ALTAIR

GUIDE TO CONSUMER ELECTRONICS DESIGN AND PACKAGING

INTRODUCTION

Manufacturers today are tasked with designing smart, connected products at a breakneck pace to stay ahead of the competition. To develop the next generation of smart products, organizations are turning to simulation to improve device aesthetics and performance and drive profitability.

Simulation-driven methods help designers and manufacturers streamline the development process and reduce costs associated with design iteration. It also enables companies to take a comprehensive approach to sustainability, directly addressing the carbon footprint of the product and packaging.

Consumer Electronics Design and Packaging

To get a beautifully designed electronic product safely delivered to your customer, the work must start at the product design phase. Leveraging simulation-driven design, manufacturers are gaining greater insight and control over the development of innovative products, consistent manufacturing processes, and cost-effective, sustainable packaging.

What to Expect

INDUSTRIAL DESIGN

Aesthetics play a major role in a product's perceived value to consumers. Industrial design tools allow designers to create, evaluate, and see their vision faster than ever before. Rendering tools let users model freely, make changes, and render stunning photo-realistic images and animations with physically accurate lighting.

USB sound device rendered within Altair Inspire Studio.

3D design and rendering software enhances creativity by letting designers drive their design. With its powerful construction history tool and an intuitive user interface, Altair Inspire Studio users can quickly create, explore multiple iterations, and make changes without any rework.

Designers can also mix and match modeling techniques within the same environment. Fast, free-form polygonal modeling can be combined with the control and precision of surface and solid modeling to create and explore even the most challenging designs effortlessly.

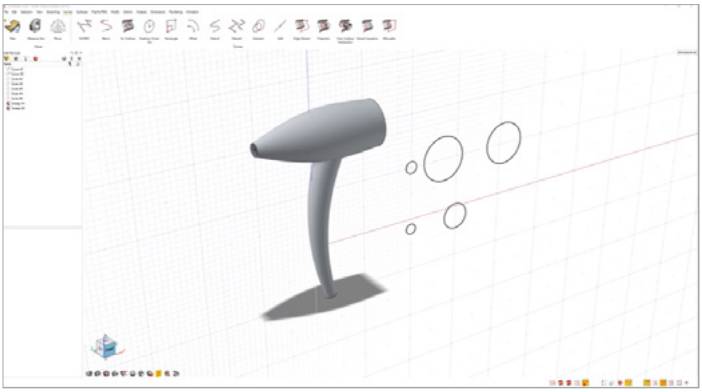
And when it comes time to render a design, Inspire Studio offers an intuitive setup and large choice of environments and materials to create stunning images and complex animations in real time with physically accurate lighting.

THE DESIGN AND RENDERING PROCESS

The steps below demonstrate how a hair dryer design can be simply sketched, modified, and rendered using Altair Inspire Studio.

