Samsung Uses OptiStruct to Redesign Washing Machine Component for Optimized Weight and Material Usage

Overview

Suzhou Samsung Electronics Co. is a joint venture between Korean and Chinese companies that develops and produces major home appliances. Over the past 17 years, the company has introduced many new types of refrigerators and washing machines, each carefully engineered to provide the greatest value through optimization that reduces product weight while maintaining top-quality performance.

Every component is designed to contribute to this goal, so it should not be surprising that Suzhou Samsung has focused intently on ways to optimize the design of a belt pulley for one of its washing machines. The belt pulley is an important component of a drum washing machine, connecting the motor to the drum and driving the drum during operation.

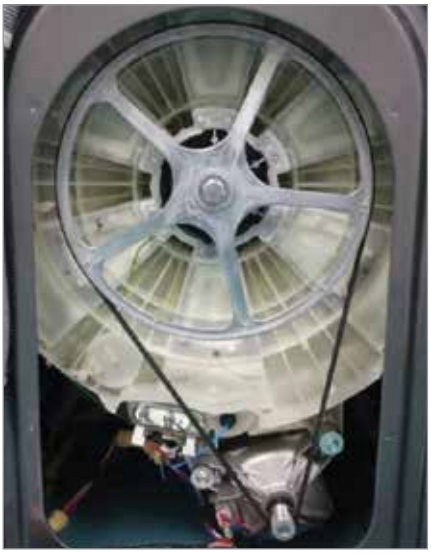
Challenge

Conventionally, the belt pulley is constructed from cast aluminum. With cost pressures increasing, however, companies like Suzhou Samsung have become interested in reducing the pulley's weight by optimizing its design and/or using new materials for its production. When considering alternative materials, both their performance and cost become primary factors; so Suzhou Samsung employs topology optimization to meet the challenges relating to design and materials.

Solution

To carry out optimization on the pulley, Suzhou Samsung chose OptiStruct, a key component of Altair's HyperWorks suite of computer-aided engineering tools and a modern structural analysis and optimization solver. "OptiStruct provided us with important optimization features," said Mr. Cheng, "such as topology, size and shape optimization. We were particularly interested in topology optimization to obtain the most efficient structure or distribution of material used in the structure."

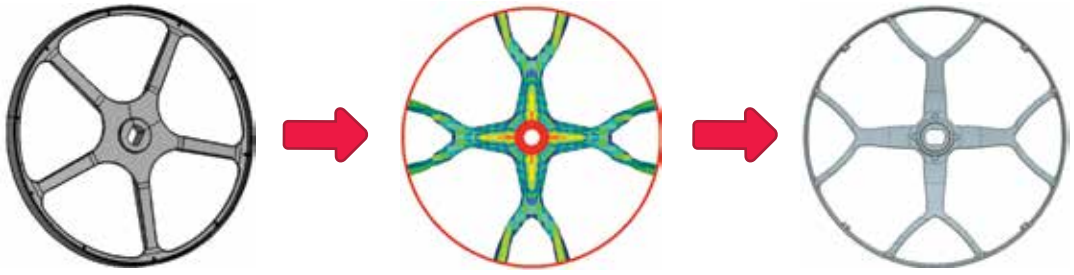
For the pulley, the company employed the variable-density method of topology optimization, which uses the relative density of the elements as the design variable to determine the optimized material distribution by looking for the best load path.



The original aluminum belt pulley installed on a washing machine

"This light-weighting design effort using OptiStruct will provide a valuable reference for the optimization of structures in the future."

Cheng Fuping
Senior Engineer
Suzhou Samsung Electronics Co.



Original model of aluminum-based belt pulley

Topology optimization results (iso density)

Optimized CAD model of four-spoke aluminum-based belt pulley

To begin the process, static analysis was performed on the model of the original pulley. Then engineers defined the topology optimization model, which included the definition of design variables, objective function and constraints. After solving the optimization problem, they rebuilt the model based on the topology optimization results and conducted size and shape optimization on that model. The process concluded with a static analysis of the optimized structure, comparing results before and after optimization.

The aluminum pulley that Suzhou Samsung sought to optimize incorporated five spokes. Engineers sought to find the optimal material distribution or the minimum volume for the spokes area of the pulley.

The optimized four-spoke aluminum belt pulley runs in mass production

Results/Benefits

The topology optimization resulted in the creation of a four-spoke pulley. Further, shape optimization enabled the engineers to determine the optimal divergence angle of the outer edge of the spoke.

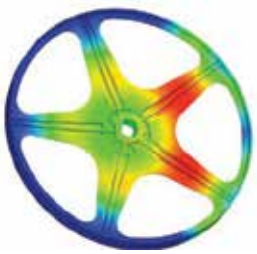
The reconstructed CAD model reflected a 6 percent reduction in the total volume of the pulley, compared with the five-spoke version.

Next, Suzhou Samsung evaluated the potential benefits of switching from aluminum to a nylon-based belt pulley. Nylon offers lower density, but more material must be used to meet the stiffness requirements of the pulley.

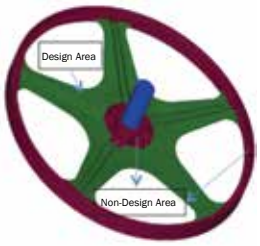
Again, engineers conducted a static analysis of a nylon-based belt pulley and then employed OptiStruct for topology optimization, measuring various densities of material, and they read the results in Altair's HyperView. OptiStruct enabled a five-spoke nylon belt pulley that removed non-essential material without impacting performance and reduced the total volume of material by 10 percent compared with the original nylon model.

"The final optimized belt pulley uses less material while meeting our displacement and stiffness requirements," Mr. Cheng said. "Topology optimization with OptiStruct helped reduce the weight of the structure reasonably and enabled us to find the optimum material distribution without numerous tests, while satisfying mechanical performance requirements. This light-weighting design effort will provide a valuable reference for the optimization of similar structures in the future."

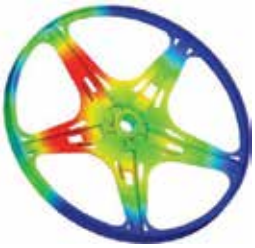
As of today, the four-spoke aluminum belt pulley has been running smoothly in mass production, and the company has applied for a patent on its redesigned pulley. The nylon pulley currently is in the experimental stage.



Structural stress on the nylon-based belt pulley



Design space for Topology optimization



Optimized pulley shows same performance with 10% weight saving

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