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# Practice of Artificial Intelligence Technology in Mechanical Design, Manufacturing and its Automation

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**Abstract:** With the arrival of the fourth industrial Revolution, artificial intelligence technology is profoundly changing the face of the traditional manufacturing industry. This paper focuses on the artificial intelligence technology in the field of mechanical design and manufacturing and automation practice, analyzes the industry development situation, expounds the importance of artificial intelligence to industry transformation and upgrading, and discusses the artificial intelligence in design application, application in information processing and application in fault diagnosis. This paper aims to provide a valuable reference for practitioners and researchers in the field of mechanical design, manufacturing and automation to promote the further development and application of artificial intelligence technology in this field.

**Keywords:** Artificial intelligence; Mechanical design and manufacturing; Automation; Intelligent manufacturing

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## Introduction

In today's increasingly fierce global competition, the traditional manufacturing industry is facing the great pressure of transformation and upgrading. As an important branch of the manufacturing industry, the mechanical design and manufacturing and its automation field is no exception. The rapid development of artificial intelligence technology has brought new opportunities and challenges to the industry. How to effectively use artificial intelligence technology to improve the level of product design, optimize the production process, and realize intelligent manufacturing, has become the focus of the industry. Based on the development status of mechanical design, manufacturing and automation field, the importance of artificial intelligence technology to the transformation and upgrading of the industry, and analyze the specific application practice of artificial intelligence in this field in detail, in order to provide beneficial ideas and reference for the future development of the industry.

## 1. The development status of mechanical design and manufacturing and its automation field

The field of mechanical design and manufacturing and its automation is the foundation of modern industry, and its development level is directly related to a country's industrial strength and comprehensive national strength. In recent years, with the rapid development of information technology, new material technology and advanced manufacturing technology, this field has shown the following remarkable characteristics: First, digital design and manufacturing technology is widely used. The popularization of computer-aided design, computer-aided manufacturing and computer integrated manufacturing system has greatly improved the efficiency and accuracy of product design and shortened the product development cycle. Second, the degree of automation continues to improve. The application of intelligent equipment such as robots, CNC machine tools and automatic production line makes the production process more efficient, accurate and stable, reduces human error and improves product quality. However, despite the significant progress, the mechanical design and manufacturing and its automation field still face many challenges. For example, the traditional manufacturing mode is inefficient and resource waste is serious; product innovation ability is insufficient, high-end equipment depends on imports; information and intelligence level needs to be improved, the solution of these problems needs the introduction of new technologies and new ideas, and artificial intelligence is one of the most potential breakthrough.

## 2. The importance of artificial intelligence technology for industry transformation and upgrading

### 2.1 Improve the design efficiency and accuracy

The application of artificial intelligence technology in the mechanical design process can significantly improve the design efficiency and accuracy. Through machine learning algorithms, AI systems can quickly analyze massive historical design data and market demand information, providing designers with optimal design suggestions. For example, deep learning-based topology optimization algorithms can automatically generate lightweight, high-intensity structural designs, greatly reducing the trial and error time of designers. In addition, AI can also assist in simulation analysis and performance prediction, improving design reliability and accuracy. The application of intelligent design

software makes the design process more efficient and intelligent. For example, through natural language processing technology, designers can directly describe the design requirements with voice or text, and the AI system can generate the corresponding 3D model sketch, greatly reducing the time from concept to physical model.

## **2.2 Optimize the production process and reduce the cost**

In the production process, the application of artificial intelligence technology helps to optimize the production process, improve production efficiency, and reduce production costs. Through real-time analysis and prediction of production data, AI system can realize intelligent scheduling and dynamic adjustment of production plan and maximize the utilization of production resources. For example, machine learning-based demand prediction models can more accurately estimate market demand, helping enterprises achieve accurate production and reduce inventory overhang. The introduction of intelligent quality control system has greatly improved the product quality and production efficiency. The defect detection technology based on computer vision can realize comprehensive, fast and accurate product quality detection, far exceeding the efficiency and accuracy of manual detection. At the same time, the AI system can also find the abnormal situation in the production process, predict equipment faults, realize preventive maintenance, and reduce downtime and maintenance costs. In addition, AI technology can also optimize energy management and reduce production energy consumption. Through the analysis of energy consumption data of production equipment, the AI system can formulate the optimal energy use strategy to achieve energy saving and emission reduction and reduce production cost.