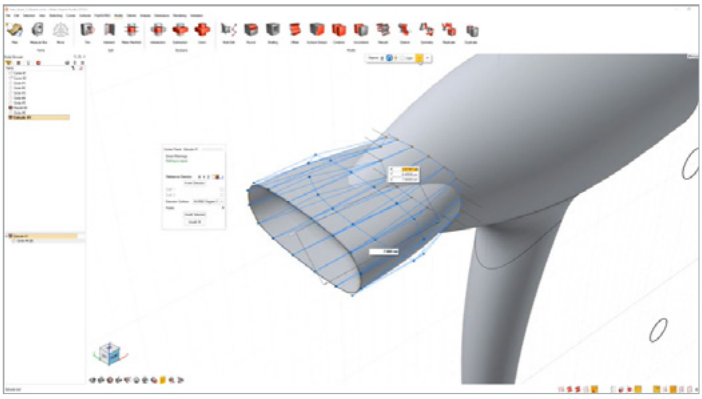
1

Create Main Body Curves and Initial Surfaces



2

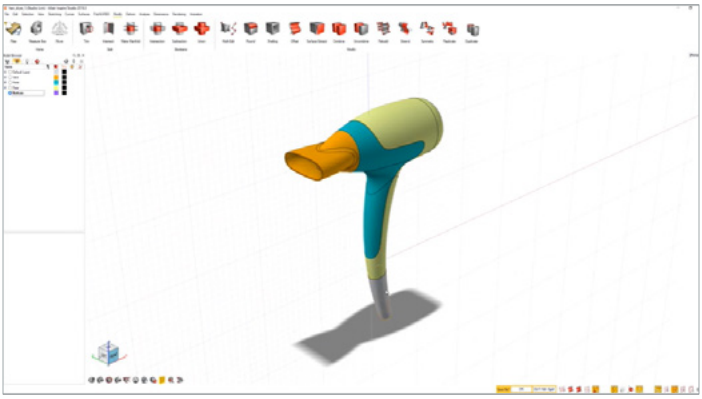
Add and Edit Additional Surfaces



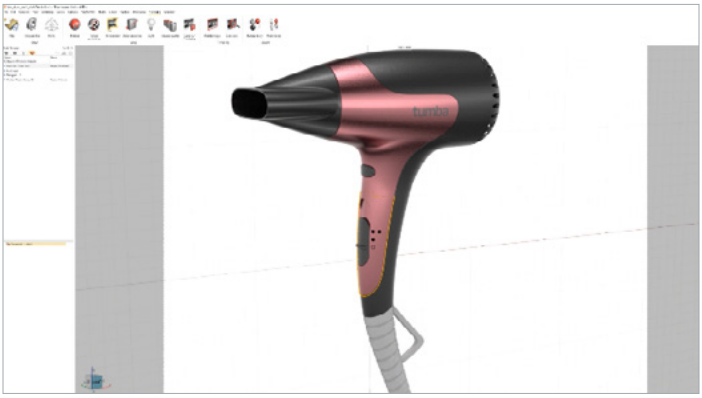
3

Create Construction Geometry for Editing the Surfaces

4 **Complete the Details of the Hair Dryer Body**



5 **Apply Materials, Set Up Environment, and Add Lighting**



LIGHTER AND BETTER PERFORMING STRUCTURES

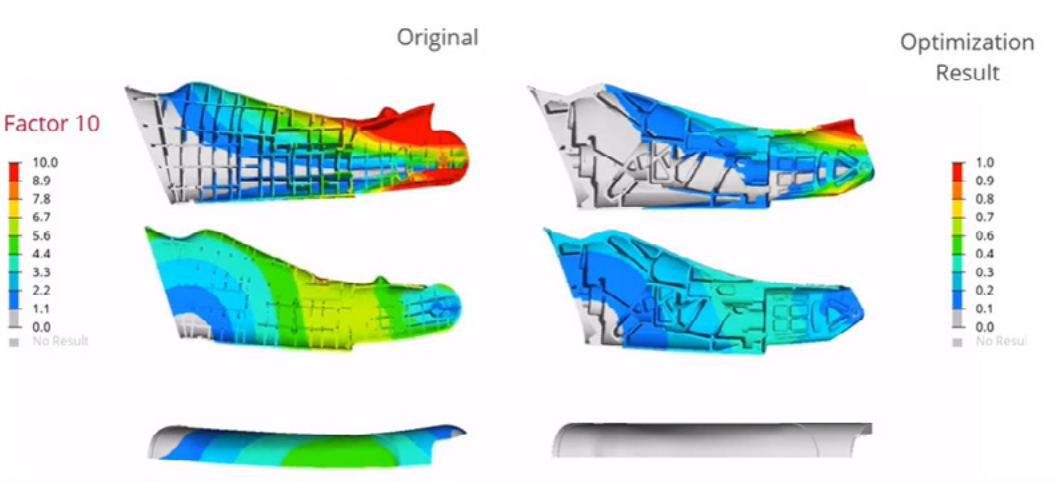
Applying generative design upfront in the product development process allows manufacturers to explore design options that meet performance targets while making products lightweight in the concept phase rather than working to take mass out later. Packaging space within many consumer electronics devices is also at an immense premium. Generative design can also be used to develop products that need fewer internal supports to meet structural performance requirements for normal use, drop, and misuse scenarios. With more packaging space within the product, engineers are left with more space within the device for critical actuators and electronic components.

Additionally, designers need the ability to evaluate different material selections to meet their weight and performance targets. The development of sustainable, efficient, minimum weight designs requires accurate multi domain material properties. Altair users are able to browse, search, and compare materials in a standalone application or through the interface of their simulation and optimization tools.

Altair develops and implements intelligent simulation technologies that allow designers to find the optimal balance between weight, performance, and cost.

Topology optimization result

In a joint project with Nolato, Avalon Innovation and Altair, a generative design principal called topology optimization was used to improve strength and maximize packaging space in a medical auto-injector.



Re-analysis: Displacements for dominant load cases

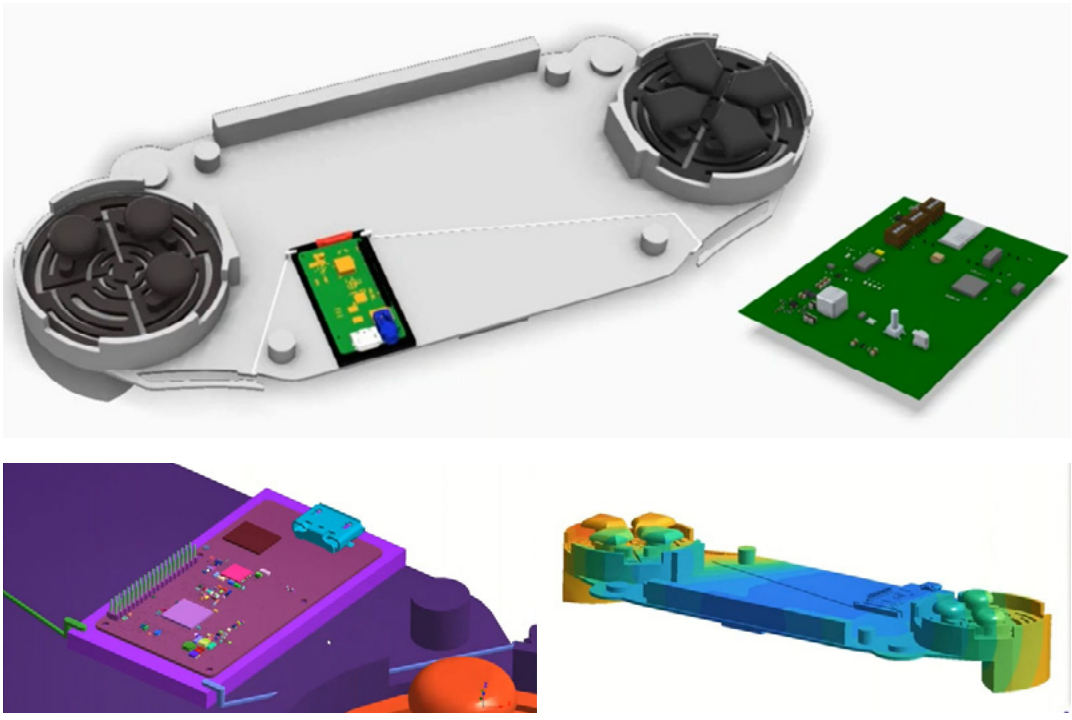
Comparison of bending stresses on the original and optimized medical auto-injector.

STRUCTURAL ANALYSIS AT THE DESIGN STAGE

Rapid design iteration is key to early-stage evaluation of a design's feasibility. Consumer electronics need to withstand abusive loads both during use as well as during storage, shipping, and in the retail setting. Solving structural load cases on PCBs, which are comprised of complex mix of materials, can be time consuming in traditional CAE tools due to the pre-processing requirements on these intricate geometries.

If you're interested in the electronic system development process, including the design of electronic hardware and firmware, as well as the sensors, actuators, and antennas on the device: Read the Guide to Electronic System Development.

