ATLANTIS PRESS

Advances in Engineering Research, volume 204

Proceedings of the 2021 10th International Conference on Applied Science, Engineering and Technology (ICASET 2021)

Research on the Construction and Key Technologies of Cloud Manufacturing Platform for Intelligent Manufacturing

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ABSTRACT

Manufacturing level and resource scheduling optimization ability are the core operation problems of manufacturing enterprises. Integrating the Internet of things and other advanced information technologies with traditional manufacturing industry, and establishing an intelligent manufacturing system platform based on cloud manufacturing can realize centralized sharing of enterprise resources and manufacturing capabilities, realize networked cooperation in the whole life cycle of product design, manufacturing, logistics and after-sales service, improve resource utilization, change traditional enterprise manufacturing operation mode, and reconstruct industrial value chain, To provide users with safe, reliable, high-quality and cheap service technology, in order to improve the core competitiveness of enterprises. This paper analyzes the connotation of intelligent manufacturing, discusses the functional architecture of cloud manufacturing platform for intelligent manufacturing, and studies the key technologies in intelligent manufacturing.

Keyword: *Industry 4.0, Intelligent manufacturing, Internet of things, Intelligent workshop, Virtual factory*

1. INTRODUCTION

With the rise and development of information technologies such as big data, internet of things, and artificial intelligence, the problem of low intelligence in traditional manufacturing has become more prominent. The integration of internet technology with traditional manufacturing and the development of the intelligent manufacturing industry have become the main theme of the current promotion of social progress. Intelligent manufacturing is to lead enterprises to a digital, intelligent, and networked manufacturing model, to realize the interaction and co-fusion between the physical world and the information world, and to encourage enterprises to centrally share corporate resources and manufacturing capabilities, manage them in a unified manner, and achieve covered products networked collaboration in design, manufacturing, management, transportation, and after-sales throughout the life cycle provides users with safe, reliable, high-quality and low-cost service technologies, changes the traditional manufacturing and operation methods of enterprises, reconstructs the industrial value chain, and improves the core competitiveness of enterprises, and it has become an important direction for the development of current manufacturing enterprises. For this reason, in recent years, countries around the world have successively proposed advanced manufacturing development strategies that conform to the characteristics of each country, such as "German Industry 4.0". With the advancement of science and technology, my country's industrial development process is advancing by leaps and bounds, and the "Made in China 2025" strategy with Chinese characteristics has been proposed, with a view to realizing a new format of interconnection, cross-border integration, intelligent leadership, data-driven, and shared services in the future.

At present, domestic companies have accumulated a large amount of data and resources during the entire cycle of product production. However, because these data resources are usually scattered in different institutions, there is insufficient data integration in product design, production, service and other cross-phase data, and they are not closely

related to each other, lacking of unified management, having low sharing efficiency, and unable to play core values in the full life cycle of the product. In this case, with the help of intelligent manufacturing concepts, research and development of the manufacturing service platform in a cloud environment, unified management of R&D and design knowledge resources, will help realize the full sharing and effective use of knowledge resources.

2. THE CONNOTATION OF INTELLIGENT MANUFACTURING

Intelligent manufacturing refers to the use of "Internet +" technology to dynamically adjust production products and goals according to market demand. Throughout the product life cycle, based on the individual needs of customers, from design concepts, development, production to recycling and other related services, that is, the ability to provide all relevant information in real time through the network in the creation value chain, and the ability to obtain the best value stream from the data. In 2015, the rise of industrial development strategies represented by "German Industry 4.0" and "Made in China 2025" is a typical representative of the concept of intelligent manufacturing, and has become a search hotspot in recent years, as shown in Figure 1.

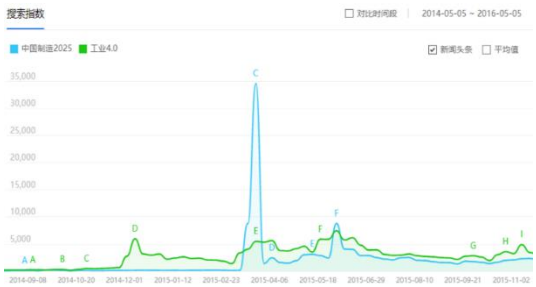

Figure 1 Intelligent manufacturing search index

The essence of intelligent manufacturing is to realize the transformation from informatization to intelligentization of manufacturing industry through the internet and the physical information system, to improve the efficiency of resource allocation, and to carry out precise and rapid control of each link in production, thereby constructing a kind of highly flexible flexible production system, in order to improve the market competitiveness of enterprises. Intelligent manufacturing has the characteristics of interconnection, innovation, integration, and big data, as shown in Figure 2. Interconnection refers to the realization of the interconnection between production equipment, equipment and products, and between physical and information. Equipment with different locations and functions is integrated through the network world and the physical world to form an intelligent workshop, carry out intelligent production, and collaborative manufacturing, and then form a huge intelligent production system; integration refers to the realization of seamless connection from product design, manufacturing, logistics and transportation, and after-sales service, and it is not only the connection and coordination of the internal links of the enterprise itself, but also realize the transformation from enterprise internal information integration to industrial chain information integration, so that the cooperation between enterprises is closer; innovation is a process of continuous development and innovation of technology, process, management and production mode, and realizes the intelligentization of the entire product life cycle in order to meet different manufacturing needs; big data refers to the massive amount of data information generated in the manufacturing process of the enterprise. The intelligent manufacturing system collects, stores, analyzes and manages each data, and controls and schedules each link through the control system. Big data processing technology directly affects the level of intelligence in production and is a key element to realize intelligent production.

