Research on Digital, Networked and Intelligent Manufacturing of Modern Ship

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Abstract: The development of ship intelligent manufacturing is divided into three stages of digital, networked and intelligent manufacturing. In the digital manufacturing stage, shipbuilding enterprises strengthen the relationship between manufacturing and design to improve the efficiency of manufacturing. In the networked manufacturing stage, shipbuilding enterprises use the internet of things technology to improve the controllability in the production process and effectively enhance the coordination and cooperation between machines and persons. In the intelligent manufacturing stage, shipbuilding enterprises let the new generation of artificial intelligence technology run through the design, management, service and production, greatly improving the flexibility of manufacturing. This paper studies the application model of industrial design system in ship design, the application model of internet of things technology in the production control of shipbuilding enterprises, and the application model of new generation artificial intelligence technology in intelligent decision support, which makes a preliminary exploration for the intelligent development of shipbuilding enterprises.

1. Introduction

The digital, networked and intelligent transformation of modern shipbuilding enterprises is the basic modernization direction of the world shipbuilding industry. The traditional shipbuilding industry belongs to the capital and labour-intensive equipment manufacturing industry. In order to reduce costs or improve the level of technology and process management, intelligent transformation is the necessary development direction. The world's advanced shipbuilding enterprises have begun to study and promote the transformation. In order to achieve better development, China's backbone shipbuilding enterprises also need to implement intelligent transformation. Digitalization, networking and transformation of modern shipbuilding enterprises are the basic goals of the modernization development of China's equipment manufacturing industry. The Made in China 2025 plan is the first ten-year action program for China's government to implement the strategy of manufacturing power. Its core is the intelligent transformation. The intelligent shipbuilding construction should take this as the goal to realize the transformation and development. The digital, networked and intelligent transformation of modern shipbuilding enterprises is the basic choice for China's shipbuilding enterprises to achieve high-quality development. At present, there are some problems in the shipbuilding industry, such as serious overcapacity at the middle and low end, intense price competition, obvious shortage of high-end capacity, and lagging behind in design, manufacturing and supporting facilities. The implementation of intelligent transformation can not only improve the production efficiency, enhance the price competitiveness, realize batch shipbuilding, but also improve the design and research ability and product quality control level. Speeding up the development of medium and high-end ship types is the fundamental requirement to solve the problems such as high labour and procurement costs, weak construction capacity of high-tech and high-value-added ships, realize the transformation of construction advantages from labour and procurement costs to the improvement of construction capacity and quality, and create a new sustainable shipbuilding core competitiveness.
Intelligent manufacturing is the main grasp of innovation and development of China's manufacturing industry, the main path of transformation and upgrading of China's manufacturing industry, and the main direction of accelerating the construction of manufacturing power. Intelligent manufacturing in western developed countries has formed a digital, networked and intelligent development process. As is shown in Figure 1, our country should give full play to the advantages of backwardness, adopt the technical route of parallel and integrated development of three basic paradigms, and take a digital, networked and intelligent parallel promotion of intelligent manufacturing innovation road. To promote the innovation of intelligent manufacturing, China must adhere to the innovation guidance. At the same time, we must seek truth from facts, adjust measures to the enterprise's conditions, and gradually promote the technological transformation and intelligent upgrading of enterprises. According to the actual needs of their own development, enterprises should adopt advanced technology to solve the problems that traditional manufacturing is difficult to solve. From the perspective of shipbuilding industry in developed countries, they have introduced more advanced intelligent manufacturing technology, so they have more advanced technology from production mode to specific production process, which can improve the competitiveness of shipbuilding industry. Based on this, China also needs to speed up the development of intelligent shipbuilding, improve the degree of digitalization, networking and intellectualization of shipbuilding, so as to cope with the current market impact and make new progress in China's shipbuilding industry.

Figure 1. Update process of digital, networked and intelligent manufacturing

2. Digital manufacturing of modern ship

2.1 Basic concept of digital manufacturing
Digital manufacturing is the first basic paradigm of intelligent manufacturing, also known as the first generation of intelligent manufacturing. Digital manufacturing uses equipment products based on digital control technology, which produces manufacturing system with whole life cycle concept and solution represented by computer integrated manufacturing system. In the 1950s, information technology with digitization as the main feature began to be applied in manufacturing industry, and gradually promoted the transformation of manufacturing industry from automation to digitization. Under the background of the integration of digital technology and manufacturing technology, digital manufacturing can rapidly produce products that meet the requirements of users through digital description, analysis, decision-making and control of product information, process information and resource information. The main characteristics of digital manufacturing are as follows: first, in terms of products, digital technology has been widely used in products, forming "digital generation" products represented by machine tools; second, in manufacturing, a large number of digital equipment, digital design, digital modelling and simulation are widely used, and information management is adopted; third,
integration and optimization of operation become production. The outstanding characteristics of Cheng.
Since the 1980s, Chinese enterprises have gradually promoted the application of digital manufacturing, promoted the digitization of the design, manufacturing and management process, promoted the digital control system and manufacturing equipment, and promoted the informatization of enterprises. In particular, in recent years, various localities have vigorously promoted the "machine replacement" and "digital transformation", and established a large number of digital production lines Digital workshop, digital chemical plant, many enterprises have completed the upgrading of digital manufacturing. China's digital manufacturing has entered a new stage of development. The framework of digital manufacturing is shown in Figure 2.