The structural analysis solver available within the Altair Inspire™ design, analysis, and optimization suite offers a way for designers to get structural analysis insights on complex assemblies in seconds or minutes without CAD geometry cleanup or meshing and assembly work. On the game controller below, multiple design variants of this 250-part assembly were imported and analyzed in seconds to compare structural and thermal deformations.



Structural analysis of game controller and PCB with Altair SimSolid.

An often-overlooked aspect of early-stage product design is part manufacturability. A design on a computer screen might not exactly match what ends up being manufactured, or even be possible if part details cannot be executed by the chosen manufacturing method. Discrepancies between virtual and physical prototypes can end up being a major burden at later stage of the product development process.

The choice of manufacturing process, materials used, and machine tolerances can dramatically affect what designs can be efficiently produced and how well that part performs compared to its virtual counterpart.

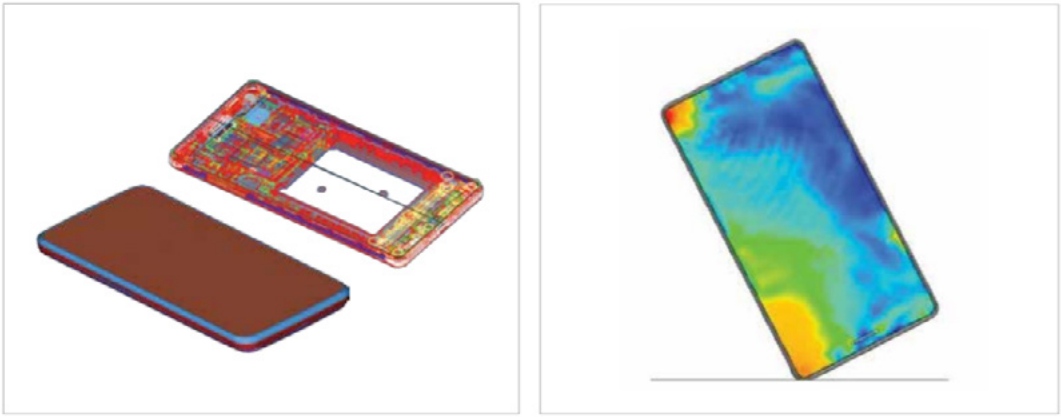
Trial-and-error approaches can make it difficult to anticipate manufacturing issues and know how best to correct them. This often results in engineering teams committing time and resources to modify designs and physically retest new prototypes, and as a result, parts run the risk of being over-engineered, adding cost and negatively impacting performance.

By contrast, a Simulation-driven Design for Manufacturing (SDfM) approach delivers manufacturability insights directly into the hands of product designers. Design flaws can be detected and corrected early, allowing users to confidently design to their chosen manufacturing method. Designing for production right the first time helps bring products to the market faster and enables the exploration of more cost-effective workflows for additive manufacturing, casting, molding, metal forming, and more.

DROP AND ABUSIVE LOADS

Impact analysis or drop testing is one of the most important stages of product design and development, and software that can simulate this testing accurately yields dramatic cost and time-to-market benefits for manufacturers by reducing the need for physical prototypes.

It is the job of the manufacturer to design and develop products that perform as well as possible when dropped, crushed, or otherwise placed in danger of permanent damage. Drop test simulation software helps manufacturers by speeding up the time to test a product, enabling higher levels of design quality and reducing the need for physical testing. Structural analysis tools can replicate the complexity of the physical environment and materials, simulates the impact or drop event, and provides detailed technical information about how the product performs during this event. Altair's structural analysis software provides a rapidly expanding and efficient set of nonlinear analysis features for drop test simulation, large displacement testing, preload temperature testing, contacts, and non-linear material analysis.



LG Electronics performs drop test simulation on a smartphone design.

Learn more about the LG customer story.

“Simulation with Altair HyperWorks brought great efficiencies and savings to the redesign process. It helped reduce the huge amount of work involved in physical tests...

of the product and its packaging, making redesign more efficient and eliminating the costs of physical testing.”

Bill Maffeo, Senior Design Engineer. Unilever Global Packaging Design Group.
View Unilever Customer Story: https://www.altair.com/resource/hyperworks-optimization-capabilities-integrated-into-packaging-design-process-help-unilever-cut-costs-and-development-time

DEVICE DESIGN FOR MANUFACTURING

Without consideration of manufacturability, all of the hard work put in the conceptual design and validation stages may not translate to the final product. Typically, between 20-55% of total development time is spent in the iterative loop between enclosure design and prototyping, where electronic performance and aesthetic factors are assessed, and updates are made to the CAD and retested. A simulation-driven design for manufacturing (SDfM) approach helps designers to reduce product lead-time by identifying issues before the prototyping stage and eliminating costly design iterations.

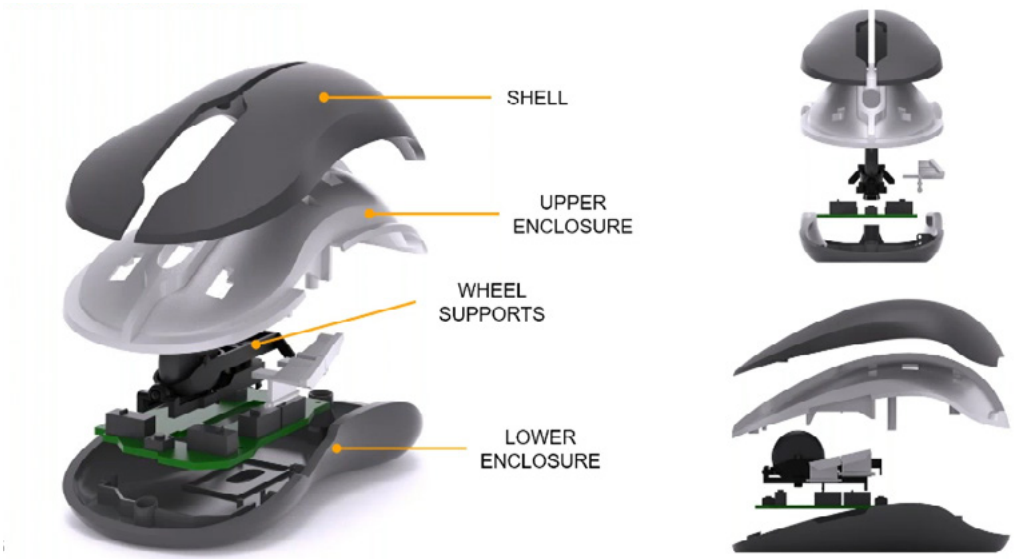
Each manufacturing process has strengths and limitations, and simulation tools are there to ensure that the design can be manufactured as intended. Altair Inspire™ offers developers of consumer electronics the ability to simulate multiple manufacturing processes including injection molding, metal forming, casting, extrusion, or additive manufacturing.

