Digital Design and Manufacturing Technology Innovation in Mechanical Manufacturing

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Abstract: With the rapid development of information technology, digital design and manufacturing technology has become an important trend and development direction in the mechanical manufacturing industry. However, in the actual application process, there are still practical difficulties such as high technical costs, high technical difficulty, and limited technical talents, which require continuous improvement of the efficiency, accuracy, and quality of mechanical manufacturing. In this context, in-depth exploration of the application innovation of digital design and manufacturing technology in mechanical manufacturing can further achieve intelligent management of mechanical manufacturing processes, digital analysis of mechanical product data, and simulation analysis of mechanical product quality, truly promoting the digital transformation and sustainable development of the mechanical manufacturing industry.

1. Introduction

With the rapid development of information technology, digital design and manufacturing technology has become an important trend and development direction in the mechanical manufacturing industry. The application of digital design and manufacturing technology can improve the efficiency, accuracy, and quality of mechanical manufacturing, reduce costs and resource consumption, and promote industrial upgrading and transformation development. At the same time, digital design and manufacturing technology can also promote innovation and promote the development of the mechanical manufacturing industry towards intelligence, efficiency, and greenery. Therefore, the research and innovation of digital design and manufacturing technology has become an important task in the mechanical manufacturing industry. Through research on digital design and manufacturing technology in the field of mechanical manufacturing, it can provide certain reference and inspiration for the digital transformation of the mechanical manufacturing industry, and promote the sustainable development of the mechanical manufacturing industry.

2. Basic principles of digital design and manufacturing technology

Digital design and manufacturing technology is a comprehensive application that integrates various technologies such as computer-aided design, computer-aided manufacturing, computer-aided engineering, computer vision technology, three-dimensional measurement technology, simulation technology, and information management technology. The basic principle is to transform traditional manual design and manufacturing methods into digital automated design and manufacturing methods, and achieve efficient, accurate, low-cost, and high-quality production of products through digital modeling, digital processing, digital testing, digital simulation, and digital management.

One is digital modeling, which uses computer software to perform three-dimensional modeling of solid objects, transforming the geometric shape, size, material and other information of the object into a digital model. The second is digital processing, which imports digital models into equipment such as computer numerical control (CNC) machines or laser cutting machines, and achieves precise processing and manufacturing of objects through automated control. The third is digital detection, which utilizes computer vision technology and three-dimensional measuring instruments

to perform digital detection on processed objects, ensuring that their dimensional accuracy and surface quality meet the requirements. The fourth is digital simulation, which uses computer simulation technology to simulate and analyze the structure and performance of objects, optimize design schemes, and improve the reliability and performance of products. The fifth is digital management, which utilizes computer information management systems to comprehensively manage the design, manufacturing, testing, and maintenance processes of products, achieving informatization and intelligence in the production process.

3. The application dilemma of digital design and manufacturing technology in mechanical manufacturing

3.1 High technical costs

Digital design and manufacturing technology requires a large number of high-performance computers and advanced software systems to support, which makes the technology cost very high. This is because digital design and manufacturing technology requires processing a large amount of data, conducting complex calculations and analyses, and therefore requires high-performance computers and advanced software systems to support it. In addition, digital design and manufacturing technology also requires the use of a large number of hardware devices such as sensors and actuators, which also increases costs. The high cost of digital design and manufacturing technology can have a series of negative impacts. Firstly, high costs will limit the application of digital design and manufacturing technology in small and medium-sized enterprises and emerging industries, which often do not have sufficient funds to support the application of digital design and manufacturing technology. Secondly, high costs will also limit the promotion and popularization of digital design and manufacturing technology, making it difficult for more enterprises and industries to enjoy the benefits of digital design and manufacturing technology. Finally, high costs may also lead to a phenomenon of "wealth inequality" in the application of digital design and manufacturing technology, which only some large enterprises and multinational corporations can afford, while small and medium-sized enterprises find it difficult to bear[1].

3.2 High technical difficulty

The application dilemma of digital design and manufacturing technology in mechanical manufacturing is mainly manifested in the high technical difficulty. This is because digital design and manufacturing technology involves multiple disciplinary fields, requiring the comprehensive application of knowledge and skills from multiple disciplines such as computer science, mechanical engineering, and materials science. In addition, digital design and manufacturing technology also requires highly precise equipment and tools, as well as a large amount of data and information support, which requires a significant investment of manpower, material resources, and financial resources. The main reasons for this situation are as follows: firstly, digital design and manufacturing technology requires a large number of high-precision equipment and tools, which have high manufacturing and maintenance costs. Therefore, only large enterprises or research institutions can bear the burden. Secondly, digital design and manufacturing technology requires highly complex software systems to support the design and manufacturing process, and the development and maintenance of these software systems also require a significant amount of funding and manpower investment. Finally, digital design and manufacturing technology also requires a large amount of data and information support, which requires enterprises or research institutions to establish a comprehensive information management system to ensure the security and reliability of data.