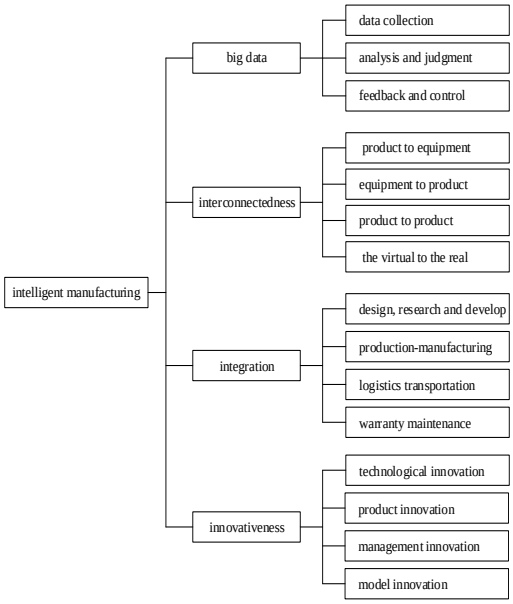

Figure 2 Characteristics of smart manufacturing

3. CLOUD MANUFACTURING PLATFORM CONSTRUCTION FOR INTELLIGENT MANUFACTURING AND RESEARCH ON KEY TECHNOLOGIES

3.1. The functional architecture of the cloud manufacturing platform

Based on intelligent manufacturing concepts such as the internet of ihings technology and cloud platform technology, building a heterogeneous network of equipment, data collection, real-time monitoring, resource scheduling, the cloud manufacturing

application platform of logistics services can realize the requirements including virtual manufacturing simulation, real-time health status analysis, resource optimization scheduling, fault prediction and early warning, maintenance decision support, etc. The platform consists of three levels, namely the resource layer, the platform layer and the application layer. Its technical architecture is shown in Figure 3. The system platform demonstrates the interconnection, measurement and control, and optimization capabilities of products in the entire life cycle process of R&D, manufacturing, and service in the manufacturing process, and intelligent manufacturing capabilities. It reflects the information exchange and resource sharing and ways between enterprises in the entire industrial chain of product production, and the ability of intelligent collaboration and intelligent operation capabilities.

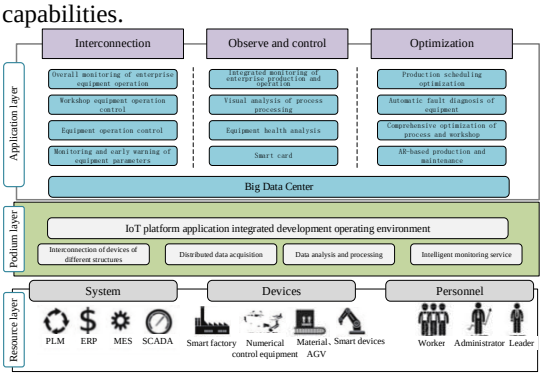

Figure 3 The technical architecture of the cloud manufacturing platform for intelligent manufacturing

1. The application layer realizes functional applications such as heterogeneous interconnection, production process measurement and control, and resource allocation optimization based on the business needs of the enterprise, and can fully perceive the elements of the production process. The interconnection realizes the real-time transmission of manufacturing data, and the analysis and early warning of equipment operation status. Measurement and control provides enterprise production and operation monitoring applications, visual analysis of process processing, and equipment health analysis. Optimization provides functions such as virtual manufacturing, resource optimization configuration, and automatic equipment fault diagnosis.
2. The platform layer is composed of various system platforms, data communication protocols, data analysis solutions and other applications. It establishes a heterogeneous device interconnection framework. According to the heterogeneity and functional characteristics of different devices, it integrates devices with different regions and different types of functions. Networking realizes distributed collection, data mining, analysis and processing of operating data, and provides decision support for management personnel in production scheduling and resource allocation.

The resource layer is the basic layer of the entire platform, which mainly includes various production personnel, related application systems and intelligent production equipment, which constitute the data source of the manufacturing platform. Production personnel mainly include decision-making leaders, management personnel and technical production and other roles, which are the main body of the intelligent manufacturing process. The application system mainly includes office software such as management software, simulation modeling, etc. It is an auxiliary tool for production personnel to analyze, manage and optimize the use of intelligent equipment. Equipment is a tool for manufacturing and an execution terminal for the intelligent manufacturing process. Software systems, smart equipment and production personnel form a closed-loop chain of the entire product production cycle. The essence is to use advanced information technology to monitor the status of industrial equipment, health analysis, process optimization, resource sharing, and decision support to improve the maximum operation of production equipment Efficiency and corporate effectiveness.

