Improving the Protection of Appliances for Global Distribution with Packaging Optimization

mabe

Key Highlights

Challenge

Improve the protection of a washer-dryer by optimizing packaging material

Altair Solution

Utilize a simulation-driven design approach to define the ideal multi-material packaging layout

Benefits

- Improved product protection
- Reduced packaging material costs

Customer Profile

For white goods manufacturers, the quality of the design and engineering of their home appliances is paramount for the best possible customer experience. However, products ranging from washing machines and dryers to fridges and ovens are all subject to potential drop and impact damage from the warehouse through to transportation to the customer's doorstep.

Mabe, a $3 billion global company headquartered in Mexico City, understand the importance of carefully designed packaging to protect the 15 brands of appliances that it designs, manufactures and distributes for sale in 70 countries. Mabe wanted to improve the packaging of its goods to reduce possible transit damage while avoiding the use of an unnecessary amount of packaging that would lead to significantly higher material and shipping costs.

Improving Product Protection

Computer-aided engineering (CAE) has long been used to design and test products, while developing product packaging has relied mainly on physical drop tests.

Mabe wanted to apply the same CAE tools that had been so successful in developing its appliances, to optimize product packaging for a combination washer-dryer. The challenge for the company was to produce an optimized packaging design that took into account a variety of loading scenarios and alternative package designs,

Keywords: Mabe, HyperWorks, RADIOSS, HyperMesh, HyperView, OptiStruct, HyperStudy, Altair Product Design, White Goods Manufacturing

Mabe Success Story

"The improvements in packaging performance derived from the simulations during the entire design cycle were very significant. The maximum acceleration levels experienced by the product were reduced by 29 percent, and the maximum product strain was decreased by 28 percent."

Dante Sánchez Rojas,
CAE Specialist
Mabe

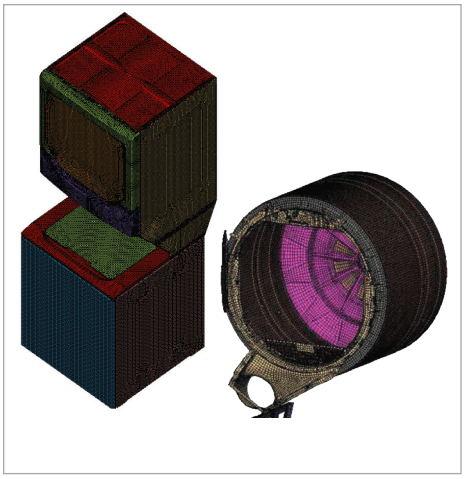
and to do so very early in the design stage, before any physical testing of the packaging was performed. In that way, the packaging design would be driven by computer simulation in an effort to find the ideal solution faster and reduce the necessity for repeated physical testing.

Furthermore, Mabe wanted to be able to transfer the analytical simulation techniques developed for the washer-dryer, to packaging for other products in the future, allowing the company to optimize and accelerate its design efforts.

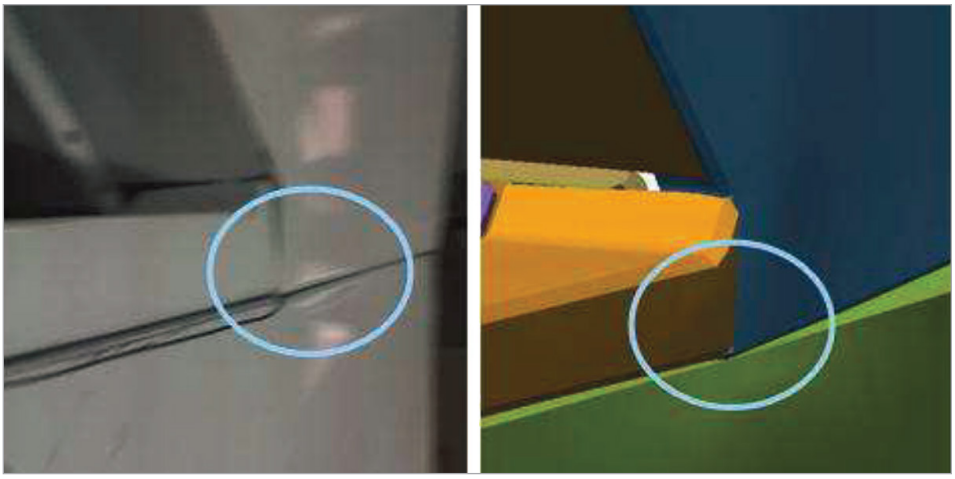
Simulation Strategies from Altair

Mabe called on Altair ProductDesign for its experience in applying optimization strategies for an extensive array of products and packaging. The first task was to generate a finite element analysis (FEA) model that accurately represented Mabe's product and its packaging structure. HyperWorks' pre-processing solution, HyperMesh, was utilized to create a complete FEA model of all the product's relevant structural components as well as such packaging structures as expanded polystyrene (EPS) foams, laminate paper and corrugated board.