## **3. The application of artificial intelligence in mechanical manufacturing and its automation**

### **3.1 Practical application in the design**

The application of artificial intelligence technology in the field of mechanical design is revolutionizing the traditional design methods and processes. The AI system based on deep learning can analyze massive historical design data and market demand information, and automatically generate innovative design solutions<sup>[2]</sup>. For example, a car manufacturer used an AI-assisted design system to complete the conceptual design of the new model in just a few weeks, greatly shortening the design cycle. Secondly, through machine learning algorithm, AI system can quickly optimize parameters and find the best design parameter combination.

Deep learning-based topology optimization algorithm can automatically generate a lightweight, high-intensity structure design. In the field of 3D printing, AI-driven topology optimization technology has been able to design complex structures that are unimaginable by traditional methods, greatly improving product performance. Finally, combining natural language processing and computer vision technology, a new generation of smart CAD systems can understand the designer's voice commands or hand-drawn sketches and quickly generate 3D models. Greatly improve the design efficiency, so that designers can focus more on creativity and innovation.

### **3.2 Application in information processing**

Efficient information processing is crucial in the mechanical manufacturing process. The applications of AI technology in this field include intelligent data analysis, natural language processing, computer vision, and intelligent decision support<sup>[3]</sup>. First, intelligent data analysis provides valuable information through machine learning algorithms from massive production data to support decision making. This analysis can not only identify potential production problems, but also predict future trends and optimize production processes. Secondly, natural language processing systems can automatically process and analyze unstructured data such as technical documents and customer feedback to extract key information.

Computer vision technology plays an important role in quality control. The vision system based on deep learning can quickly and accurately identify product defects, which not only improves the detection efficiency and accuracy, but also works 24 hours a day, greatly reducing human error. In addition, these systems can be continuously learned and updated to adapt to new product types and defect patterns. Finally, the intelligent decision support system provides intelligent suggestions for key decisions such as production planning, inventory management and equipment maintenance by integrating various kinds of data and information. This not only improves the scientificity and accuracy of decision-making, but also can quickly respond to market changes and enhance the competitiveness of enterprises.

### **3.3 Application in fault diagnosis**

Artificial intelligence technology has demonstrated remarkable capabilities in the field of mechanical equipment fault diagnosis, which has brought revolutionary changes to the industry. In terms of predictive maintenance, AI systems can accurately predict potential faults through in-depth analysis of equipment operation data, so as to achieve advance maintenance<sup>[4]</sup>. This forward-looking approach significantly reduces the equipment failure rate and greatly improves the overall operational efficiency. At the same time, the intelligent fault diagnosis system based on machine learning can quickly and accurately identify the type of fault and their root causes, greatly reducing the diagnosis time, especially in the complex production line environment.

Voice analysis and diagnosis is another important area of application. With the help of deep learning technology, AI systems can identify potential problems by analyzing the sound characteristics of devices during their running time, greatly extending the fault warning time. This non-invasive diagnostic approach is not only efficient, but also has little effect on device operation. Through the extensive application of artificial intelligence technology in the key links such as design, information processing and fault diagnosis, the machinery manufacturing industry is developing rapidly in a more intelligent, efficient and reliable direction. This process has not only improved the production efficiency and product quality, but also injected a strong impetus into the transformation and upgrading of the whole industry, opening a new era of the manufacturing industry.

#### 4. Tag

The application of artificial intelligence technology in the field of mechanical design, manufacturing and automation has shown great potential and value. From improving the design efficiency and precision, to optimizing the production process and reducing costs, and then to promoting technological innovation and industrial upgrading, artificial intelligence is profoundly changing the face of this traditional industry. Through intelligent production lines, intelligent robots, intelligent manufacturing cloud service platform and other specific applications, artificial intelligence technology is bringing unprecedented opportunities and challenges to the machinery manufacturing industry. In this new era full of opportunities and challenges, we look forward to seeing more innovative applications and breakthroughs, and promote the machinery manufacturing industry into a more intelligent and digital future.

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