

## Discuss the Modern Design Methods of Mechanical Parts

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**Abstract.** The traditional design method of mechanical parts only required product can realize the expected function, and with the increasing development of science and technology progress, the quality of product and performance requirements more and higher. Therefore, modern mechanical parts to break through the traditional design concept, make mechanical design to the systematic, information-based and intelligent direction. In this paper, the modern design method of mechanical parts, and for the future development trend is discussed, at the same time put forward its own proposals.

**Keywords:** Mechanical parts; Optimization design; CAD.

### 1. Introduction

Mechanical parts is the smallest unit of mechanical equipment, its performance directly determines the quality of the whole machine performance. With constantly enrich and perfect the theory of mechanical parts design, as well as the new material, new craft, new technology appear constantly, reliability and economy of mechanical parts and advanced requirements also more and more high, make mechanical parts design method and technology modernization, to speed up development of new products[1]. The traditional mechanical parts design method has not completely adapt to the needs, the designer's goal is not entirely confined to accomplish the work, is also committed to how to use the modern design concept, continuous innovation, design a more competitive product, in this situation, emergence and development of the dynamic, optimization and computer into the core of the modern design method [2]. This paper, systematic and reliability optimization design, intelligent design aspects of modern design methods are introduced, provide theoretical reference for the design of mechanical parts.

### 2. The classification of modern design method of mechanical parts

Modern mechanical parts design includes two methods, namely: the professional modern design method and the general modern design method, the two methods is connect with each other, each other unified, only will be a combination of two methods of modern design, can make a design there are both targeted and scientific, is more perfect and the system of modern design method.

#### 2.1 Professional design method

Professional modern design method is to point to by computer professionals and mechanical designers to develop a computer software, make the software can accurately response of mechanical products, failure and failure mechanism of damage in working condition, and the quantitative analysis of dynamic behavior of each parts and mechanical form stable design program, for example: temperature field analysis, tribology design and strength design, etc.

#### 2.2 Universal design method

With the widely application of the computer, in order to further meet the requirements of mechanical product performance, in the computer technology widely used in mechanical parts design, system analysis and aided design and optimization simulation, etc., called the general method of modern design. Including optimal design, reliability design, the computer simulation, intelligent expert system and CAD auxiliary analysis, etc.

### 3. The development trend of modern mechanical parts design

#### 3.1 Reliability

Reliability design is to apply probability theory and mathematical statistics in the design of mechanical parts, and the reliability index to introduce a method of mechanical design. Its task is to the failure problems of the design object, to establish design calculation theory and method, make have inherent reliability. Reliability mainly with product reliability and the reliability of two indicators to measure.

Reliability refers to the products under specified working conditions and within the stipulated time, the ability to complete the required function. Otherwise considered a failure, the failure probability can be expressed as:

$$F(t) = P(T < t) = \int_0^t f(t)dt \tag{1}$$

Where:

$f(t)$  —Probability density function of a random variable;

$T$  —Failure time of the product;  $t$  —Working time.

Reliability refers to the parts under specified working conditions and within the stipulated time, complete the required function of probability, the probability of complementary principle, the reliability of the product can be represented as:

$$R(t) = 1 - \int_0^t f(t)dt = \int_t^\infty f(t)dt \tag{2}$$

Reliability design of mechanical parts is "stress-strength interference theory" as the theoretical basis, as shown in figure 1, when the mechanical parts of the probability density function of the strength and stress curve overlapping, namely "interference" occur, the shaded part said cannot guarantee working stress is less than the limit stress under any circumstances, some parts are failure probability.

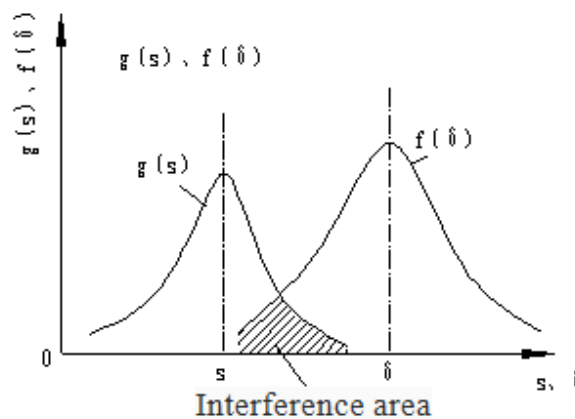


Fig.1 Stress-strength interference model

#### 3.2 Systematic and quantitative

Systematic design method is a breakthrough of the traditional method, it will be as a total system, mechanical products it is decomposed into several subsystems, using various theory and method of modern design, coordinate matching of other subsystems, achieve the purpose of the systematic, using computer technology, the realization of human, machine and environment coordination. Traditional design method, static analysis is adopted, with only experience value and qualitative analysis, not quantitative dynamic design, is difficult to reflect the real working condition. But its function of mechanical products is completed under the stochastic dynamic, thus realize the mechanical design of quantitative is the development direction of the future. Modern mechanical design of fully considering the strength of materials, parts damage, using the finite element method and the mathematical programming method to realize the design of the dynamic, reliable, not only shortens the development cycle, and ensure the success of a design.

