ASPECTS CONCERNING THE STUDY OF THE TECHNOLOGICAL SHAPE OPTIMIZATION FOR A CONNECTION PIECE

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"The software does not replace the designer. It makes him more efficient."

INTRODUCTION

Years ago, making an organ of a machine, supposed to make a prototype and some experimental determination on these prototypes, after the initial planning. Further more, this involved costs for materials, handworks, energy, etc…

Presently this cycle is minimized by the use of calculus application and 3D simulation through the finite elements method.

1 GENERAL CONSIDERATIONS

Considering globalisation and foreign market opening, projects engineers face the challenge of launching new products in a shorter time, products that need to have qualities like minimum volume, and therefore minimum weight.

This way, the mechanism composing different products must function in low volume, but along with the cinematic calculus, the weight of the composing parts must reduce.

In order to achieve these requirements at low costs, fewer prototypes must be made until the launching of the product. A modern approach to this issue is to create virtual prototypes in CAD/CAE applications and to test more constructive options and charging scenarios, in order to detect cinematic and resistance problems.

2 THE STUDY OF TECHNOLOGY SHAPE OPTIMIZATION

Next we study the mass minimization of a piece, assuring the movement transmission between the elements of a mechanism (figure 1).

In the initial phase, after the constructive projection of the mechanism, the cinematic calculus will show the gears accelerations and force from the couple. The present study, show the gears acting upon the components of the assembly have been obtained; the next phase is the mass reduction of the connection flange from figure 1. For this study ha been used the Visual Nastran application for the cinematic calculus and for the finite elements calculus.

Figure 1

The first step in the mass optimisation is the materials define of the piece (ally steel), the loading and the staying, taken them over from the cinematic calculus of the mechanism and from the network of the finite elements (figure 2).

At the end of the static calculus, it gets the equivalent tensions (figure 3), which are compared with the admissible material tension and the conclusion is the piece will resist to the solicitations, being possible to reduce its masse after we stabled the insurance coefficient. This objective could be reach using 2 ways: topological optimisation or shape optimisation.

2.1 Topological optimisation

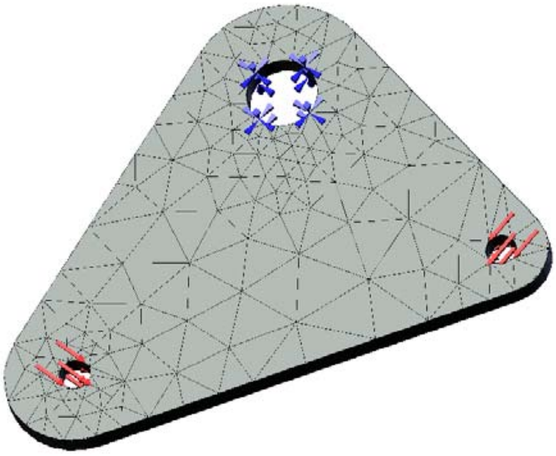

Figure 2

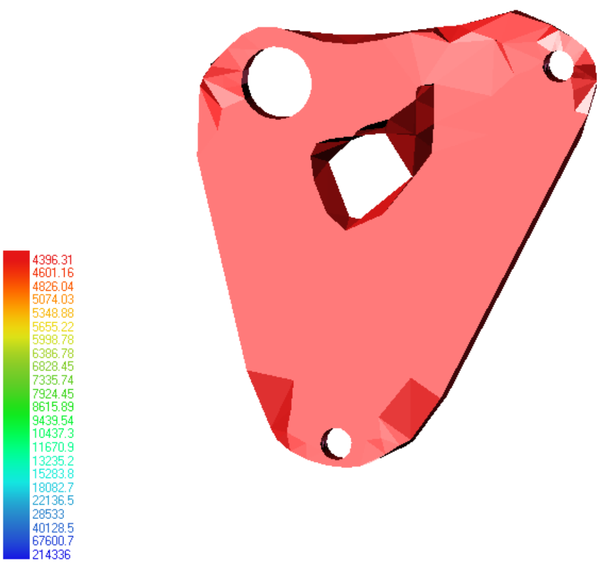

Figure 4

Topological optimisation has an objective function to reduce the volume of the analysed piece, following the mandatory geometrical constrains by the user, without overtaking the admissible tension of the material.

In the analysis of this piece, the surface on which the stays and the loads are applied imposed as geometrical constrains and the topological optimisation ran, resulting the form from figure 4.

This way we obtained the volume minimization with 25%, but the obtained shape is non-technological, forcing us to redesign it in order to answer to the technological request. After

