Global Journal of Engineering Design & Technology

Engineering Design at Concept Stage for a Front Axle Design — A Case Study

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Abstract

Now-a-days, in an industrial growth, cost and quality production in time as well as quality improvement are of major interest in engineering design. Therefore, in order to make a decision as early as possible and according to the product specifications, mechanical analysis is used more and more, and earlier and earlier in the engineering process. Then, a multitude of mechanical models are elaborated during engineering design, and management difficulties appear with engineering changes or evolution of specifications. Moreover, when the designer is faced with design or modeling options, previous analysis could answer the choice of options for decision making. Then, the reuse of a previous analysis must be envisaged.

Keywords:

Engineering design; 3D CAD; Product development; Modeling; Analysis; Simulation

Introduction

Reduction of cost and improvement of quality are of great importance in an industrial context. Analysis is often used in order to make the best decisions as soon as possible in the engineering design process. On the one hand, knowing that 80% of the final product cost is fixed during engineering design, each decision in the design process must fit at best the product requirements. On the other hand, with time to market being one of the major factors in a product's success, the length of time of the different stages of product development, and in particular engineering design, has to be reduced. Good design options must be chosen at the earliest stages, in accordance with the required specifications. However, when engineering changes occur, the modification of the design has to be controlled in order to limit lost time. This control depends on knowledge of the linkages existing between the different product patterns in order to keep consistency of the whole representation of the product. Another way to save time could be systematic use of a reusable analysis library. This reusability

depends both on the tracks of the first analysis and on the accessibility of these tracks. A way to face this problem is to structure the information handled during design and analysis in order to facilitate the control and reuse of multiple models.

Mechanical Analysis in Embodiment Design

Engineering design is a process of creation that transforms a need into a product. It is characterized by its complexity and the multitude of jobs and actors it implies. When a requirement list is elaborated and a principle solution is chosen, the construction of the structure can be divided in two steps: first, its development, i.e. preliminary layouts and form designs and, second, its definition, i.e. detailed layouts and form designs. For embodiment design, best layouts must be chosen. Then, refinement and improvement of the structure is necessary related to technical criteria. Thus, in order to select and to evaluate solutions, mechanical analysis is required in the design process.

The Different Uses of Analyses

The use of an analysis depends on its final goal. Three types of uses can be distinguished:

- Analysis for validation
- Analysis for aiding decision making,
- Analysis for understanding.

CAD Technology and Model

Computer aided design refers to the design process using sophisticated computer graphics techniques

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backed up with computer software packages to aid in analytical problems associated with design work The 3-D models created on a CAD system with the help of curves and surfaces. Those curves and surfaces are generally NURBS. Wire frame models are used as input geometry for simple analysis work such as kinematics studies, surface models are used for visualization automatic hidden line removal, and animations, solid models are used for engineering knowledge and visualization and are mathematically accurate description of the products and structures. The solid model can be shaded to improve visualization of the product, structure, and physical models are automatically generated from the geometric models through rapid prototyping technology.

Model analysis and result

The model of the front axle was created using 3D CAD software. This model was analyzed using the finite element analysis software to find out the Von mises stress and the displacement. Maximum Von misses stress was found to be 109 MPa while displacement was 5.6 mm. As the stress is within the Yield stress of the material (350 Mpa), the design was found to be safe.

Conclusions

Mechanical analysis in an engineering design process involves the use of many models. Four main classes of models were identified: functional models, design models, mechanical models and simulation models. The importance of two particular uses of analysis, the so-called elementary case and simplified case, was emphasized. On the one hand, the purpose of this work is to provide a formal aid to mechanical modeling. In this case study we have developed a front axle using 3D CAD software followed by analysis. This analysis was important to check the breakage/damage of the axle during static and as well as dynamic condition.

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