Learn more about Altair's manufacturing simulation tools.

Injection Molding Simulation

The manufacturability of this computer mouse enclosure design can be assessed using injection molding manufacturing simulation software, an established, proven industrial manufacturing process for the mass production of identical components. The basic process, forcing a molten polymer under pressure into a cavity machined in a metal tool, has evolved to become highly sophisticated and is now utilized to produce a wide range of complex shapes with a diversity of polymer resin grades.

Tools like Altair Material Data Center enable designers to browse and compare material properties for use in simulation and optimization workflows.

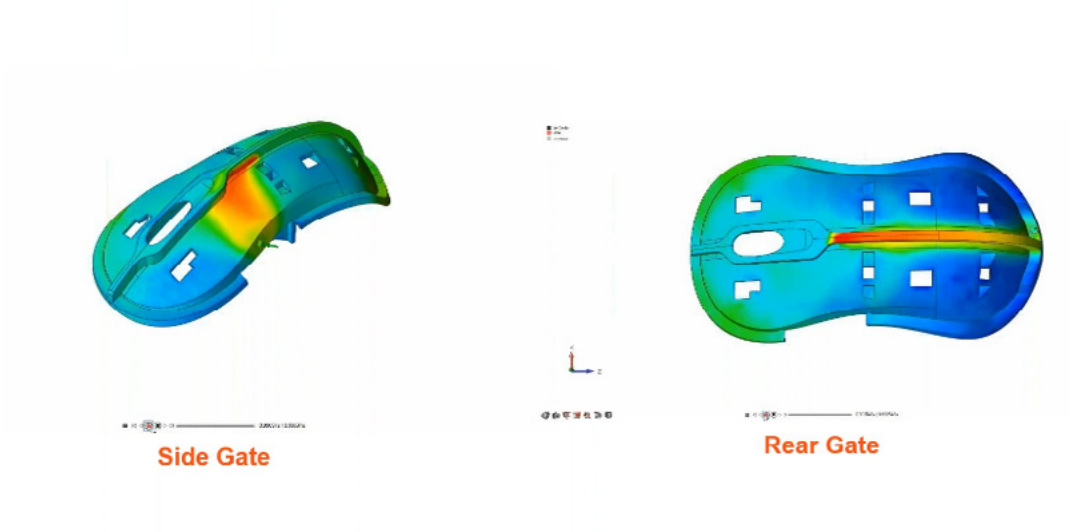


To remain competitive, consumer electronics manufacturers have turned to modern computer-based tools to virtually design and gain a better understanding of the entire molding process.

Altair Inspire Mold provides a modern integrated SDfM approach to streamline the design of injection molded components. Rather than relying solely on validation by specialized analysts at the latter stages of development or on physical prototyping trial and error, SDfM simulation tools can be placed in the hands of designers and product engineers early in the development cycle. These tools enable easy exploration of design options while also delivering improved products and aiding in cost reduction by limiting scrap and tooling rework.

Designers can use Inspire Mold to understand how the mold fills with a fast analysis, then dig deeper into the process with a detailed simulation of all the advanced physics.

Virtual testing, validation, correction and optimization of molding designs can be easily performed through a five-step workflow, providing access to evaluation of injection molded part manufacturability that mitigates common manufacturing defects (warping, sink marks, short shots, etc.) long before a mold is made.



Filling simulation to quickly evaluate different injection gate positions.

Learn more! Download the Injection Molding eGuide

Polyurethane Foaming Simulation

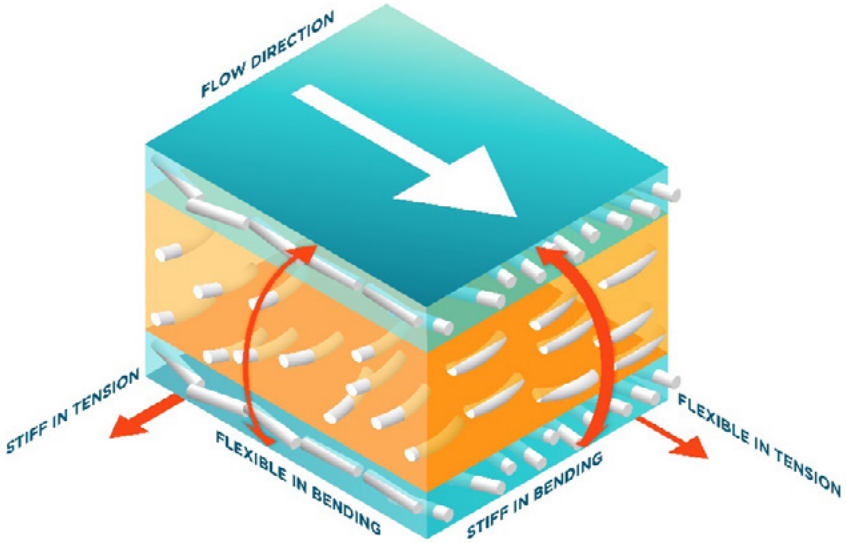
"Polyurethane (PU) foam is a common solution for panel insulation in white goods due to it's lightweight, sustainable nature, adaptable strength per unit weight, and low energy requirements for production. PU foam, however, can be susceptible to common manufacturing defects caused by foam shrinkage and porosity. Altair Inspire PolyFoam is a modern, integrated approach to polyurethane foaming simulation, allowing users to efficiently explore the design and optimize molded foam parts to reduce scrap and tooling rework costs.

