Research of Design Method for Key Parts of Automotive Interior Based on NX Software

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Abstract. Take the car door-handle as an example, propose a design method for key parts of automotive interior based on NX software, which is to do concept design for interior first, secondly, carry out framework design for the motion plan, then do structure design, shape design and topology optimization design through kinematics and dynamics analysis, and finally verify the reliability of the parts by finite element strength analysis and fatigue life analysis. This method can guarantee the unification of product data, shorten the product design life cycle, and guarantee the quality of product design.

1. Introduction
According to incomplete statistics, in the first 4 months of 2017, China's passenger car sales have reached more than 7 million 700 thousand, which is expected to reach more than 23 million 100 thousand vehicles throughout the year. With the increasing demand for cars, the car has been developing from the initial rapid running to be comfortable, safe, intelligent, reliable, beautiful and so on. Consumers begin to have higher and higher requirements for automobile performance, interior and exterior decoration. Compared with the important parts such as the engine and gearbox, the design and manufacture of automotive interior parts are easier to get started for the PRD enterprises which are eager to improve the added value of products. Take the car door-handle as an example, as shown in figure 1, it is the most touched one of the automotive interior parts except the steering wheel. People now have more and higher requirements for its beauty and strength. Most of the door-handle material is PC+ABS plating, which can not guarantee the strength well. It often occurs issues such as pull, deformation and each other. Therefore, it is imperative to study an effective method for the design and reliability analysis of automobile door-handle.

2. Current Status and Research Methods
At present, the foreign automobile companies have rich experiences in the design of automotive door-handle assembly due to their long history and strong technology. They have great advantages in material, structure and inspection. However, most domestic manufacturers do not have their own designed products. They are basically using foreign customers’ drawings for processing, production and assembly. Although some domestic manufacturers and researchers use reverse scanning and other methods for reverse design\cite{1-6}, or even copy foreign related products, they can not form their own brands, and the product added value is low. Therefore, in the country's strong advocacy of "made in China" environment, from the perspective of long-term economic efficiency of enterprises, it has become the inevitable trend of enterprise sustainable development to design beautiful, practical and reliable car door-handle independently.
3. Research Scheme

Design of the car door-handle assembly usually need to meet the following requirements: a. Meet its functional requirements: switch and anti-theft lock function. b. Meet its aesthetic requirements: innovative modelling fashion. c. Meet its strength and life requirements. d. Meet cost control requirements, such as manufacturing process cost, assembly cost, etc.

The design of the car door-handle should take into account of the above problems, and these problems interact with each other. For example, in the design process of automotive door-handle assembly, how to solve the contradiction between shape and strength, life strength and cost, etc. are needed to consider. Therefore, this paper prepared to explore an effective and far-reaching automotive interior parts design method which is to speed up the design, shorten the product design cycle, ensure the quality of product design by virtual design.

There are two important simulation analysis in the design process. They are kinematic analysis of skeleton model for automotive door-handle assembly and finite element strength analysis of automotive door-handle. Therefore, the requirement of editability and parameterization of the digital model is relatively high. To solve the above problems and ensure the unity of data, the method proposed in this paper is intended to work under NX software in each section. Figure 2 shows the automotive door-handle assembly under NX software. All the processes under the NX software include skeleton design, motion simulation, finite element analysis, topology optimization design and structural detail design. The technical route is shown in Figure 3.

4. About NX Topology Optimization

NX10.0 is a three-dimensional powerful digital software which assembles CAD/CAE/CAM. Its feature covers the whole process of product life cycle, including the design, assembly, graphics, advanced simulation, motion simulation and processing and other modules. The NX advanced simulation module is used to realize the finite element analysis and topology optimization analysis of the mechanism. NX topology optimization uses the Tosca topology optimization solver from FE DESIGN Company. Optimization determines the optimal material distribution by adjusting the
material density of units in the area of design. The material of the optimized model is distributed in block-shaped. Then the software creates a smooth transition for the model, so that the distribution of the material is more continuous. The smoothed model (STL file) can be imported into the NX modelling to be a reference for optimization design.

Figure 3. technique flow chart

Topology optimization technology can seek the best material distribution in a given design space, and define the material flow pattern by the two kinds of methods of Homogenization (equalization) and Density (Density). For density method, the material density of each element is directly used as a design variable, with the continuous variation between 0 ~ 1. 0 and 1 representing respectively empty or real. The process of topology optimization is shown in Figure 4[7].
Figure 4. process of topology optimization
(1) The design area to be optimized
(2) Optimized model (3) Smoothed model
(4) Final CAD design.

5. Conclusions
Thus, that use the PLM software NX10.0 to do product design can effectively integrate CAD/CAE or even CAM together, so that the product data is unified, it also can shorten the product development time, and ensure the quality of product design.

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