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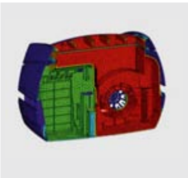
# OPTIMIZATION OF A VACUUM CLEANER HOUSING

**Parametrical design optimization of a dust container**



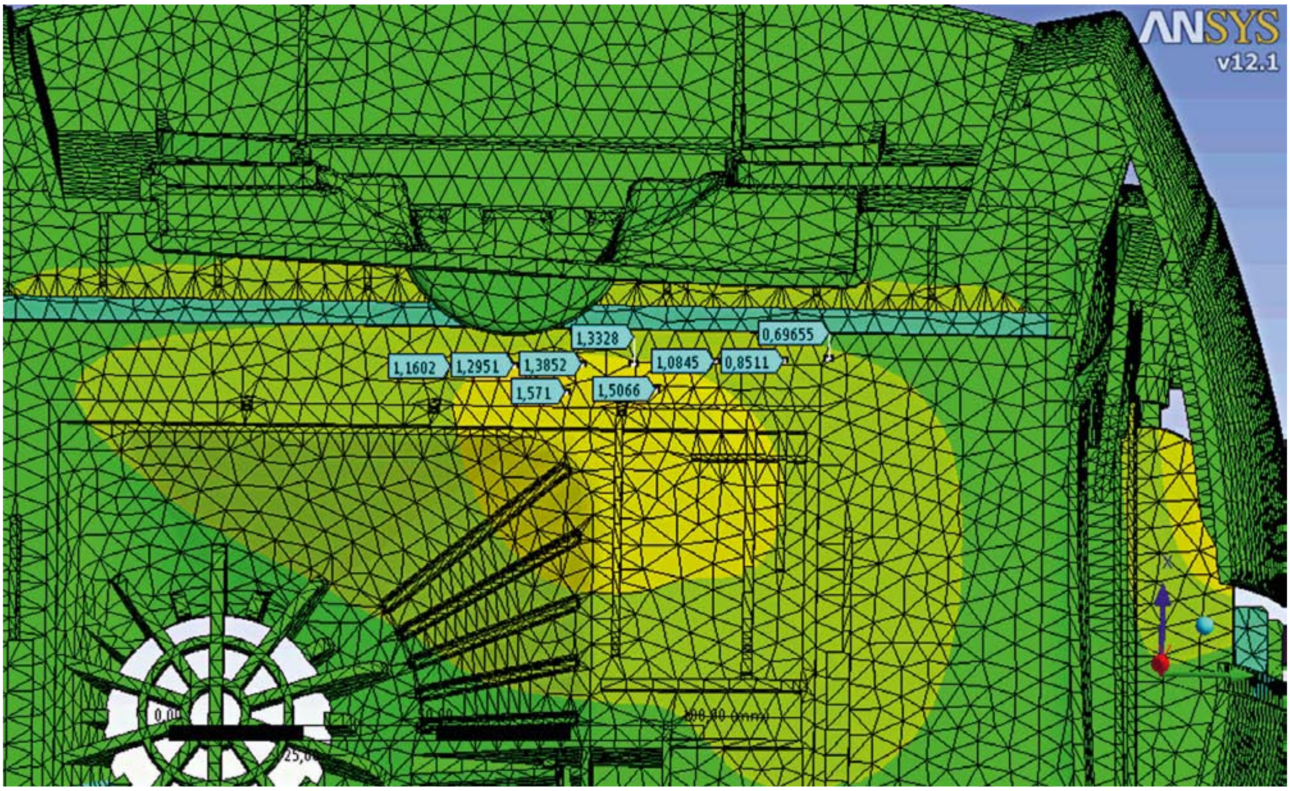
## Optimization Task

The goal of the project was to reinforce the back wall of a dust container in a way that minimizes distortion while in operating mode, where it is under the influence of temperature change and exposed to negative pressure. The FE-modeling of the thermal mechanical coupled simulation was performed in ANSYS Workbench. The sensitivity analysis and optimization were carried out with the help of optiSLang.

Vacuum cleaners are tested by simulating a malfunction. The device runs at full load while the suction tube is closed. The blocked supply of air causes a strong negative pressure in the dust container. In addition, it is heating up continuously, because the air is also used to cool the motor and housing. Exposed to this permanent malfunction temperature increases to such an extent that the limits of the material's elasticity may be exceeded, causing inadmissible deformation of plastic parts, which can cause a short circuit of air flow to occur. The hot air in the motor housing is blown back through the seal into the dust container. This creates a cycle of steadily warming air. The goal of the optimization is to prevent this occurring.