55% of part designers find selecting the correct material a challenge.

Source: Michelle Boucher | Vice President | Tech-Clarity Inc. : "The How-To Guide for Designing and Molding Better Plastic Parts" 2019 https://tech-clarity.com/

Composite Material Modeling

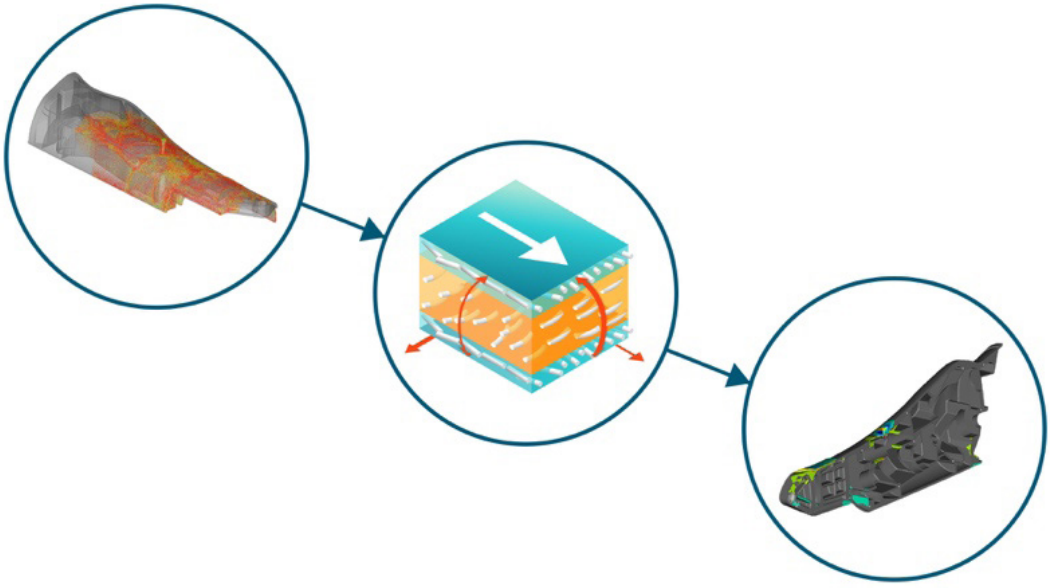
Many consumer electronics devices utilize a composite outer enclosure made of short fiber-reinforced thermoplastic. In these types of materials, the fiber orientation throughout the part not only defines the material properties but is affected by variations throughout a molded component part. The multiscale approach can be used to create a material model for structural stress analyses. Optimization technology can also be utilized to improve any underperforming part.



Process dependent fiber orientation and resulting material behavior: Depending on the plastic used, the geometry of the component and the process conditions, a three-layer distribution of the fibers occurs. On the edge of the component, the fibers tend to lie in the direction of molding, while in the center the orientation is transverse.

First, injection molding simulation is run to obtain fiber orientation data to map into the structural mesh. A higher mesh density is needed in the molding simulation compared with a structural mesh to accurately calculate fiber orientations. A fill simulation provides the fill time, temperature, defect predictions (sink and weld marks), and fiber orientation. Fiber orientation is then mapped onto the structural mesh to determine the material model, which is used in the structural solver.

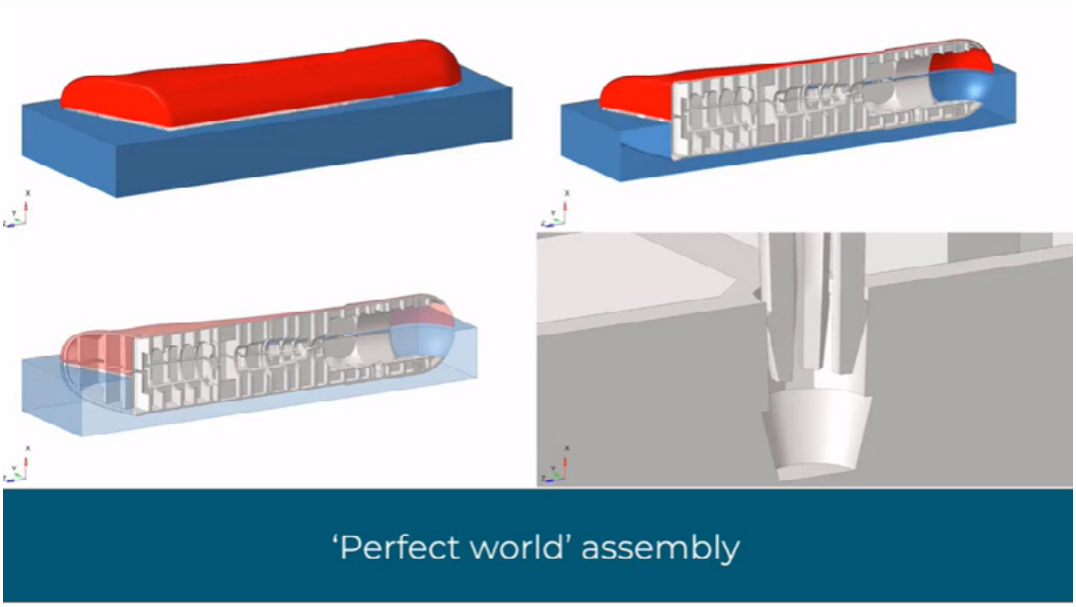
Designers can then take results from the material characterization and map it onto the structural analysis mesh to apply displacements, stress, and warpage results.



