3D Printing Distributed Mold Intelligent Manufacturing Model Analysis

Canze Ju

Department of Electronic and Electrical Engineering, University College London, London, NW3 3HY, United Kingdom

jucanzeuk@163.com

Abstract. In recent years, with the rapid development of technologies such as 3D printing, distributed manufacturing, and intelligent management, the manufacturing industry is undergoing a revolutionary transformation. The emerging 3D printing distributed mold intelligent manufacturing mode combines these cutting-edge technologies, aiming to achieve personalized and flexible production. This is leading the manufacturing industry towards intelligence and customization. This paper discusses the core concepts and key technical elements of 3D printing distributed mold intelligent manufacturing mode. This model combines 3D printing technology, distributed manufacturing, and intelligent management to achieve personalized and flexible production. From cloud intelligent platform, 3D printing manufacturing, distributed manufacturing to business model innovation, the management characteristics of this model in production, design, value chain management and business are discussed. Examples such as Quirky and 3D Systems are used to illustrate the practical application and innovation of the model. This model not only promotes innovation in manufacturing, but also brings new prospects for personalized production and consumption patterns.

Keywords: 3D printing distributed molds, Intelligent manufacturing mode, Key elements, Innovative content.

1. Introduction

3D printing distributed mold intelligent manufacturing mode is a novel manufacturing paradigm that combines 3D printing technology with distributed manufacturing. The model takes personalization and flexibility as the core, and realizes intelligent management through the cloud intelligent platform. Its basic features include: 1) Personalized design: to meet the differentiated needs of consumers, to achieve small batch, customized production; 2) Distributed manufacturing: disperses production resources to improve production efficiency; 3) Cloud intelligent platform: achieve precise production and consumer participation through big data analysis; 4) Business model innovation: Build an "online + offline" business model to provide personalized services. The rise of this model has facilitated the transformation of manufacturing, opening new avenues for innovation and sustainable development.

The paper explores a novel manufacturing paradigm, the 3D Printing Distributed Mold Intelligent Manufacturing Mode. This model integrates 3D printing technology, distributed manufacturing, and intelligent management to enable personalized and adaptable production. The study delves into the model's aspects including cloud-based platforms, production processes, design implications, value chain management, and innovative business models. Practical instances like Quirky and 3D Systems illustrate the model's application and innovation. Ultimately, the model not only spurs manufacturing innovation but also ushers in a new era of personalized production and consumption trends.

2. Key technical elements

2.1. Cloud intelligent manufacturing technology

Cloud intelligent manufacturing technology plays a key role in the intelligent manufacturing mode of 3D printing distributed molds. By integrating data, resources, and collaboration environments in

the manufacturing process into a cloud platform, information is centrally managed and shared in real time. This technology enables multiple participants to work together in different locations, thus speeding up the mold manufacturing process and reducing communication and logistics costs. Cloud intelligent manufacturing technology can also provide real-time data analysis and prediction capabilities for mold design and production, optimize production processes, and carry out quality control during manufacturing. This integrated intelligent approach helps to improve production efficiency, reduce manufacturing risk, and promote the innovation and development of 3D printing distributed mold intelligent manufacturing models [1].

Intelligent manufacturing develops within a progressively expanding ecosystem, building a tight network of connections. In this network, intelligent integration, intelligent manufacturing cloud, intelligent products, intelligent production and intelligent services form a continuous development chain. This chain starts with intelligent integration, coordinated and supported by the intelligent manufacturing cloud, leading to intelligent products and intelligent production. Ultimately, intelligent services will be connected to the entire process, forming a closed loop. This close interconnection enables the networking of industrial intelligence, which not only enables the sharing of data and information, but also accelerates innovation and productivity. The intelligent integration diagram composition is shown in figure 1.