To ensure that the simulation results of these packaging materials would give accurate results, materials testing and characterisation was first required. This was achieved by creating simplified physical tests of the EPS foam and other materials, the results of which could be used to adjust the virtual materials' properties and generate more accurate simulation models. Altair ProductDesign engineers were then



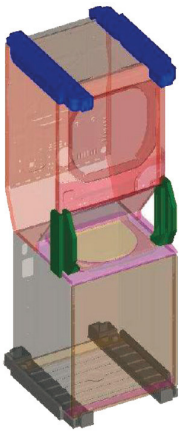
FEA Models of the Washer-Dryer and Internal Component Structures



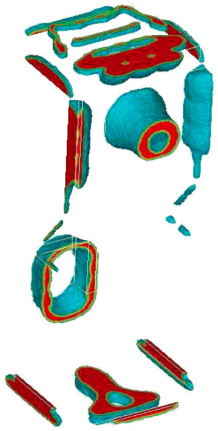
Product Damage During Test Correlation with Simulation

About Mabe

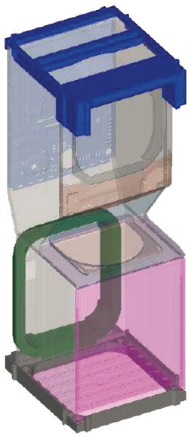
Mabe is a global company which designs, produces, and distributes appliances to more than 70 countries. The company was incorporated in 1946 in Mexico City and produces a wide range of goods including fridge freezers, ovens and washer-dryers.



Baseline Packaging Layout



Topology Optimization Results



Optimized Packaging Layout

able to subject the virtual model of the washer-dryer and packaging material to the same loads that they endured in physical testing. Simulations were carried out with HyperWorks' RADIOSS solver to reflect nine types of possible load cases including straight, front and back drops, left and right side impact and several corner drops. After ensuring that these simulated drops correlated well with a set of similar physical drop and impact tests conducted by Mabe, Altair ProductDesign created a set of baseline simulations to determine structural performance in each of the scenarios that could potentially lead to damage. The results of the simulation were studied using an "onion peel" feature of HyperWorks' post-processor, HyperView, that allows parts to be turned off one at a time to observe the performance of internal components deep within the product. With this capability, the engineers could determine the amount of energy absorption shared between the product and the packaging in each of the drop and impact tests. The overall performance of the baseline simulations correlated very well with that of the physical tests.

Optimizing the Protective Packaging

Topology optimization using HyperWorks' OptiStruct and HyperStudy technologies were utilized to improve product protection, reduce material costs, reduce packaging weight and improve performance of both the EPS foam structures and the laminated paper corner posts. Since these structures have different purposes and functionality, separate topology optimization models were created for each material.

For example, for the EPS foam structure topology optimization, a simplified FE model of the product structure with an accurate product mass was created, and the remaining space between the product and corrugate box was filled with design space. The design space is all the material the optimization solver is allowed to consider or discard in order to meet predefined constraints and objectives. For the foam, the objective was to absorb the maximum amount of energy which in turn would reduce the transfer of energy into the product. These results were then interpreted into CAD and inserted back into the dynamic simulation models for verification.

The optimized corner post design developed from the topology results was further optimized using size and shape optimization, a method which adjusts the material thickness and cross-sectional shape of the material to generate an optimized design. A final comparison of the corner post design before and after size and shape optimization was made showing that peak reaction forces had reduced by as much as 22%.

Project Summary

"The improvements in packaging performance derived from the simulations during the entire design cycle were very significant. The maximum acceleration levels experienced by the product were reduced by 29%, and the maximum product strain was decreased by 28%," said Dante Sánchez Rojas, CAE Specialist at Mabe. Eight of the nine load cases reflected reductions in peak G levels ranging from 3% to 29%.

Altair ProductDesign's technology transfer program was applied throughout this project starting at the initial project planning stages. The program allowed Mabe to pilot this program and receive high level support in order to make sure the HyperWorks tools are used effectively and accurately, with the added benefit being that knowledge grows and resides in-house at Mabe.

Mabe has been successful in applying the knowledge gained from its work with Altair ProductDesign to utilize the HyperWorks suite and perform similar impact testing for its oven range. By extending its use of the HyperWorks tools to packaging design, Mabe expects to benefit from a reduced time to market, lower prototyping costs, less physical testing and improved product protection.

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About Altair

Altair empowers client innovation and decision-making through technology that optimizes the analysis, management and visualization of business and engineering information. Privately held with more than 1,500 employees, Altair has offices throughout North America, South America, Europe and Asia/Pacific. With a 26-year-plus track record for high-end software and consulting services for engineering, computing and enterprise analytics, Altair consistently delivers a competitive advantage to customers in a broad range of industries. Altair has more than 3,000 corporate clients representing the automotive, aerospace, government and defense, and consumer products verticals. Altair also has a growing client presence in the life sciences, financial services and energy markets.

Altair ProductDesign is a global, multi-disciplinary product development consultancy of more than 700 designers, engineers, scientists, and creative thinkers. As a wholly owned subsidiary of Altair Engineering Inc., this organization is best known for its market leadership in combining its engineering expertise with computer aided engineering (CAE) technology to deliver innovation and automate processes. Altair ProductDesign firmly advocates a user-centered, team-based design approach, and utilizes proprietary simulation and optimization technologies (such as Altair HyperWorks) to help clients bring innovative, profitable products to market on a tighter, more efficient time-scale.

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HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

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