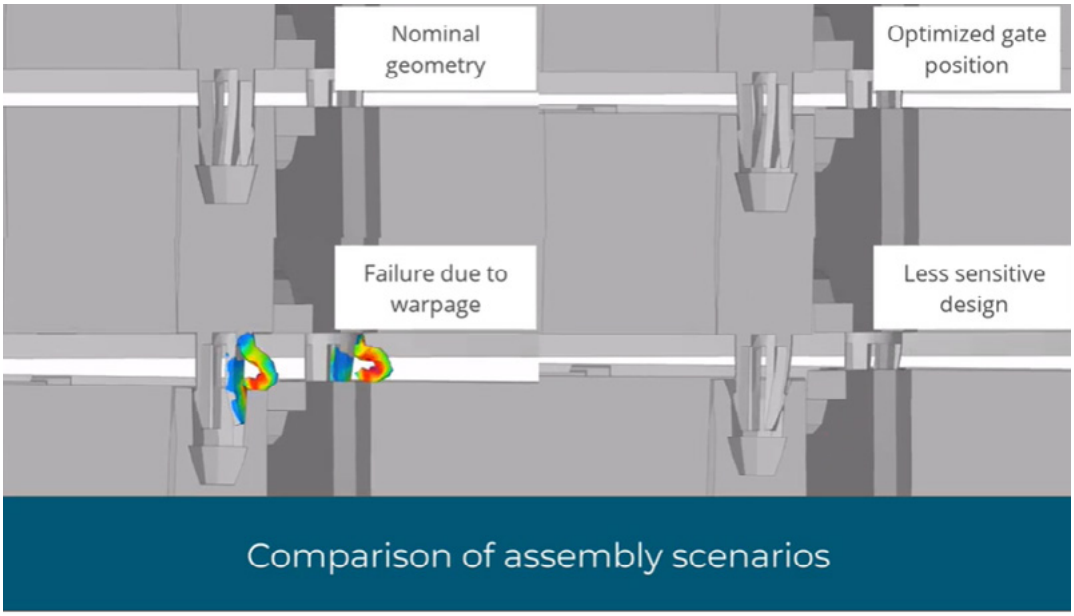
The simulation of the injection molding process provides the fiber distribution that is considered in the material property to improve the prediction quality of the structural assessment of the part.

DEVICE DESIGN FOR ASSEMBLY

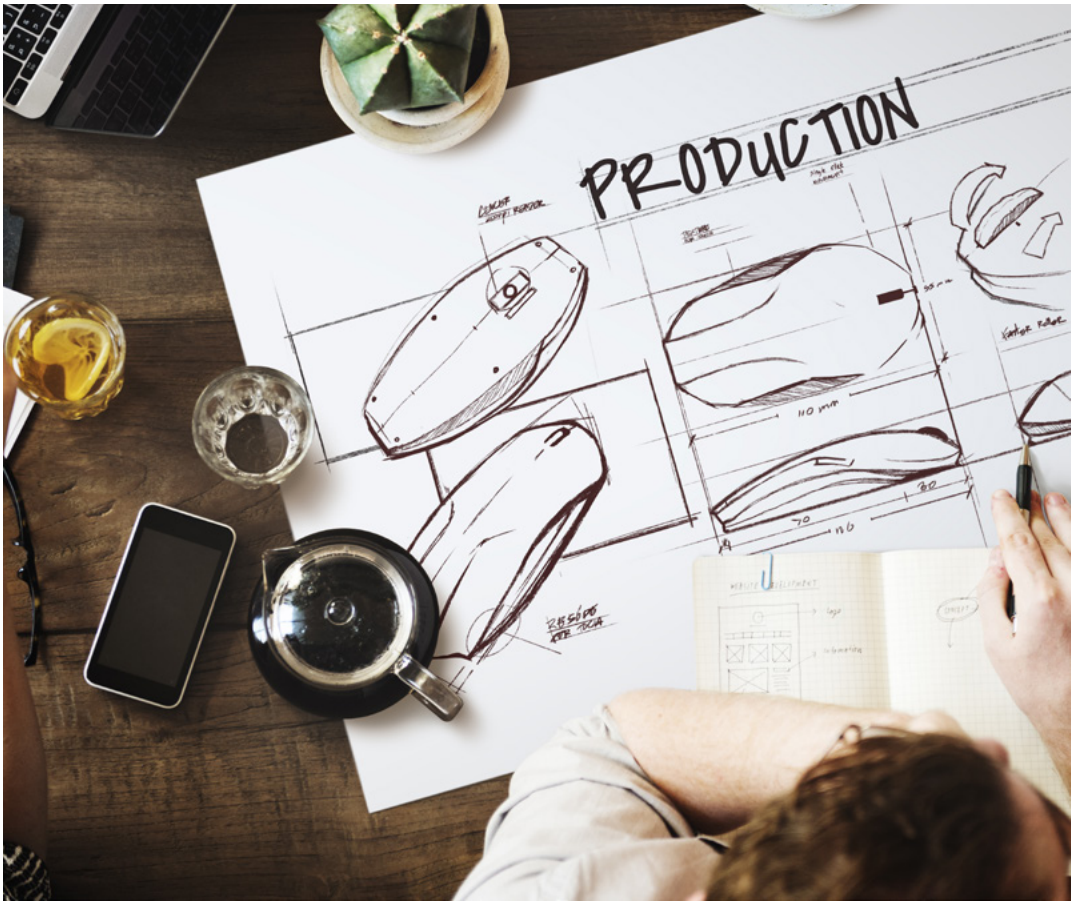
Many electronic devices are manufactured in multiple parts, which need to fit together seamlessly to ensure aesthetic quality and performance. Product design can help reduce part count by design, which plays a major role in whether the design can be consistently manufactured within tolerance so that it can be correctly assembled. Structural analysis software can simulate the nonlinear structural behavior of parts during the assembly process, giving insights into potential failures which can be fed into a design optimization loop.