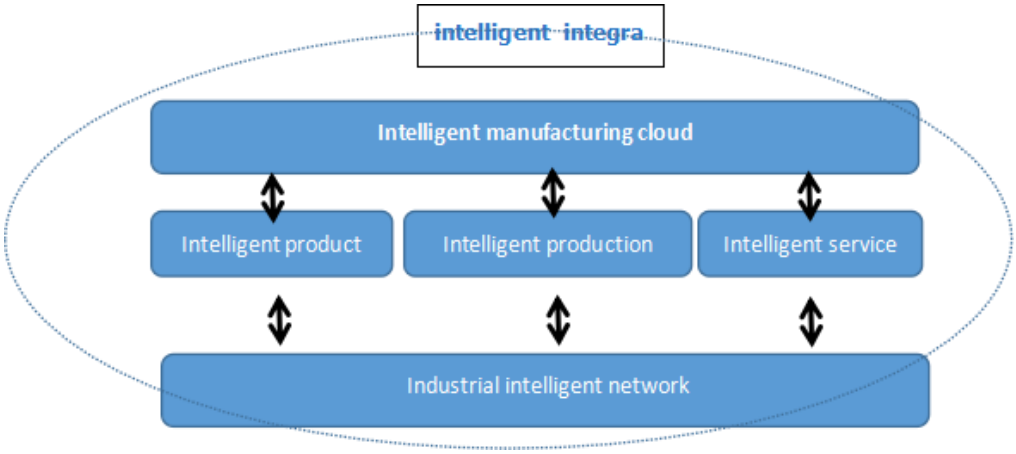


Figure 1. Intelligent integration diagram composition

2.2. 3D printing manufacturing technology

3D printing manufacturing technology is the core component of 3D printing distributed mold intelligent manufacturing mode. The technology transforms digital design models into actual objects by stacking materials layer by layer, enabling a fast, customized manufacturing process. In the field of mold manufacturing, 3D printing technology has outstanding advantages, which can flexibly manufacture complex shapes of molds, reducing the cost of working hours and resources in traditional manufacturing. In addition, 3D printing can also quickly respond to design changes and improve the flexibility of production. By distributing manufacturing to multiple locations, transportation and inventory costs can be reduced. The application of this technology makes the manufacturing process more efficient and sustainable, and promotes the realization of intelligent manufacturing mode [2].

2.3. Cloud intelligent platform technology

Cloud intelligent platform technology plays a key role in 3D printing distributed mold intelligent manufacturing mode. By integrating technologies such as cloud computing, big data analysis and artificial intelligence, the cloud intelligent platform can achieve comprehensive monitoring, management and optimization of the mold manufacturing process. This technology enables manufacturing companies to share data in real time, collaborate globally, and make more informed decisions based on data analysis. The cloud intelligent platform can also provide intelligent assistance for mold design and manufacturing, from optimized design to material selection, to further improve

production efficiency and quality. In addition, cloud intelligent platform technology also provides support for the sustainable development of mold manufacturing, reducing the impact on the environment by optimizing resource utilization and production processes. This comprehensive technical solution helps to promote the innovation and development of 3D printing distributed mold intelligent manufacturing model [3].

2.4. Distributed manufacturing technology

Distributed Manufacturing technology, also known as DM (Distributed Manufacturing) technology, refers to different production capacity, scale and geographical manufacturing technology and cooperation mode. This technology allows manufacturers to produce in a decentralized manner according to market demand and individual requirements. Distributed manufacturing provides support for 3D printing technology and is particularly suitable for single-piece and small-batch manufacturing, which can precisely meet site-specific production characteristics. This helps solve the problems of resource allocation, equipment utilization and manufacturing services faced by the 3D printing field. Taking 3D Systems as an example, they used the distributed manufacturing model to build a shared 3D printer network based on community units, which not only optimized resource allocation, but also improved equipment utilization efficiency, thus improving the business performance of the enterprise [4].

3. Management characteristics

At present, there are differences between the intelligent manufacturing model and the traditional manufacturing model in the application of 3D printing distributed technology. In order to better understand the actual value of these two technology manufacturing modes, it is necessary to in-depth comparative analysis and clarify the core management characteristics of the 3D printing distributed mold intelligent manufacturing mode.