Figure 2. Layout of digital manufacturing

2.2 Applications of digital manufacturing in modern ship industry
Many factors should be considered in modern ship design, not only in ship design and manufacture, but also in every step of data control. It is also necessary to evaluate the quotation of the ship demander, select the appropriate manufacturing materials, and the type and function of ship design. The preliminary design of ship type should be carried out according to the needs of ship owners, and then the ship design should be refined to ensure that every design direction and step meets the requirements of ship manufacturing regulations and industry standards. The key to the digital management of process documents for intelligent manufacturing is to digitize the process information to form a data and file system that can be recognized, reused and correlated by computers. This paper analyses the process data characteristics of hull components processing and forming, small and medium assembly welding, hull section outer plate coating and pipe flange welding, and formulates a more general data specification according to the data application requirements of the final short plate equipment. According to different design software, the corresponding model interface is developed to extract and reorganize the data. Through the process planning software for robot application, the process and path planning of robot operation is carried out, or the process information is transferred to the intelligent processing equipment of digital workshop to drive the robot to run. For the unstructured process documents, the digital archives are established, and the process documents are uniformly filed, checked, browsed and distributed through the process document management platform.

At present, the mainstream ship design software includes Tribon, SPD, CATIA and so on. Different CAD systems have different data formats, so it is difficult to exchange and share multi-source data. It is necessary to study the information exchange technology of heterogeneous CAD systems, propose a standard format for multi-source data, and establish a general process data structure. Based on the intermediate file, the mapping relationship between the parts attributes of different CAD systems and the process data management system is established, To realize the intelligent extraction of heterogeneous CAD data and convert it into a unified data format. The implementation of intelligent manufacturing of ship processing requires more urgent design process information. There must be a
large number of unstructured process documents in the delivery of process design. In view of the difficulties in the management of large number of process documents, process approval and multiple versions in the process of ship design, It is necessary to study the centralized management of ship process design documents to realize the electronic approval process management technology, process document change management technology, multi view design task feedback technology, multi dimension process document safety control management technology and print information tracking management technology. Form the management methods covering the process of process document design plan, design drawing, audit, filing, printing, distribution, etc., and develop the ship design process document information management software, so as to provide effective support for the process document digital management technology oriented to intelligent manufacturing.

3. Networked manufacturing of modern ship

3.1 Basic concept of networked manufacturing

Networked manufacturing is the second basic paradigm of intelligent manufacturing, also known as the second generation of intelligent manufacturing. China Internet plus technology has been gradually maturing since the end of 1990s. The Internet plus manufacturing industry in China has deepened the deep integration of Internet and manufacturing. Nodes in the past isolated from people, processes, data and things are connected by the network. Through the collaboration among enterprises and enterprises, the integration and optimization of various social resources, and the "Internet + Manufacturing" reshape the value chain of manufacturing industry, and promote the development of the Internet. Manufacturing industry has developed from digital manufacturing to digital networked manufacturing. The first of the model, in terms of products, on the basis of digital technology application, network technology has been widely applied, and has become a product of network connection, and collaboration and sharing in design, development and other links have been achieved. Secondly, in the aspect of manufacturing, on the basis of in plant integration, further realize the integration of supply chain, value chain and end-to-end integration of manufacturing, and realize the connectivity of data flow and information flow of manufacturing system. Third, in terms of service, the whole life cycle of products such as design, manufacturing, logistics, sales and maintenance, as well as users and enterprises, realize the connection and interaction through the network platform, and the manufacturing mode changes from product-centred to user-centred. The framework of networked manufacturing is shown in Figure 3.
3.2 Applications of networked manufacturing in modern ship industry

Production is the core link of shipbuilding enterprises. The management and control of production links are directly related to the quality of ship products, construction cycle, construction cost, etc., which is the core of shipbuilding enterprise management. At present, China has basically established a production management mode guided by lean production theory and supported by digital and information management system. MES is the link between workshop control level and management decision-making level, and its essence is an integrated workshop management and control system for manufacturing process. On the one hand, MES can refine and decompose the plans from the upper management system and transmit the operation instructions to the bottom control system; on the other hand, MES can monitor the operation status of the underlying equipment in real time, collect the real-time data of the equipment and instruments, and feedback the production situation to the upper management system, so as to realize the integration and optimization of management. MES can well meet the needs of shipbuilding enterprises for workshop production management. The key to realize the effective management of the workshop by MES is to realize the real-time data collection and feedback of the workshop. With the development of Internet of things technology, its advantages in perception information, data processing and transmission can be combined with MES system to realize comprehensive collection of field data and overall perception of site environment, realize real-time information interaction between production equipment and management system, realize automatic control of production process, and finally realize closed-loop control and continuous improvement of production.

