ADEKO
MAY 18TH 2009, 49TH ANNIVERSARY
OF THE FACULTY OF TECHNICAL SCIENCES, NOVI SAD
MACHINE DESIGN
ISSN 1821-1259

STRUCTURAL OPTIMIZATION IN CAD SOFTWARE

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Abstract: *In this paper one way of integrating structural optimization and CAD tools is presented. Structural optimization is an automated synthesis of a mechanical component based on structural properties. In the first part of this paper two methods of CAD based optimization are described. After that three types of structural optimization are elaborated. Integrated structural optimization as method proper for structural optimization in concrete CAD software is particularly described.*
As illustration of suggested approach optimization of bracket clamped on the left side and saddled on right side by the vertical force is performed. Modeling, FEM analysis and optimization is performed using different workbenches in PLM software CATIA V5. Optimization results indicate improvement of objective function value of over 60 percent.
Proposed approach is designer oriented. The designer is fully involved in optimization process, as well as in design process. This approach assures practical implementation of optimization results.

Key words: *Optimization, CAD, FEM*

1. INTRODUCTION

Computer Aided Design (CAD) tools become very popular and common within engineering and design departments. They considerably facilitate the designer work and some of them even offers powerful calculation function using Finite Element Method (FEM). However, there is still a lack of CAD tools that give the opportunity to proceed to optimization calculations. This is a bit surprising that a major concern for most manufacturers is optimization of a product before its launching. New competitive products must meet the growing demands of the market. They must be light-weighted, resource-efficient, durable, stable, etc. At the same time, the product must be introduced quickly into the market. These demands can only be met if optimization tools are used in addition to establish CAD, CAE, DMU and/or PLM systems. Calculation of different product variants and improvements can be carried out on digital prototype at a very early project stage. Then, the number of required prototypes can be reduced which results in probable time and cost savings. The functionality, the handling and especially the integration and combination with other tools of the virtual product development process are of decisive importance. So far, the optimization tools have not been completely integrated in the design process.
Among the few existing products that offer optimization capabilities for design, some of them propose to optimize a structure by using FEM. This roughly means that FEM calculations are performed at each of iterations of the optimization process in order to optimize the static or dynamic behaviour of the studied system.
Optimization of mechanical systems is very difficult task because of very complex mathematical model which have to describe operating of real system in real circumstances. CAD based optimization can be performed using stand alone optimization or CAD imbedded optimization. Typical examples of stand-alone optimization are given in [1, 2] on gear train optimization sample. Some other optimization examples of concrete mechanical systems are presented in [3, 4, 5 and 6].
In reference [7] parameter - based topology optimization is given. The basic of the optimization approach, which is presented in this paper, is bubble method. The strategy of this method is an alternation of shape optimization and positioning of additional holes (bubbles).
Three –dimensional structural optimization is described in [8]. This paper presents an automated process for interpreting three-dimensional topology optimization result into a smooth CAD representation. A tuning process is employed before the interpretation process to improve the quality of the topology optimization result.
Paper [9] considers isogeometric structural shape optimization as special case of shape optimization. Extensive mathematical optimization engine is applied on relatively simply practical problem.
Paper [10] presents a new approach to topology optimization based on implicit functions. The implicit functions are approximated by the same mesh and shape functions that are used for the solution of equilibrium equation.
A web based interface for topology optimization program is presented in [11]. The paper discusses implementation issues and educational aspects as well as statistics and experience with the program.
Paper [12] presents advanced solution methods in topology optimization and shape sensitive analysis. Topology optimization is usually employed first, in order to avoid local optima due to a crude initial layout, followed by shape optimization in order to fine tune the optimum layout.
Beside foregoing there is large number of references in area of structural optimization but mostly they consider special methods and software for stand-alone structural optimization.
Number and actuality of published research indicates importance and contemporarity of structural optimization topics.