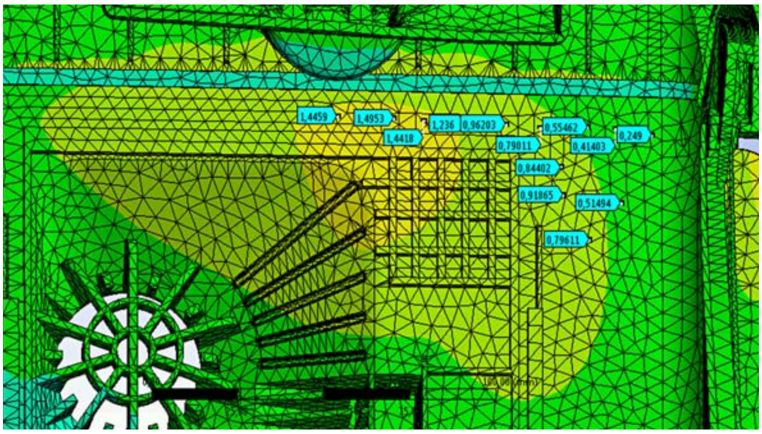
## Solution Methodology

The basic model was built up in ANSYS Workbench v12.1. Those parts of the model were used which dipict the rear wall of the dust container. Parts such as the cable drum and electronic board determined the chosen part. The reinforcement of the back wall was created by braces, which were attached to the plastic housing. These braces were placed onto the back wall parametrically in ANSYS design modeler. In order to keep computation time moderate the sensitivity analysis was calculated to be geometrically

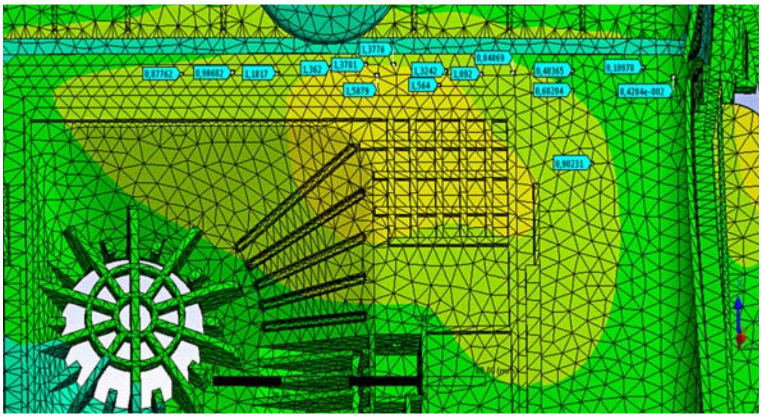



Best design from the design pool of the sensitivity study for the relevant area and materially linear. This made it possible to limit the calculation of a design variation of a coupled temperature-mechanics simulation to 2 hours. Due to the parametric structure of the braces, it was possible to create a fairly unrestricted design of the braces in optiSLang. This allowed an optimal utilization of the design space and at the same time adhering to the engineering limits of the braces. Starting with a sensitivity analysis, it was possible to reduce the parameter space of the braces from the original nn optimization parameters to a number of 15. By reducing to the 15 most effective optimization parameters an optimization algorithm of adaptive response surfaces could be chosen. This optimization method is characterized by its very effectiv identification of the most important potentials of design improvements while beeing relativly not sensitive towards small scattering due to remeshing of each geometry variations. Thus a brace pattern was created which enabled an improvement of reinforcement by about 20%. The fact that reinforcement increased to such an extent, the relative deformation of lower parts of the dust container was reduced compared to the upper part. This caused the positive effect of the dust container vacuum seal to be pressed perfectly into its fitting and so being able to maintain its function. Another blowing occurance was prevented.

A final computation was conducted to validate the results concerning the non-linearity of plastic materials and their time-temperature dependence of resistance. The result of this calculation confirmed the result of the linear optimization.



Parametric Design Optimization: The additional braces reinforce decisively the component in the relevant area. The area above the motor protection filter shows only small deformations below 1.5 mm, which corresponds to a reduction of 15-25% of the internal wall.



Deformation after non-linear analysis on the internal side of the compartment after 120s. Deformation is strongly reduced. Especially in the critical area values are decreased between 1.3 to 1.5 mm! This corresponds to a decline of 17-27% compared to the starting point!

## Customer Benefits

By a parametric design optimization using a CAD-based geometry it was possible to reinforce the dust container back wall to such a extent that in interdependence between the corresponding housing parts, top cover and seal an air blowing through the engine compartment was prevented. A significant reinforcement of the back wall of partly up to 25% was realized in compliance with production limits of space and material consumption. This reinforcement was confirmed by a computational evaluation concerning temperature-time dependence of the plastic materials.

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