Construction of Intelligent Manufacturing Teaching Factory for Engineering Education

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Abstract: This paper presents an intelligent manufacturing teaching factory for "Hub Intelligent Production". The system is based on industrial robot, machine vision, CNC machining, 3D animation simulation, combined with MES(Manufacturing Execution System), network communication technology, Information technology, big data identification application technology, virtual simulation technology, to achieve intelligent production scheduling, intelligent production process synergy, intelligent quality process management, intelligent decision support and other functions. Considering the characteristics of different experimental objects, design modular and gradient teaching content to meet different levels of practical teaching. We can cultivate high-quality interdisciplinary in the new era and provide talent support for the field of intelligent manufacturing.

1. Introduction

With the continuous development of intelligent technology in the global manufacturing industry, a new round of industrial revolution represented by German "Industry 4.0" is profoundly changing the structure of modern manufacturing. Manufacturing industry is the main body of China's national economy. Without a strong manufacturing industry, there will be no national and national prosperity [1]. In order to build an internationally competitive manufacturing industry and promote the intelligent trans formation of manufacturing industry, China has put forward the "Made in China 2025"[2]. Therefore, how to cultivate engineering talents with intelligent manufacturing innovation capabilities has become an important subject of engineering education in colleges and universities [3] [4].

The concept of the Teaching Factory originated in the 1990s, aiming to introduce the actual corporate environment into the teaching environment and build a teaching training place with perfect equipment, advanced technology and realistic environment. Through the construction of a teaching factory, the combination of theoretical teaching and practical teaching can be realized in the school, and the purpose of cultivating students 'practical ability and improving students' comprehensive quality can be achieved [5].

This paper combines the construction of Intelligent Manufacturing Teaching Factory of our college, taking "Hub Intelligent Production" as the carrier, analyzes the demand of intelligent manufacturing talents training from the perspective of the system framework of Teaching Factory, constructs the model of intelligent manufacturing. The combination of intelligent technology and teaching environment based on multi-dimensional practical teaching scheme.

2. Intelligent Manufacturing Teaching Factory Construction

2.1. The Teaching Factory Framework

The key of the intelligent manufacturing system is embodied in the intelligent factory, the product

manufacturing has experienced the process of automation and digitalization since its birth. On this basis, the interconnection of equipment can be realized with the help of Internet of Things, the vertical integration of the intelligent factory architecture can be realized, and the bottom-up data channel can be established with cross-level data transmission capability. Which provides the component foundation for the establishment of green, energy-saving and environmental friendly ecological intelligent factory [6]. At the same time, through visualization technologies such as 3D modeling, the seamless integration of physical world and the virtual world, simulation is integrated into the product design and manufacturing process. The various subsystems can coordinate with each other and reorganize dynamically, has the ability of self-diagnosis and self-maintenance as a whole, so as to provide a better means for the manufacturing industry.

Intelligent factory is the foundation and premise for intelligent manufacturing, which is composed of five levels in. As show in Fig 1.
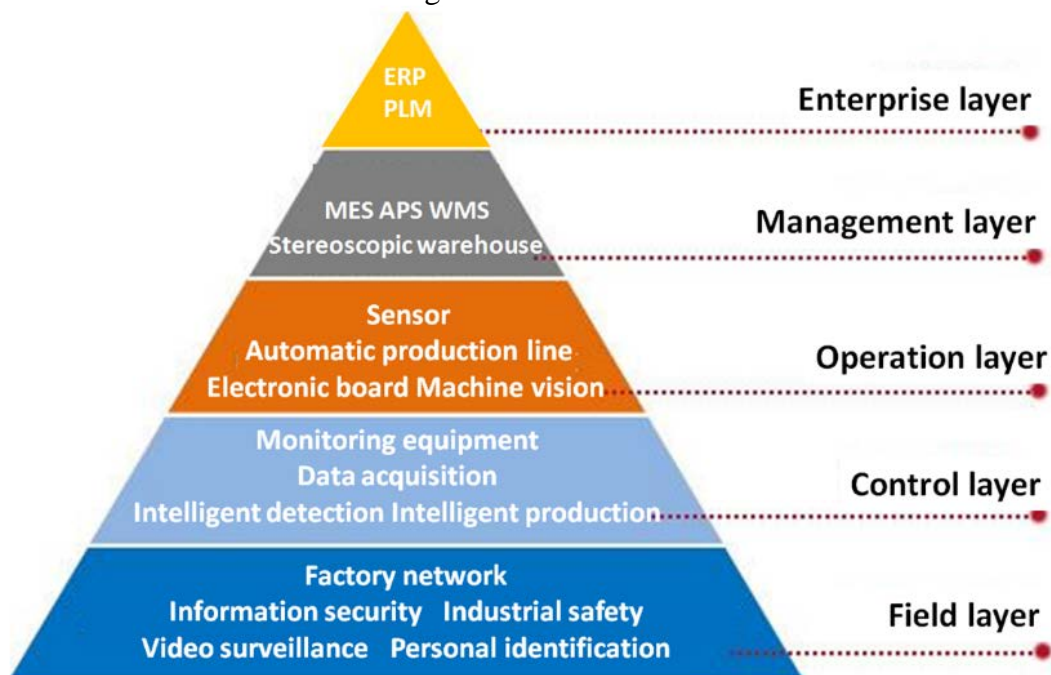