3.2. Intelligent workshop

The intelligent workshop is to upgrade the traditional production workshop under the environment of the information Internet of things, and build an intelligent production workshop based on cloud manufacturing technology, so that the production process can be networked, digitized and intelligent. In the transformation process, on the basis of the existing fieldbus, the deployment of industrial wireless networks is increased, and the connection between the equipment and the network is realized through the industrial gateway. According to the actual production needs of the enterprise, functions such as intelligent processing centers, automated warehousing systems, intelligent logistics systems, and product tracking services are set up. For example, in the intelligent machining center, it can automatically complete the work-piece loading and unloading, mechanical processing, quality inspection, label printing, product storage and other processes. Through intelligent data collection and intelligent monitoring, real-time information interaction between workshop stations and each equipment is realized, intelligent data collection and control are realized, and the data in the production process is transmitted to management personnel to realize real-time online monitoring of the manufacturing process, as shown in Figure 4. During the operation of the intelligent workshop, scientific and advanced computer algorithms are used to optimize the process to obtain a more reasonable scheduling plan, so that the management of manufacturing resources is more reasonable, the sharing is stronger, and the production efficiency and economy of the enterprise are realized. Maximize benefits.

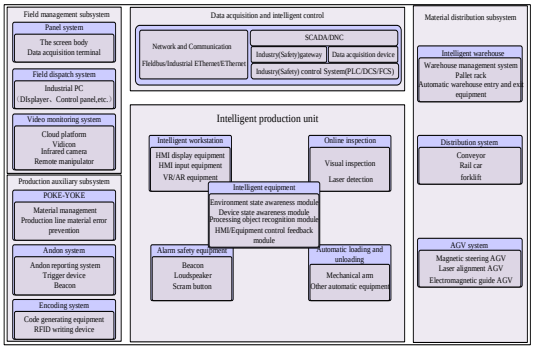

Figure 4 Intelligent workshop system function

3.3. Virtual Factory

As the core content of intelligent manufacturing, virtual factory is driven by data throughout the life cycle of product design, manufacturing, assembly, and management. It can monitor manage, and evaluate all aspects of the manufacturing process through technologies such as computer simulation and virtual reality, provide production line virtual modeling and simulation environment, accurately and intuitively feedback the highly complex production process to the staff, and obtain an optimal solution through simulation. The virtual factory can use virtual simulation technology to verify the product design plan, reversely correct product parameters, and optimize the process flow to ensure that the equipment, process, and materials used in product manufacturing are correct. Realize the visual management of production process, project progress, processing quality and resource consumption, optimize the entire manufacturing process, thereby reducing R&D cycle and planning costs, reducing waste caused by unreasonable planning, so as to realize the interaction between man and machine, user and user. For example, in the automobile manufacturing industry, when analyzing the anti-collision performance of automobiles, repeated simulations and tests are carried out through virtual experiments to obtain the optimal design plan. Figure 5 is an example of virtual factory function modules. The platform realizes the data collection and processing at the equipment level of the manufacturing field, and realizes the interaction and integration with the enterprise application layer ERP, PLM and MES business systems, and supports the twin model of the production line. The platform can realize visual monitoring based on the virtual production line, monitor and manage all aspects of the production process, and realize the evaluation and optimization of the manufacturing process, so as to guide the operation of the company's production plan and provide intelligent and precise production services. Make it have the ability to react quickly in the market competition, and always remain invincible.

After testing, the functional modules of the virtual factory system are running well, capable of fast and accurate real-life human-computer interaction, strong observability, good scalability and portability, and have important guiding significance and practical value for enterprise production.

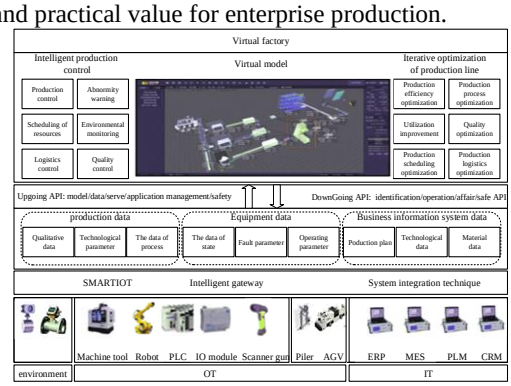

Figure 5 Virtual factory

4. CONCLUSION

In view of the low resource utilization efficiency, high manpower and operating costs and many other problems currently faced by the manufacturing industry, the "German Industry 4.0" and "Made in China 2025" manufacturing concepts with smart production as the core came into being to improve resource allocation, respond to efficiency and market demand, reduce labor costs and logistics costs, and improve corporate competitiveness. By building a cloud manufacturing platform for smart manufacturing, and researching and discussing key technologies such as smart workshops and virtual factories, it fully integrates traditional manufacturing with advanced technologies such as the internet of things, industrial big data, and cloud computing to achieve product design, production, and optimize the configuration of logistics and after-sales service throughout the life cycle, realize the sharing and utilization of resources, provide users with safe, reliable, high-quality and low-cost service technology, restructure the industrial value chain, accelerate the independent control of key industries, and have ability to adapt to complex environments , improve the production efficiency of the enterprise.

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