Research on Mechanical Design, Manufacture and Automation in the Background of Information Technology

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Abstract: Under the perspective of the rapid development of information technology, the field of mechanical design and manufacturing has ushered in unprecedented changes. Traditional design methods and manufacturing processes gradually show limitations under the wave of digitalization and intelligence, such as low work efficiency, limited design accuracy, high production cost and other problems have become the bottleneck of the development of the industry. In order to solve these problems, this paper focuses on the integrated application of computer aided design (CAD), automatic manufacturing technology and intelligent monitoring system, aiming to improve the design accuracy, optimize the manufacturing process, reduce costs, so as to promote the development of mechanical design and manufacturing industry to a more efficient and accurate direction.

Keywords: Information Technology; Mechanical Design and Manufacturing; Automation

Introduction

Mechanical design and manufacturing is an art and science that involves the transformation of various materials into mechanical equipment and components. It includes the whole process from the initial conceptual design to the final product manufacturing, covering material selection, design principles, manufacturing technology, quality control and so on. In the design stage, engineers use advanced tools, such as computer-aided design (CAD), to create and test models of mechanical components, which are transformed into actual mechanical components through various manufacturing techniques, such as casting, welding, machining, etc. Quality control ensures that these components meet strict standards and performance requirements. With the rapid development of information technology, this field is experiencing a revolution driven by digitalization, automation and intelligence, constantly promoting the mechanical design and manufacturing process to a more efficient direction.

1. Application of information technology in mechanical design and manufacturing

1.1 Progress in computer-aided design (CAD)

Progress in computer-aided design (CAD) has brought about fundamental changes to the field of mechanical design. The CAD system enables designers to create detailed engineering drawings and 3 D models in a digital environment, greatly improving the accuracy and efficiency of the design. The application of this technology is not limited to the first draft of the design stage, but also extends to the entire life cycle of the design, including modification, analysis, and optimization[1]. Advanced tools embedded in CAD systems, such as finite element analysis (FEA) and computational fluid mechanics (CFD) simulation, allow engineers to evaluate the overall performance of the design before actual manufacturing. This assessment can predict the material stress, heat flow distribution, and other key performance indicators, thus reducing the need for practical testing and shortening the product development cycle.

With the progress of CAD technology, its application in mechanical design has become more common and diversified. The integration of cloud computing and artificial intelligence makes CAD systems more intelligent and user-friendly. For example, through the cloud infrastructure, multiple designers can simultaneously collaborate on a complex mechanical design project, enabling data sharing and real-time update, greatly improving the efficiency of teamwork. The application of artificial intelligence can help designers automatically perform repetitive tasks, such as automated sketching and design optimization recommendations, thus allowing designers to focus more on innovation and solving complex problems.

1.2 Three-dimensional modeling and simulation technology

3 D modeling and simulation technology have brought profound influence on the field of mechanical design. Three-dimensional modeling technology enables designers to build accurate models of mechanical components and systems in a virtual environment that not only demonstrate the geometry of an object, but also reflect its material, quality, and working principle. In this way, the designer is able to view and test the design in detail before actual manufacturing, ensuring compliance with technical specifications and functional requirements[2]. In addition, 3 D modeling provides unprecedented flexibility and accuracy for the design of complex mechanical systems, which can easily modify the design and view the effects of changes in real time, greatly reducing the possibility of design errors and rework. With the continuous progress of modeling technology, modern 3 D modeling software not only supports static design, but also can simulate dynamic behavior and practical operating environment, providing a more comprehensive and detailed design assessment.

Closely related to the 3 D modeling technology is the simulation technology. Simulation technology allows engineers to test and validate designs in virtual environments that can simulate actual working environments in a variety of physical, chemical, or biological conditions. For example, simulations can evaluate the performance of mechanical components under extreme temperature, pressure, load, or vibration conditions, thus ensuring the reliability and safety of the design. This method not only saves a lot of physical testing costs, but also greatly shortens the product development cycle. More importantly, the simulation technology enables designers to identify and solve potential design problems at an early stage, reducing the cost and risk of later modifications[3].