In the workshop production, the main way of data collection is through RFID tags, sensing equipment and layer control system, among which RFID technology is a breakthrough technology of factory data collection. Then through the workshop level wired or wireless short-distance transmission network, such as fieldbus, ZigBee, etc., it is transmitted to the gateway equipment for information transmission and interaction of each node. It also includes the function of extracting and filtering all kinds of messy information. Finally, the screened data is transmitted to the management system through the LAN of the vehicle, and the field staff can watch it through PDA, mobile phone and electronic Board and other networking equipment for real-time query or control. There are two main functions of production scheduling: one is to make detailed plan of workshop level according to enterprise level plan, workshop equipment, personnel, site and other conditions, and arrange it to each team for workshop personnel to consult or display on the Kanban in real time; the other function is to coordinate scheduling, which is to coordinate the implementation and coordination of the plan, that is, to continuously coordinate the various events in the workshop according to the plan This is the core function of MES. The application of Internet of things technology can better realize the monitoring of various resources in the workshop and tracking the actual performance of the plan. The workshop production management system needs to be integrated with the enterprise management system to realize the coordination between the enterprise level plan and the workshop level plan, and through the analysis of the diachronic data collected by the system, it can provide decision support for the enterprise management.

4. Intelligent manufacturing of modern ship

4.1 Basic concept of intelligent manufacturing

Intelligent manufacturing is the third basic paradigm of intelligent manufacturing, which can also be called the new generation of intelligent manufacturing. Intelligent manufacturing is based on the deep integration of new generation information and communication technology and advanced manufacturing technology. It runs through all aspects of manufacturing activities such as design, production, management and service. It has the functions of self-perception, self-learning, self-decision-making, self-implementation and self-adaptive. In recent years, driven by the rapid development of new generation information technologies such as Internet, cloud computing, big data and Internet of things, the new generation of artificial intelligence technology, represented by big data intelligence, cross media intelligence, human-computer hybrid enhanced intelligence, and swarm intelligence, has accelerated and achieved strategic breakthroughs. The new generation of artificial intelligence technology and advanced manufacturing technology are deeply integrated to form a new generation of intelligent manufacturing. The essential feature of the new generation of artificial intelligence is that it
has the ability to learn, to generate knowledge and to better use it, and to achieve a qualitative leap. The framework of intelligent manufacturing is shown in the following figure.

4.2 Applications of intelligent manufacturing in modern ship industry

In ship product research and development, through the analysis of the market environment and the prediction of customer demand, the accuracy of research and development goals can be improved, and the customer satisfaction of new products can be improved; in the ship design stage, more design data, technology and knowledge support based on the previous similar ship types can be obtained, so as to improve the design efficiency; and through the whole life of ship from design to recovery, the accumulation of life cycle data can continuously optimize the design standards, knowledge base and model base. Based on the establishment of digital model of various resources of shipbuilding enterprises, that is, the virtual simulation system of production process, logistics process and even the whole shipbuilding enterprise is established, which provides intelligent decision support for the construction plan, site and layout, transportation path, etc. Speed up the construction of communication network infrastructure covering the whole plant. The technology of optical communication and industrial Ethernet Internet should be effectively used to implement the full coverage of modern communication network in the factory area, so that the data of key equipment in the main station can be collected and transmitted in an all-round way.

Around the whole process of shipbuilding, promote the construction of data acquisition and analysis system in production, safety, quality and efficiency, accurately analyse data, and realize lean production control. The information analysis and application system with full cycle coverage and full link penetration has been built. At the same time, based on the real-time collection and analysis of field data based on internet of things technology, the process optimization, quality management, problem prediction and production scheduling of manufacturing process based on big data processing are realized, and historical data are continuously accumulated to optimize various knowledge and algorithms; especially in the aspect of precision management and forming processing technology, through the continuous accumulation and statistical analysis of deformation data, the standard is formed. The accuracy control system and process method of standardization. In the ship operation stage, through the analysis of various data of ship operation, such as equipment operation data, ship navigation positioning data and stress data of important parts. The construction of a service platform based on ship operation data can provide intelligent service for the maintenance and repair of ship operation stage, and also provide intelligent business decision for ship operation users. As a general assembly plant, shipbuilding enterprises can also outsource part of parts manufacturing and segmented manufacturing through cloud platform, which can realize network collaborative planning and management for outsourcing enterprises.
5. Conclusions
Under the background of digitalization, networking and intellectualization of the manufacturing industry, this paper outlines the blueprint of the future intelligent shipyard, and studies the application mode and implementation plan of the relevant intelligent manufacturing technology in the shipbuilding enterprises, and makes a preliminary exploration for the intelligent development of the shipbuilding enterprises. This paper mainly describes the application mode of intelligent manufacturing technology in general, and does not put forward specific implementation scheme. There are many technical problems in the real implementation and application process, which need to be further studied.

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