3.3 Lack of technical talents

One of the application difficulties of digital design and manufacturing technology in mechanical manufacturing is the shortage of technical talents. This is because digital design and manufacturing technology involves multiple disciplinary fields, requiring knowledge and skills in multiple

disciplines such as computer science, mechanical engineering, and materials science. Therefore, comprehensive interdisciplinary abilities are required. In addition, digital design and manufacturing technology also requires mastery of relevant software and the use of software tools, which also requires corresponding technical training and practical experience. Firstly, digital design and manufacturing technology is an emerging technology, and related majors and disciplines are relatively new. Currently, a complete talent training system has not been formed, resulting in a relative shortage of technical talents. Secondly, digital design and manufacturing technology require interdisciplinary integration, which requires technical talents to possess a wide range of knowledge and skills. However, in reality, there is often a problem of high degree of specialization, leading to a lack of interdisciplinary comprehensive abilities for technical talents. Finally, digital design and manufacturing technology requires a large amount of data and information support, which requires technical talents to have the ability to analyze and process data. However, in reality, there is often a lack of corresponding data analysis and processing talents.

4. Application innovation of digital design and manufacturing technology in mechanical manufacturing

4.1 Implement intelligent management of mechanical manufacturing processes

With the continuous development of digital technology and intelligent manufacturing, the application innovation of digital design and manufacturing technology in mechanical manufacturing has become an important direction for the transformation and upgrading of the current manufacturing industry. It can help mechanical manufacturing enterprises achieve intelligent, efficient, and reliable production management.

Specifically, digital design and manufacturing technology can achieve intelligent management of mechanical manufacturing processes through the following aspects. Firstly, intelligent design. Digital design and manufacturing technology can achieve intelligent design in the mechanical manufacturing process. Through the application of computer-aided design (CAD) software and computer-aided manufacturing (CAM) software, the design and manufacturing processes in the mechanical manufacturing process can be digitized, improving the accuracy and efficiency of the design. At the same time, it can also achieve intelligent management of materials, processing technology, and other aspects in the mechanical manufacturing process. Secondly, intelligent production. Digital design and manufacturing technology can achieve intelligent production in the mechanical manufacturing process. Through the application of Internet of Things technology, cloud computing technology, and big data technology, real-time monitoring, data analysis, and optimization adjustment of the production process in the mechanical manufacturing process can be achieved, thereby improving production efficiency and quality, and reducing production costs. Thirdly, intelligent maintenance. Digital design and manufacturing technology can also achieve intelligent maintenance of mechanical manufacturing processes. Through the application of sensor technology, remote monitoring technology, and artificial intelligence technology, remote monitoring, fault diagnosis, and maintenance of mechanical equipment can be achieved, thereby reducing maintenance costs and downtime, improving equipment reliability and service life.

4.2 Implement digital analysis of mechanical product data

Digital design and manufacturing technology is one of the key technologies in the digital transformation of the mechanical manufacturing industry, and its application can achieve digital analysis of mechanical product data. Firstly, digital design and manufacturing technology can achieve digital collection of mechanical product data. Through sensors and intelligent devices, real-time monitoring of the operating status, temperature, vibration and other parameters of mechanical products can be carried out. The collected data can be digitized and stored in the database of mechanical products, forming digital data. Secondly, digital design and manufacturing technology can achieve digital analysis of mechanical product data, using machine learning, data mining and other technologies to analyze mechanical product data, extract valuable information and

knowledge, such as the operation status, fault prediction, maintenance and other aspects of mechanical products, thereby achieving optimization and improvement of mechanical products. Finally, digital design and manufacturing technology can achieve digital visualization of mechanical product data. Through data visualization tools, mechanical product data can be visualized and displayed, such as using charts, maps, and other methods to present the operating status and fault information of mechanical products, making the management and maintenance of mechanical products more intuitive and efficient. Through the application of digital design and manufacturing technology, mechanical manufacturing enterprises can achieve digital analysis of mechanical product data, thereby optimizing and improving mechanical products, improving product quality and production efficiency, reducing production and maintenance costs, and thereby enhancing their competitiveness and market share[2].

4.3 Simulation analysis of achieving mechanical product quality

Through the application of digital design and manufacturing technology, mechanical manufacturing enterprises can achieve simulation analysis of mechanical product quality, optimize product design and manufacturing processes, improve product quality and performance, reduce development costs and time, and thereby enhance their competitiveness and market share. Firstly, a virtual model can be established. Digital design and manufacturing technology can achieve the establishment of virtual models for mechanical products, digitizing the geometric shape, material properties, motion status and other information of mechanical products, and establishing them as virtual models to provide data support for subsequent simulation analysis. Secondly, simulation analysis can be conducted. Digital design and manufacturing technology can achieve simulation analysis of mechanical product quality, analyzing the operating status, stress distribution, deformation situation and other information of mechanical products under different working conditions, and evaluating the quality and reliability of mechanical products. Finally, the design scheme can be optimized. By using digital design and manufacturing technology to simulate and analyze the quality of mechanical products, problems and deficiencies can be identified, and optimization design schemes can be proposed to optimize the design and manufacturing process of mechanical products, thereby improving product quality and performance.

5. Conclusion

Digital design and manufacturing technology is one of the key technologies in the digital transformation of the mechanical manufacturing industry. Its application can achieve innovation in digital design, intelligent manufacturing, and quality management of mechanical products, thereby enhancing the competitiveness and market share of enterprises. In the future, digital design and manufacturing technology will continue to develop and innovate, bringing more opportunities and challenges to the mechanical manufacturing industry. Therefore, we need to continuously explore and research the application of digital design and manufacturing technology to promote the digital transformation and sustainable development of the mechanical manufacturing industry.

References

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