Fig 1. Teaching factory framework

At the enterprise layer, product R&D (Research and Development) and manufacturing preparations are uniformly controlled, integrated with ERP (Enterprise Resource Planning), unified top-level R&D and manufacturing management system is established. The management layer, operation layer, control layer, and field layer are networked through the industrial networks to achieve network connection from production management to the bottom layer of the industrial network to meet the management of production processes, monitoring production site execution, and collecting the field production equipment and material data. In addition to modeling and simulating the product development and manufacturing process, it is also necessary to simulate the reorganization and operation of the production according to the product changes. Before putting into operation. It is necessary to understand the performance of the system, analyze its reliability, economy, quality, duration, provide support for process optimization and large-scale network manufacturing production in the manufacturing process.

2.2. The Intelligent Manufacturing Teaching Factory

The Intelligent Manufacturing Teaching Factory is a set of intelligent manufacturing teaching system that our college and Three-way Intelligent Company jointly participate in planned and designed. As show in Fig 1.According to the relevant technical requirements of the "National Intelligent Manufacturing Standards System Construction Guide", this system is development to cultivate a set of intelligent manufacturing Teaching Factory that meet the requirements of "China

Intelligent Manufacturing 2025" for high-quality compound talents in the new era and stepping on disciplines.
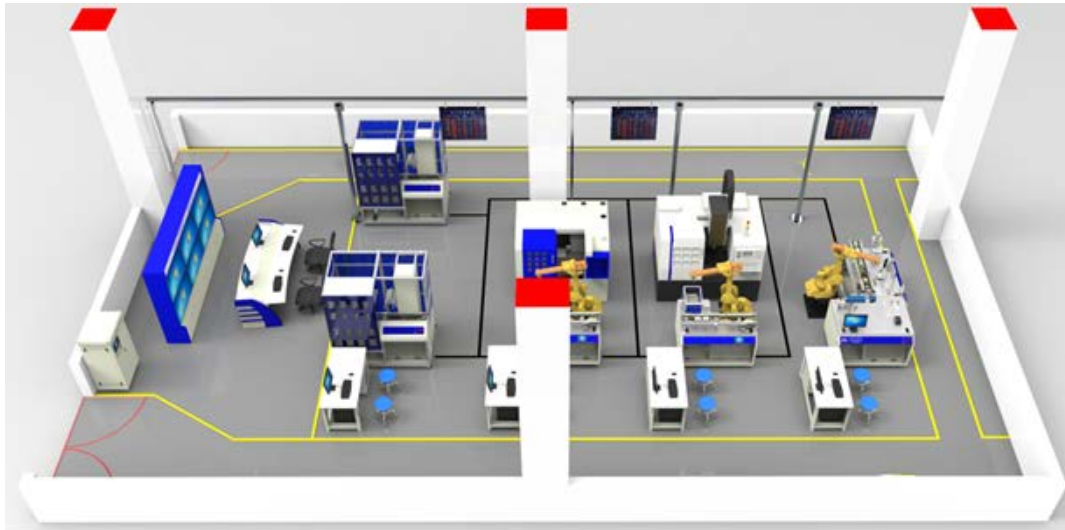