Structural analysis of a medical auto-injector during part assembly.



To ensure correct assembly, the gate positions for parts fitting together can be optimized to give similar warpage and shrinkage. In parts with unmatched gates, analysis of the assembly process using multiscale material properties can identify cases of potential pin connection failure, causing pins to be crushed during assembly. By increasing tolerances, these costly assembly issues can be avoided.



‘Less packaging’ needs to become ‘higher-performing packaging.’ This starts at the product-design stage – avoiding packaging layers while still meeting the right level of product requirements, including preservation, usability, and safety.

Legl, Carina (2019), “The Power Of Sustainable Packaging”, July 2019, Forbes Media LLC, Accessed 29 January 2021 https://www.forbes.com/sites/sap/2019/07/10/the-power-of-sustainable-packaging/

COST REDUCTION AND SUSTAINABLE PACKAGING

An important and sometimes overlooked aspect of electronics product design is its packaging, which constitutes between 10 and 40 percent of a product's retail price. The packaging must protect the device from stacking loads and impacts in storage and shipment. Lightweight design and material usage also need to be considered, which can offer cost savings to the manufacturer and positively impact environmental sustainability.

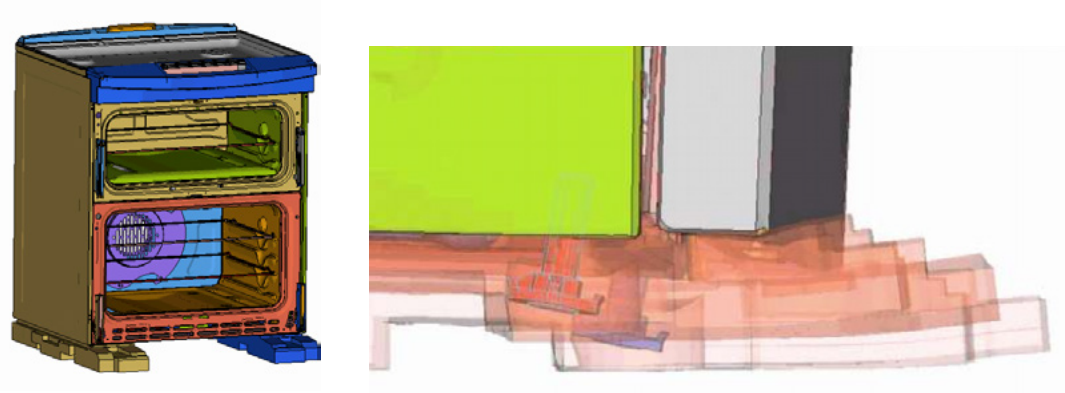
The possibility for transformational change exists within retail packaging for consumer electronics. Comprehensive sustainability changes are within reach, allowing manufacturers to directly address climate change and carbon impacts. And by assessing the true hidden costs of product packaging, it becomes easier to coordinate changes up and down the value chain to dramatically influence profitability.

STRUCTURAL ANALYSIS OF PACKAGING

Finite element analysis can be used to determine the effects of loading on physical structures. This provides insights into the stress, strain, deflection, buckling, natural frequencies, forced vibration response, and impact energy factors that may affect the electronic device and its packaging.

PACKAGING IMPACT SIMULATION

Predictive impact and drop test simulation are important to ensure electronics remain safe during storage and delivery. In addition to predicting damage from container impact and drop, these tools can also simulate top load buckling that may occur when boxes are stacked on a pallet and even specific events like appliance door closure impact.



Mabe uses Altair structural analysis tools to predict and prevent damage during shipping and handling.

Learn more about the Mabe customer Story.

TOPOLOGY OPTIMIZATION IN PACKAGING SPACE

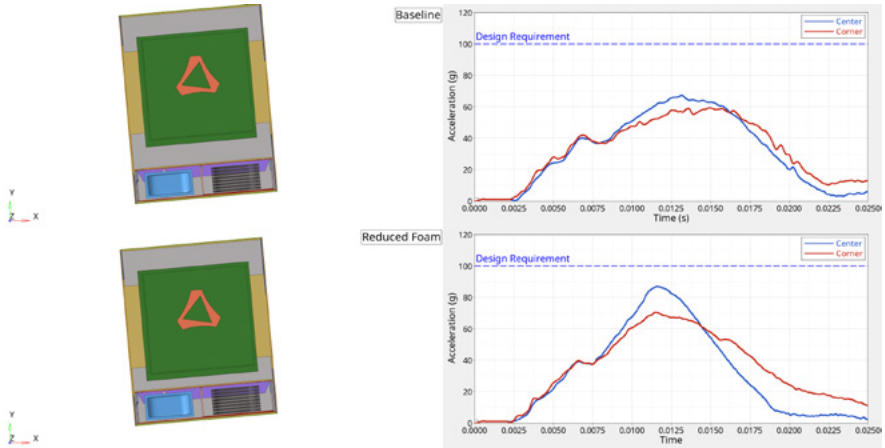
Given a package space, manufacturing constraints, and loading conditions, topology optimization can generate an ideal shape of the protective packaging needed to protect a device. The solution can be tuned to meet user-defined criteria, such as maximizing stiffness, minimizing mass, or targeting a natural frequency range.

Designers can consider different design alternatives based on multiple load cases, providing insights into where packaging materials are necessary or unnecessary. This not only produces stronger packaging, but often allows manufacturers to reduce material usage, contributing to lighter overall package weight and reduced carbon footprint. Topology optimization can also consider manufacturing constraints to reduce manufacturing costs and reduce or eliminate tooling.

