Case Study

Samsung Research Institute – Bangalore Adopts Altair OptiStruct® for Optimizing Housing Design of a Smartphone

Customer Profile

Samsung R&D Institute India - Bangalore (SRI-B) is the largest R&D centre outside Korea for Samsung Electronics. Their 3000+ engineers work across diverse domains, projects, products, clients, people and countries, and also conduct research in new and emerging areas of technology. The Mobile division is one of the oldest research and development divisions at SRI-B.

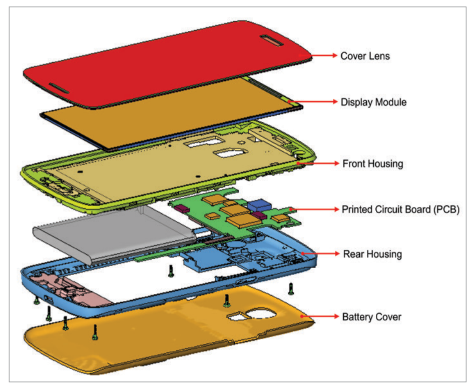

Fig. 1: Exploded view of a typical Samsung smartphone

Design Challenges

The mobile devices industry is fiercely competitive and companies are continuously being challenged to push the boundaries of their hardware design. With shorter design cycles and narrowing cost margins there has been greater emphasis on virtual testing using computer simulation.

Traditionally an analyst would use Finite Element Analysis (FEA) to iterate a design until a feasible design solution is reached. However, given the limitations to manually exploring the complete design space, the acquired solution is not always necessarily an optimal one.

Solution

Altair HyperWorks OptiStruct® Software has been used for shape and topology optimization to arrive at a detailed definition of a smartphone front & rear housing.

To demonstrate the optimization approach a typical Samsung smartphone as shown in Figure1 has been used. The phone has a plastic over molded magnesium die-cast front housing and a polycarbonate rear housing. The lens-display module is adhered to the front housing. The PCB and the battery are constrained to the rear housing, which is screwed to the front housing.

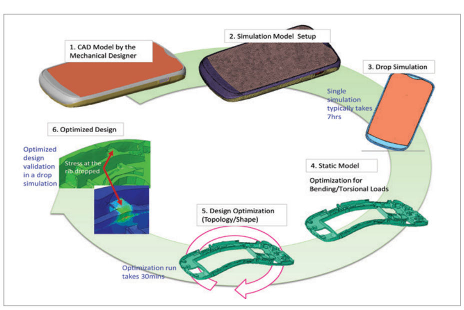

Fig. 2: Simulation Process Flow with Optimization

"Topology optimization can have a significant impact in designing a robust device when used early during the architectural definition. OptiStruct® allows for the definition of certain design / manufacturing constraints but there are some aspects such as the alignment of ribs that cannot be enforced. In such cases, the optimized design can be used as an initial reference to lead the designer towards a more robust design. I would like to thank Altair India, for their extensive support in the execution of this project"

Gaurav Gupta
Sr. Chief Engineer
Samsung, Bangalore

Mechanical Reliability Tests

One of the critical tests to determine the reliability of a mobile device is the drop test. The display glass strain and the PCB strain at the surface-mount packages are two of the high risk areas. Weaknesses in the housing design usually reflect in the drop performance of these components. The objective of this study is to address these weaknesses using optimization techniques. The device is dropped in various orientations and the deformation of the internal components is monitored through simulation. It has been observed that the drop reliability of a phone correlates to its stiffness; the higher the stiffness the greater its degree of reliability.

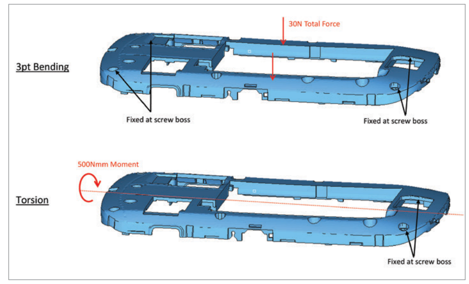

Fig. 3: Quasi-static test cases for the optimization problem

Front & Rear Housing subjected to a Quasi-static 3-point Bend and Torsional Load (Fig. 3).

Type of Test	Loads Applied	Objective
3-point bend test	30N force applied at the center of the housing. Top and bottom screw bosses constrained.	Minimize compliance (or total strain energy) of the part for applied load. Weighted compliance formulation used to combine output of the two load cases in a single objective function.
Torsion test	500Nm moment applied at a reference node connecting the top screw bosses. Bottom screw bosses constrained.	

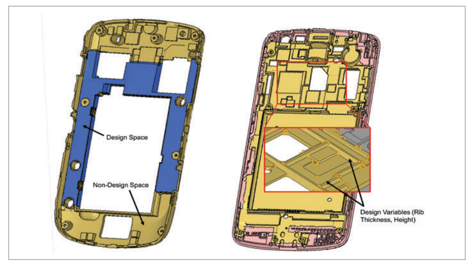

Fig. 4: (a) Rear housing geometry for topology optimization
(b) Front housing geometry with shape optimization variables

Design Space for Topology and Shape Optimization (Fig. 4: a,b)

Topology Optimization Design Space	Constraints
Fig. 4 (a) Rear housing blue region	Minimum & maximum thickness of ribs. Housing mass same as baseline design.
Shape Optimization Variables	**Objective**
Fig. 4 (b) Front housing 17 design variables - x, y position of ribs, thickness of ribs and housing floor.	Maximize the stiffness of the housing.

Results & Discussions

The quasi-static load based optimization takes 30mins to run when compared to a single drop simulation that would typically take 7hrs to run.

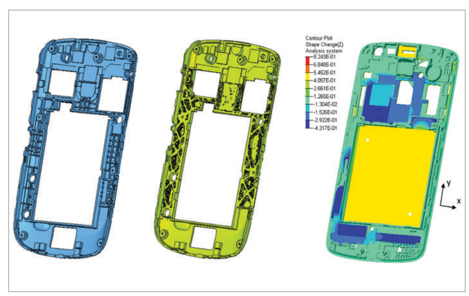

Figure 5: (a) Comparison of rear housing baseline design and optimized design from OptiStruct.
(b) Optimized front housing design with the shape changes in z direction.

Topology Optimization	Result
Fig. 5 (a) compares the topology optimized design of the rear housing with the baseline design.	The optimized design has very different rib arrangement and the stiffness is significantly higher (40% in bending and 74% in torsion). There is a 20% reduction in PCB strain in drop simulation.
Shape Optimization	
Fig. 5 (b) indicates the z dimensional changes to the shape optimized front housing.	The optimized design is 1.6gm (10%) heavier than the baseline design but is 65% and 85% stiffer in bending and torsion respectively. Without the additional weight, the optimized design is about 30% stiffer. There is a 45% reduction in display strain in drop simulation.

Altair Engineering India Pvt. Ltd.,: Mercury 2B Block, 5th Floor, Prestige Tech Park, Sarjapur Marathahalli Outer Ring Road, Bengaluru - 560 103. INDIA
Ph: +91.80.6629.4500 • Fax: +91.80.6629.4700 • E-mail: marketing@india.altair.com • www.altair-india.in • www.altairhyperworks.in