3.1. Characteristics of production mode management

Compared with traditional manufacturing, intelligent manufacturing pays more attention to personalized production, using 3D printing technology to achieve single small batch customization. Distributed manufacturing allows production capacity to be distributed across multiple locations, reducing transportation and inventory costs while increasing production flexibility. In contrast, traditional manufacturing usually tends to be large-scale, centralized production, adapting to high-volume needs. Intelligent manufacturing is more sophisticated and flexible in production methods to adapt to market changes. These features enable the 3D printing distributed mold intelligent manufacturing model to quickly meet diverse needs and improve production efficiency and customer satisfaction [5].

3.2. Product design pattern management characteristics

In the 3D printing distributed mold intelligent manufacturing mode, the product design mode management features are unique. Compared with traditional manufacturing, the smart manufacturing model emphasizes personalization and flexibility. With 3D printing technology, product design can be more flexible to meet customer needs, supporting customization and rapid response to market changes. Distributed manufacturing enables design teams to work together in different locations, improving design efficiency. On the contrary, traditional manufacturing usually adopts standardized design, which is difficult to meet individual needs.

The product design pattern management features of the 3D printing distributed mold intelligent manufacturing model make innovation easier and reduce the design-to-production cycle. This flexibility helps to develop innovative products and bring them to market quickly, enhancing the competitiveness of the company. To sum up, the management characteristics of product design mode show higher adaptability and innovation in intelligent manufacturing mode [6].

3.3. Characteristics of value chain management

In terms of value chain management, 3D printing distributed intelligent manufacturing emphasizes systematic logistics and storage facility design to ensure efficient production processes. In addition, the model introduces a "last mile" product logistics strategy to meet the needs of precise location printing, so that the public can participate in product design and manufacturing, and obtain demand information through big data analysis to achieve customized production. This feature makes the value chain management more refined, while promoting the close connection between the manufacturing mode and the consumption mode, creating an efficient production and consumption mode. For example, Shape ways, an American company, uses this process. The integration of this process has promoted the development of the intelligent manufacturing model of 3D printing distributed molds and injected innovative vitality into it [7].

3.4. Business model management characteristics

In the 3D printing distributed mold intelligent manufacturing model, the business model management characteristics show a different face from the traditional manufacturing model. This model emphasizes personalized customization and innovation to provide customers with more choices. The business model shifts the focus from mass production to meeting diverse needs. Distributed manufacturing enables enterprises to better respond to market changes and quickly adapt to the needs of different regions. In addition, 3D printing technology makes small batch production economically viable, reducing the cost of developing new products [8].

This business model feature enables closer partnerships by connecting supply chains and consumers. Customer involvement in product design and customization enhances customer loyalty. At the same time, this model encourages innovation and pushes companies to find new ones.

4. Key points of innovative practical application

4.1. Intelligent manufacturing mode innovation practice process optimization and adjustment

In the period from 2021 to 2022, several enterprises have made full use of the cloud intelligence platform to build a personalized intelligent guidance model based on technology and management innovation, and actively promote innovation in technology practice. The specific data of process optimization is shown as follows: First, the ability to obtain demand information through big data analysis has been improved by 15%, providing a more accurate direction for innovation. Second, by engaging the online community in innovation, using search and crowdsourcing, the number of innovative projects has increased by 30%, and the source of ideas has been tapped more widely. Subsequently, the selection of 3D printing plants was more precise, and the satisfaction rate increased by 25%. Finally, the average time from requirement submission to factory production has been reduced by 20% throughout the process, accelerating product innovation and time-to-market. The successful application of this social manufacturing process, such as Shape ways in the United States, provides strong support for the sustainable development of 3D printing distributed mold intelligent manufacturing mode [9]. As shown in Table 1.

