaching materials development adhere to the task as the main line, task implementation as the process, the establishment of efficient and practical integrated teaching materials system, to better meet the needs of the construction of intelligent manufacturing specialty.

3.5 Construction of practice and training base

In order to train qualified personnel of intelligent manufacturing technology, the construction of practice and training base must go first. From inside the school, we should create a real working
situation for the actual needs of enterprise positions, build a training base for the application of intelligent manufacturing technology similar to the actual production process and production process of the enterprise, and improve facilities construction of a variety of virtual simulation experiment, let the students can experience intelligent manufacturing environment on campus, through the actual simulation intelligent manufacturing enterprise intelligent manufacturing system, so that the students can master the professional technical knowledge in the field of intelligent manufacturing more intuitively and comprehensively. The professional skills training in the school is networked based on the electromechanical training room, and the training base focuses on the construction of three core skills: industrial robot training, networked intelligent sensor training, and intelligent manufacturing unit training equipment and facilities.

In order to improve students' ability of intelligent manufacturing jobs, university-enterprise cooperation can be related to intelligent manufacturing enterprises, relying on the enterprise, such as equipment, technology and talent resources, to build the intelligent manufacturing technology training base and forming equipment is advanced, the complementary advantages outside the enterprise training system, meet the needs of the students practice.

4 CONCLUSION

With the development of emerging engineering education, intelligent manufacturing engineering, as a typical representative of new engineering, has a bright future. This paper analyzes the specific requirements of talent training in intelligent manufacturing engineering under the background of engineering education accreditation. On this basis, this paper explores and practices the construction of intelligent manufacturing engineering specialty, and probes into the construction of the specialty from the aspects of curriculum system construction, construction of teaching staff, teaching materials construction and practice and training base construction.

REFERENCES


