LucasVarity Takes the Brakes Off

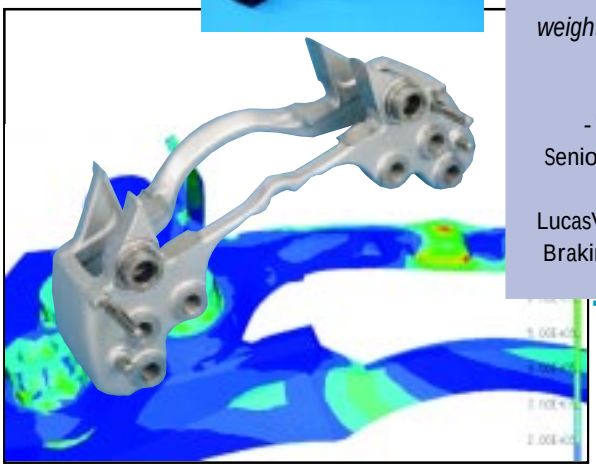
SITUATION

LucasVarity HVBS was working on a design proposal for a major new disk brake for a new range of trucks being produced by one of its most important customers. The competition among suppliers was fierce as the contract was expected to be worth in excess of £80 million (U.S. $131 million) per annum over the life of the contract. While the new contract value was significant, equally important to LucasVarity was the fact that the new design would also reduce demand for the company's existing drum brakes. Therefore, losing this order would mean losing a tremendous amount of potential business.

To help win the contract, LucasVarity engineers focused their efforts on the disk brake carrier, a critical component of the disk brake assembly which connects the assembly to the vehicle axle and experiences substantial forces during a brake application. The shape of the carrier's inboard beam had been curved to accommodate customer installation requirements for additional bolts in this area. But changing the shape in this way compromised the part's strength. So the engineers had to find a way to strengthen the part without requiring their customer to make expensive changes to the vehicle to accommodate it.

OBJECTIVES

✔ Redesign the disk brake carrier to ensure it can withstand the braking loads during the lifetime of a vehicle and still fit within the allocated space giving clearance for surrounding bolts.



PROCESS VISION

✔ Work within a fully integrated modeling and simulation environment to eliminate time-consuming and unreliable data transfers between finite element and 3D models, and maximize the number of "what if" scenarios and design iterations that can be performed.

✔ Be confident that the design simulation is extremely accurate since the safety factor for braking systems is so critical.

ACTIONS

✔ The LucasVarity team began by running extensive analyses on this component. However their initial studies yielded rather ambiguous results, so they called SDRC for advice. SDRC helped them incorporate further critical parameters into the finite element model, such as friction at the carrier mounting face, mounting bolt interference and bolt preload simulation

"A failure on our part to provide a mutually agreeable solution would have forced our customer to make expensive changes to the vehicle, and at worst, could have lost us the contract. We were extremely pleased that we were able to come up with a rather unusual design that would not have been possible without the extensive use of design simulation. Using I-DEAS software we even managed to reduce the weight of the component by 18%."

- Thomas Kunze
Senior Design Engineer/ Analyst
LucasVarity Heavy Vehicle Braking Systems (HVBS)

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✔ Several new FE models were then created within I-DEAS® to evaluate their performance with the more detailed analysis parameters such as friction and mounting bolt interference. These models were used to drive the design of a completely new shape for the inboard beam. Instead of being totally curved, it now featured a straight portion in the critical areas, with three scallops to provide the necessary clearance for the adjoining bolts.

✔ In parallel the designers conducted load cell tests on static torque rigs and dynamometers to study the effect of load and load movement during emergency braking, and the force this load exerted on the carrier. Accurate reaction force data obtained was then used to test and further improve the FE model.

✔ Once the designers were confident that the new carrier model correlated well with previous test data, the component was stress optimized. This required a large number of design modifications, the integrated nature of I-DEAS allowed an FE model update to be quickly generated after each one.

✔ After further testing and verification, the final 3D model was turned into 2D I-DEAS drawings and passed to the foundry for production level prototype castings. Following repeated and successful testing in house, the first batch of prototype carriers was sent to the customer for extensive vehicle testing.

RESULTS

✔ Using I-DEAS the team was able to generate accurate and fast FE model updates after design changes. Twelve carrier models were designed, analyzed and post-processed within three weeks.

✔ The FE analyses enabled the team to make allowances for additional forces resulting from the carrier being part of an assembly, and allow for the inevitable slippage between the carrier and the vehicle axle mounting without creating too much rigidity that would overstress the components.

✔ The amount of stress in the redesigned carrier was 50% less than the original component. The customer carried out testing and not a single carrier failed prematurely. The design was given full approval, and LucasVarity was appointed as the brake supplier for the new range of trucks.

✔ The weight of the redesigned carrier was 18% less than the original. On a production run of 250,000, this would result in a significant saving.

✔ As a result of the redesign, a production process known as broaching could be applied to some of the machined faces, instead of NC milling, saving over £1 million (U.S. $1.6 million) in tooling costs.

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