Fig 2. Intelligent manufacturing teaching factory

The intelligent manufacturing training classroom covers an area of 260 square meters. It is an intelligent production factory for hub products. The whole production process includes outputting, CNC machining, intelligent assembly, visual inspection, and laser marking. When the system receives the machining instruction from the control center, the raw material area is operated by the servo motor control stacker, the blank material is grabbed to the workbench, and then transported by the AGV to the CNC machining area for processing. The CNC machining area is controlled by the CNC lathe. The CNC machining center and the multi-degree-of-freedom robot are composed. Finish the processing, AGV transports it to the assembly inspection area for the pressure bearing and screw tightening. After the assembly, the workpiece is visually detected by the camera, the qualified product will be marked (the marking content can be customized). The unqualified products eliminates the production line. Meanwhile the unqualified signal will be fed back to the control center and the control center supplement to produce the order. Finally, the qualified product is stored by the AGV to the finished product warehouse for storage. The production line of the hub products have two sizes of 8-inch and 10-inch, and the production of qualified hub products can be put into actual production and life.

3. Talent Training Program of Intelligent Manufacturing Teaching Factory

3.1. Teaching Mode of Intelligent Manufacturing Course

The intelligent manufacturing course is open to undergraduate students, covering machine, near-machine, and non-mechanical students. The students have different majors and interests. Teachers must teach students in accordance with their aptitude. The training program is divided into three stages: cognitive training, foundation training and innovative training. Set up modular and gradient teaching content in combination with teaching documents such as experimental syllabus, experimental instruction, experimental report, etc.

3.2. Operation Mechanism of Intelligent Manufacturing Teaching Factory

The training subjects of intelligent manufacturing course are students of our college, interested teachers and innovative teams with similar interests. Different explanation methods are adopted for the needs of different objects. The curriculum mode is divided into class concentration training, open innovation training, and technological innovation, which realizes the teaching mode of combining theory and practices. At the same time, this kind of training mode has the learning goal of cross integration, from cognitive training, foundation training, comprehensive application to

innovation and improvement, the content rise level by level and cultivates students' flexible control ability of knowledge. This operating mechanism plays an exemplary role for various brother colleges in China.
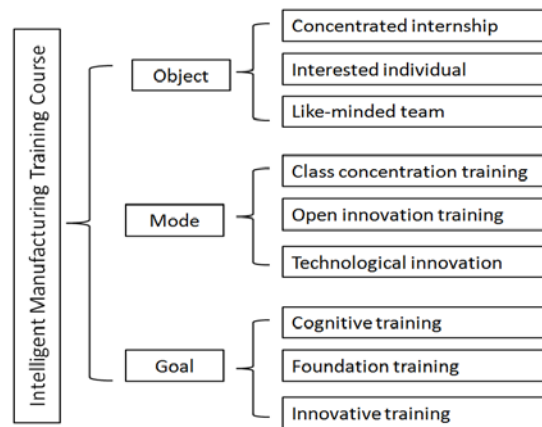

Fig 3. Talent training mechanism of teaching factory

3.3. Evaluation System of Intelligent Manufacturing Teaching Factory

For the students, the three-in-one evaluation model that combines experimental design, experimental process performance, and experimental report. According to the proportion of students under different teaching modes is slightly adjusted. Taking into account the difficulty coefficient of the work, individual or team completion, and combining students' self-assessment, mutual evaluation, and teacher evaluation in various forms, the course is incorporated the performance evaluation of the experimental process, making the course more systematic and interactive. For the course of intelligent manufacturing, the feedback of students participating in the training, the feedback of teachers in our college and domestic brother colleges, and the feedback of enterprises are used for evaluation.

4. Conclusion

Under the national strategy background of "Made in China 2025", the Engineering Training Center of our college has built the "Intelligent Manufacturing Teaching Factory" with hub processing as the carrier. According to the characteristics of this module, the overall framework and composition of the Intelligent Manufacturing Teaching Factory are analyzed, and the in-depth research and reform of the curriculum system, operating mechanism and teacher training are conducted. Through the construction of experimental systems, the design of experimental projects and the implementation of experimental teaching, improve students' engineering ability to use intelligent manufacturing technology. The students will be trained to become excellent engineers with the integration of informatization and industrialization that can meet the development requirements of intelligent manufacturing technology in the future.

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