Table 1. Intelligent manufacturing model Innovation Practice process optimization and adjustment data (2021-2022)

Data index	Range ability
The ability of big data analysis to obtain demand information	+15%
Number of innovative projects	+30%
3D printing factory selection satisfaction rate	+25%
Total process time	-20%

4.2. Establish a consumer-centered product democratic design model

The breakthrough of 3D printing distributed mold intelligent manufacturing mode is to go beyond the limitations of traditional manufacturing and show excellent design capabilities based on personalized and differentiated needs. Create a variety of products to meet consumer needs through a public service platform, build a "consumer center", and optimize the democratic design of products. For example, Quirky, a Us-Based company, uses a "consumer-centric" product democratic design model to design a variety of 3D printed products through the participation of the public and innovators on the network platform, and gets rich returns. The 3D printing distributed intelligent manufacturing model provides consumers with a comprehensive value chain solution. With the big data technology of the cloud intelligence platform, we can actively customize the individual needs of consumers, and combine it with 3D printing technology to efficiently achieve personalized and real-time production. Enterprises adopt Pareto improvement model to balance the maximization of profit with the benefit of consumers. Taking 3D Systems as an example, it provides full value chain solutions, builds product design that ADAPTS to public participation, and realizes business model innovation through online platform analysis throughout the process.

4.3. Adjust and enrich the "online + offline" business model

When expanding the "online + offline" business model, the application of 3D printing technology mainly takes advantage of the innovation of the business model, thereby gaining a competitive advantage in the market and bringing lucrative profits to the enterprise. At present, the emerging printing technology application model has formed its core competitiveness, and with its unique O2O way, to achieve the organic combination of O2O and O2O business model. This model organically combines the online cloud intelligence platform with the offline physical store, and fully realizes the personalized customization requirements of customers. For example, FabCafe adopts the O2O" online + offline "new business model, which makes use of the traditional professional intelligent production method, and makes use of the production factors and management characteristics of the new enterprise model to conduct technical analysis of products, and thus constructs a new global value chain upgrade and solution strategy [10]. In this way, 3D printing technology can organically integrate online and offline in marketing methods, providing consumers with more personalized choices, and creating huge business opportunities for enterprises.

5. Innovative practical application mode

3D printing distributed mold intelligent manufacturing mode is divided into the traditional full value chain system and cross-border platform service mode, both of which are intelligent 3D printing innovation modes, with rich technical applications and reference data, highlighting the key technical points in innovation practice.

5.1. 3D printing distributed mold intelligent manufacturing model based on the whole value chain solution

This model has improved and upgraded the traditional centralized intelligent manufacturing, established a total solution of the whole value chain, and effectively optimized the distributed intelligent innovation of 3D printing. In this model, the product logistics is optimized through 3D printing distributed manufacturing technology, and the production service system of "one-kilometer product logistics" is established. At the same time, the company adopts the crowdsourcing search method, through the unified parts supply and enterprise production inventory management system, to ensure that the integrated solution of the whole value chain plays a key role in the network technology innovation and enterprise innovation development. These changes will make the traditional production mode further meet the new technological innovation requirements, and provide beneficial technological changes for the development of distributed intelligent innovation models such as 3D printing.

5.2. 3D printing distributed mold intelligent model

Under the current trend, breaking through traditional manufacturing and building a superior 3D printing distributed mold intelligent model has become a direction that cannot be ignored. This model actively adopts a variety of new technologies to ensure that technology applications are optimized and clearly presented across platforms. The establishment of virtual control decision center becomes the key to replace the traditional enterprise management decision center and make the model more modern and innovative. This innovation will bring great changes to the manufacturing industry, improve efficiency and flexibility, and pave the way for future manufacturing development.

6. Conclusion

The 3D printing distributed mold intelligent manufacturing model represents an important advance in the direction of intelligent, flexible, and personalized manufacturing. By making full use of the cloud intelligence platform, innovative business models and cross-border cooperation, the model has revolutionized traditional manufacturing methods and promoted the optimization and innovation of production processes. As technology continues to evolve, this model will bring more opportunities to the manufacturing industry, enhance the competitiveness of enterprises, and achieve more efficient and sustainable production methods. Therefore, the development of 3D printing distributed mold intelligent manufacturing model will continue to lead the innovation and development direction of the manufacturing industry in the future.

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