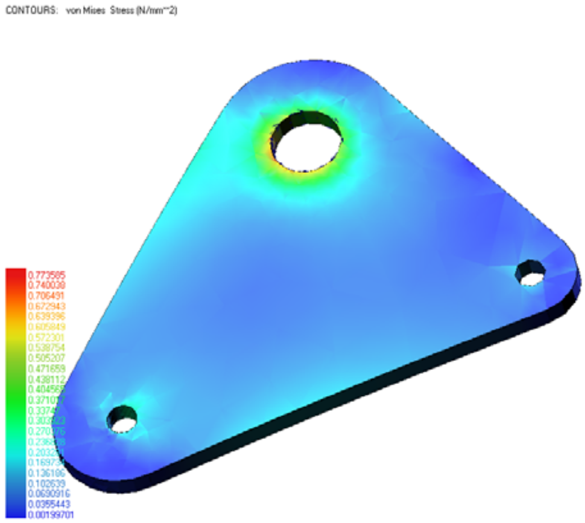

Figure 3

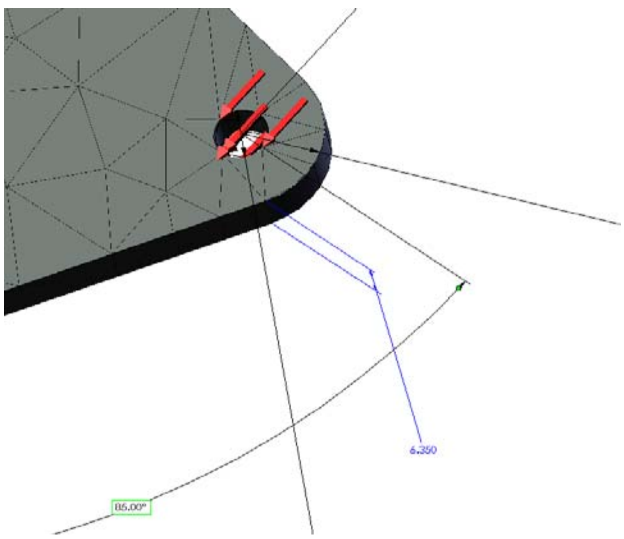

Figure 5

redesign, we

2.2 The optimisation of the technological shape

The optimisation of the technological shape has the same goal of reducing the volume (mass), but its variables are the geometrical parameters mentioned by the designer. As a constraint, there is the admissible material tension. Once the technological shape established, the next step is the mass minimization through the dimension minimization, so that the equivalent tension born in the piece don't overleap the admissible material tension. To realize the shape optimisation, the previous solved problem is assumed, with stays and loads, and the goal to achieve, is the mass minimization. For the mass reduction the geometric parameters that can be modified are specific in our case being selected the thickness as showed in figure 5.

It specifies the maxim and the minim limits between this size, could be various during the optimisation cycles. In our case, the initial value is 6.35mm and we will impose the maximum limit 7.5mm and the minimum limit 5mm. Then it imposes the maxim limits of the equivalent tension that appears in piece the software selects the admissible tension using the material already selected at the beginning of this analyses but being impossible the equivalent tension established by the designer. In the final preparation of the optimisation problem it imposes to establish the number of the optimisation cycles necessary to obtain the convergence in our case, there are establish 10 optimisation cycles and it was obtained the convergence therefore the thickness of the plate was reduced from 6.5mm to 5mm.

At the end of the final calculation it could be obtained graphic for the variation of the objective function during the optimisation cycles or the variation of the thickness till it reaches the convergences. The last operation is the acceptation of the modification of the piece thickness; therefore this modification will be propagating in the execution draw of the piece and in the assembly where this piece is used.

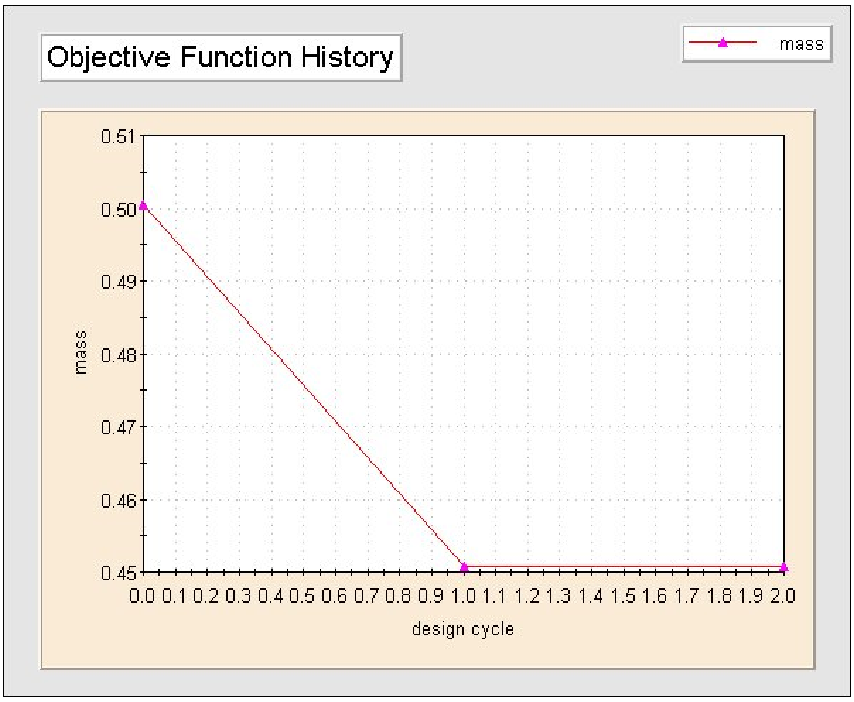

Figure 6.

The authors present their gratifications to the SC CAD WORKS SRL firm, for the rendered support to accomplish the present study by offering the use of the software promoted through this firm in Romania, (SolidWorks 2001 and Visual Nastran).

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