### 3.3 Optimization design

Optimization design on the basis of optimization theory and computing technology, with the help of a computer for semi-automatic or automatic design, to seek the optimal design scheme under the condition of existing engineering of a modern design method.

Optimization design of mechanical parts, it is under the condition of the given conditions (such as load), the mechanical parts material, geometry relations or other factors (constraints) within the scope of choosing design variables, set up the objective function and obtain the optimal value.

Optimization design of mechanical structure includes three aspects of content: one is to abstract become optimization mathematical model of the engineering practical problems, namely, to establish optimization equation. Second, selection and optimization numerical method is applied to solve the mathematical model, the solution of the optimization problem. 3 it is to analyze the results evaluation and decision making, namely the design of evaluation and decision making.

For static problems, usually is to create a system of algebraic equations, for the dynamic problems, more for the ordinary differential equations. These equations reflect the analysis of the structure of the internal relation between each parameter, so they can study, through the influence of various parameters on the design objects work performance. Mathematical model is established, the solving method, the optimization design method. The optimization results and scheme evaluation, decision-making, is the last link of optimization design, must adapt to the actual production conditions as evaluation target, whether it is necessary to adjust the optimized parameters were analyzed, and the optimization results to the optimal solution under given conditions, to make reasonable decisions.

### 3.4 Intelligent

The design of the traditional mechanical parts including three stages: the overall design of a product or component phases, parts of structure design and working drawing design phase. The three stages is repeatedly alternates, modify, perfect constantly, repeated cycle until a satisfactory design results are obtained. To reduce the financial burden on the designers, to intelligent direction of modern mechanical parts design, intelligent technology includes two aspects of CAD technology and CAE technology.

#### 1. The CAD technology

With the rapid development of computer technology in design work by computer aided design and drawing technology, computer aided design (CAD). Computer aided design is the application of computer to carry on the design in the design of information processing. It includes the analysis and calculation and automatic drawing of two parts. CAD system should support all phases of the design process, that is, from the design, make the design object model; According to provide the overall design and technical parameters of the design of the general layout design; By analyzing the structure of the static and dynamic performance, finally determine the design parameters. On this basis, to complete the detailed design and technical design. Therefore, CAD design should include 2 d engineering drawing, 3 d geometry model and finite element analysis technology.

With the popularity of CAD technology application more and more widely, more and more thorough, the CAD technology is toward the direction of opening, integration, intelligence and standardization, and computer aided analysis (CAE) and computer-aided process planning (CAPP), computer aided manufacturing (CAM) technology together constitute the series such as technology.

#### 2. The CAE technology

Computer Aided Engineering (CAE) is based on the numerical analysis method, the approximate solution using Computer Aided mechanical parts structure strength, stiffness and buckling stability, dynamic response, heat transfer, such as three-dimensional multi-body contact mechanics performance and optimize the structure performance of mechanical parts.

CAE application from start to today, has gone through 60 years of development history, the theory and algorithm are went through a process from flourishing to mature, has become in the engineering and product structure analysis (such as aviation, aerospace, machinery, civil structure etc) essential numerical calculation tool, is also the analysis of an important means for the continuous mechanics of

various kinds of problems. Along with the popularization of computer technology, and constantly improve the function of the CAE system and calculation precision are greatly improved, various CAE system based on digital modeling of product arises at the historic moment, and has become an important tool for structural analysis and structure optimization, as well as computer aided 4 c system (CAD/CAE/CAPP/CAM), an important part of the.

At present it has more mature international CAE software, the most commonly used abroad such as Ansys and Abaqus, Nastran, etc. Relative to the European and American countries, due to the technology and simulation software of price limits, some domestic CAE technology to lag behind, although this technology is widely recognized, but the popularity is not high. Mainly because of CAE technology USES threshold is higher, need professional CAE r&d staff.

#### **4. Conclusion**

Compared with traditional design, great changes have taken place in modern mechanical parts design method, its advantage lies in the integrated use of advantages in various fields, and the overall optimization; To reliable, using computer technology, the design system, smart and optimized development, from the traditional manual design to the development of computer and trial and error, by experience to the development of artificial intelligence, expert system, significantly improve the quality of mechanical product design, greatly shorten the development cycle, reduce design and development costs, improve the competitiveness of mechanical products.

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