1.3 The role of information technology in design optimization

Information technology plays a crucial role in mechanical design optimization, which not only improves the efficiency of the design process, but also significantly improves the performance and reliability of the final product. In the design stage, by utilizing advanced computing methods and algorithms, information technology can assist engineers in the detailed analysis and evaluation of the design scheme, so as to ensure the optimization of the design. For example, by using optimization algorithms, such as genetic algorithms or simulated annealing methods, optimal combinations can be found among numerous design variables, minimizing the maximum efficiency and cost of material use. In this process, information technology not only speeds up computing, but also provides a broader space to explore design solutions, allowing engineers to consider more possibilities to discover more innovative and efficient design solutions[4].

Information technology also plays a key role in continuously monitoring and improving existing designs. Through integrated sensors and real-time data analysis, the operation of the mechanical system can be continuously monitored to find potential problems and performance degradation in time. These data can not only be used for timely maintenance and repair, but can also be fed back into the design process to provide valuable data support for future design improvements. For example, by analyzing the wear patterns and failure causes of mechanical components, the design can be slightly adjusted to improve durability and reliability. In this process, information technology is not only a tool for data processing, but also a bridge connecting the actual operation and design optimization, to ensure the continuous progress of design and meet the changing application needs and technical challenges.

2. The role of information technology in the automation of mechanical design and manufacturing

2.1 Computer Integrated Manufacturing (CIM) system

The CIM system automates and realizes the manufacturing process by integrating different stages of design, manufacturing, quality control and supply chain management. This integration not only improves production efficiency, but also substantially reduces cost and error rates. Core technologies in CIM systems include advanced computer-aided design (CAD) and computer-aided manufacturing (CAM), a combination of which allows the seamless process from design to manufacturing, reducing the need for human intervention. For example, designs completed by designers in CAD software can be then directly imported into CAM software and automatically converted into manufacturing instructions, which greatly reduces the time from design to production. In addition, the CIM system includes advanced Material

Requirements planning (MRP) and production planning scheduling systems, which automatically adjust production plans and material supply according to real-time data to ensure efficient and continuous continuity of the production process.

The flexibility and scalability of CIM systems is particularly important in highly competitive modern manufacturing environments. By using a modular design and open architecture, CIM systems can easily adapt to different production requirements and changing technological environments. For example, manufacturing companies can add new functional modules, such as 3 D printing or robot automation, as needed, to adapt to new manufacturing technologies and market needs[5]. In addition, data analysis and AI algorithms in CIM systems are able to extract valuable insights from mass production data, which can help manufacturers optimize production processes and improve product quality. For example, by analyzing the data in the production process, you can identify inefficient links or potential quality problems, and then adjust the production parameters or process flow to solve them. This continuous improvement and optimization is the key to the competitiveness of the modern manufacturing industry, and the CIM system is just a powerful tool to achieve this goal.

2.2 Automated assembly and robotics technology

Automated assembly techniques utilize custom robotic arms and other automated devices to perform repetitive assembly tasks, thereby reducing reliance on labor. The application of these technologies is not limited to simple repetitive tasks, but also extends to more complex operations, such as the installation of precision parts and the welding of electronic components. Automated assembly systems often integrate advanced vision and sensing technologies that ensure precise placement and rapid adjustment of components[6]. For example, by using high-precision cameras and pressure sensors, automated systems are able to monitor the assembly process in real time and automatically adjust to ensure assembly quality.

The development of robotics has brought new dimensions to automated assembly. Compared with traditional automated systems, robots have higher flexibility and adaptability, and can perform more complex and variable tasks. Modern industrial robots are often equipped with advanced control systems and artificial intelligence algorithms that enable them to learn autonomously and adapt to different operating environments. This allows robots not to only work on highly standardized production lines, but also to meet the needs of small batch and customized production. In addition, robotics also plays an important role in improving production safety. When performing dangerous or harmful tasks, robots can replace humans, thus reducing the risk of work-related accidents. For example, robots can be used to operate in high temperature, high pressure or toxic environments to keep people safe.

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With the continuous progress of information technology, the field of mechanical design and manufacturing has ushered in unprecedented development opportunities. From computer-aided design to automated assembly to intelligent manufacturing processes, the integration of these technologies not only optimizes the design process, but also greatly improves production efficiency and product quality.

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