Figure 1. Example vertical and horizontal usage scenarios for Magliner hand trucks.

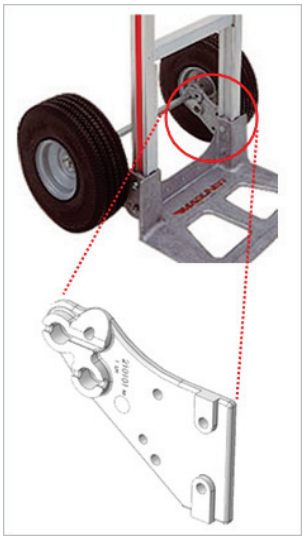

Figure 2. Die-cast wheel bracket baseline design.

Red Cedar Technology uses HEEDS® NP to reduce Magliner wheel bracket mass by 14.2% and retain superior performance

Magline is a leading manufacturer of hand trucks, which are distributed under the Magliner® brand. Delivery personnel commonly use Magliner products to transport soft drinks, bottled water, and foodstuffs between the truck and store shelves. These hand trucks are available in different configurations to serve a variety of needs.

As part of a larger mass-reduction effort, Magline enlisted Red Cedar Technology's help to optimize a die-cast wheel bracket that is used across multiple products.

The Challenge

This wheel bracket was already highly engineered, so standard engineering techniques were not likely to yield the necessary mass reduction. Further, Magliner hand trucks are recognized in the industry for their high quality and reliability, so the new optimized wheel bracket needed to retain the same performance and durability as the current design. Because this wheel bracket is used in several different hand truck configurations and in numerous usage scenarios, many load cases had to be considered during the optimization study. Finally, the design had to work for both cast aluminum and magnesium versions.

The Solution

There were 48 possible load cases for the wheel bracket. From these, five load cases were chosen as the most critical, and these were used during the shape optimization. The analysis of each design iteration was performed using Abaqus Standard.

To complete the optimization study, Red Cedar Technology engineers used HEEDS NP, which performs non-parametric shape optimization directly on the finite element mesh. HEEDS NP moves nodes around to remove volume from regions where it is not needed and add volume in regions where the stress exceeds the allowable limit. The result is a free-form shape change that meets stress and displacement targets, while minimizing the overall volume of the part.

"We were really impressed with the design identified by HEEDS NP. The mass reduction translates into a significant weight reduction for us, without compromising the quality of the final product."

Dave Garski
Magline Corporation

In a HEEDS NP shape optimization study, restrictions can be placed on the movement of nodes to ensure manufacturability. In this case, the wheel bracket was a die-cast part, so the draw direction had to be maintained. Additionally, certain regions could not change shape at all in order to accommodate the existing bearing surfaces and hardware attachments.

HEEDS NP executed each finite element analysis in series, modifying the shape based on the stress state predicted in previous shape iterations. Each analysis included all five critical load cases.

HEEDS NP required only 20 design evaluations to find a feasible solution with a mass reduction of 14.5%. A designer then used the nodal coordinates from the HEEDS NP optimized design to develop a smoothed CAD model that could be used to create tooling.

The final, smoothed design had a mass that was 14.2% lower than the baseline design and reduced the stress by up to 20% for several critical load cases to retain the expected superior durability and performance.

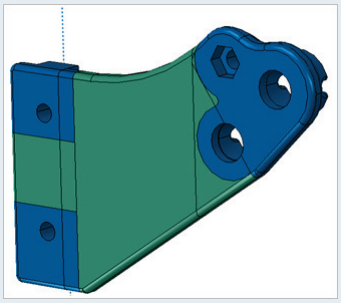

Figure 3. Baseline design indicating areas allowed to change (green) and not allowed to change (blue) during shape optimization.

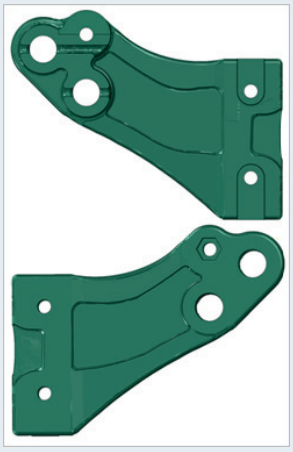

Figure 4. Final optimized design, smoothed for tooling.