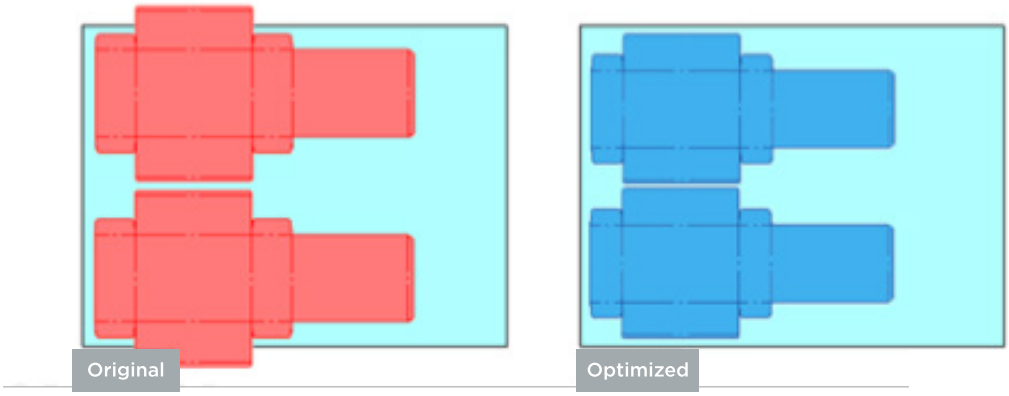
Topology optimization produced a 100% stiffer protective packaging design without increasing mass.

SIMULATION-DRIVEN PACKAGING DESIGN IN ACTION

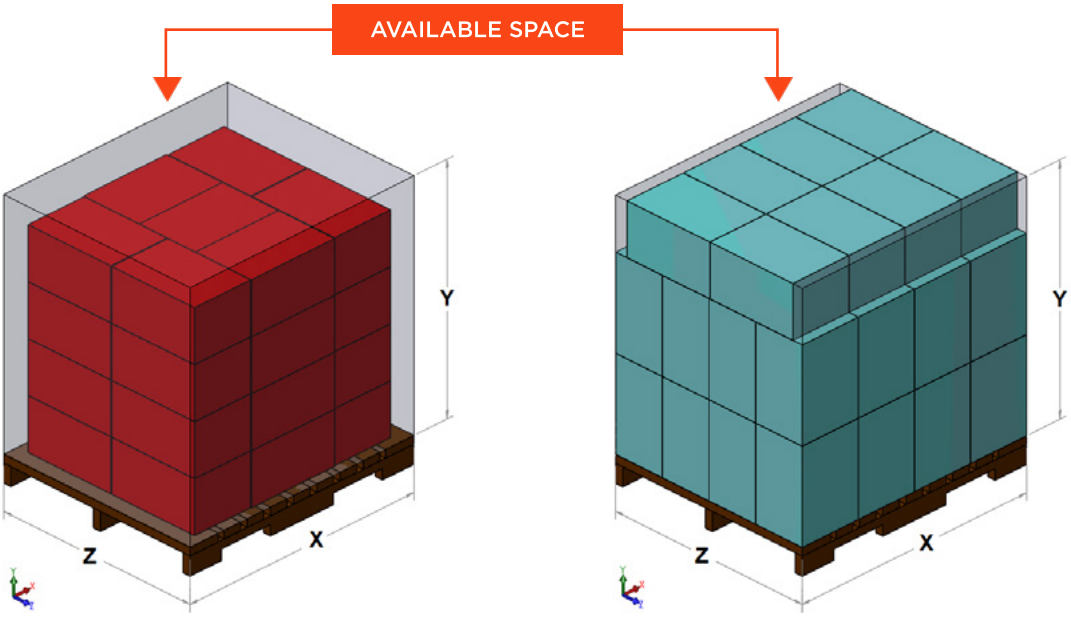
Altair can minimize the amount of protective packaging required to keep products safe during shipment. In this example, a new package design for a tablet was developed to reduce the shipping box dimensions. Despite reducing the amount of protective foam inside the box, nonlinear drop test simulation showed this smaller package still met the manufacturer's product safety requirements.



Reducing the box dimension yielded multiple cost saving benefits. In the original design, one cardboard blank was needed for each box. The optimized package design allowed two boxes to be cut from a single standard corrugated sheet, yielding considerable material cost savings.



Additionally, a smaller box made it possible to fit more units per pallet. This makes it easier to ship the same quantity of product using fewer container and fewer trucks, reducing both carbon footprint from the material reduction as well as shipping and logistics improvements.



WORKING WITH ALTAIR

Altair's simulation-driven design solutions deliver a smarter approach to consumer electronics product development, addressing challenges and infusing optimization into all aspects of the development process from initial design to packaging and manufacturing feasibility.

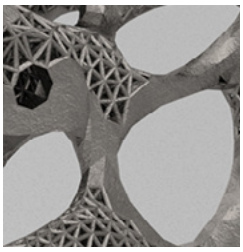
Altair Inspire provides an intuitive and powerful family of software products that enables simulation-driven design throughout the entire product development lifecycle, from concept to reality. When used early in the design process, the Inspire technology empowers the creation of designs that are focused on both performance and manufacturability and empowers its users to explore, develop, and manufacture high-performance products in a single intuitive development environment.

Combined with Altair's electronic system development software, mechanical and multiphysics optimization tools, data analytics, and advanced IoT technology, users have a comprehensive package of solutions to develop innovative, high-quality smart products faster and more cost-efficiently.

- If you're interested in the electronic system development process, including the design of electronic hardware and firmware, as well as the sensors, actuators, and antennas on the device, download the Guide to Electronic System Development: Rapid Product Development for Smart Connected Devices
- If you want to learn how to design an IoT strategy and effectively connect your smart devices at scale, download the Guide to Connecting Devices into the Internet of Things

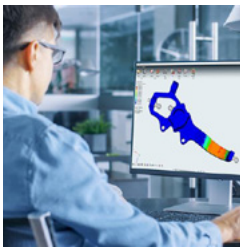
Learn more about Smart Product Development

Designers + Concept Engineers



Integrate intelligence into your design from the beginning.

MEs, EEs, Control Engineers



Build faster, stronger, more-efficient, longer lasting products.

Software + Embedded Developers

Build scalable, secure, intelligent software + hardware product ecosystems.

Data Scientists + Analytics

Continuously improve your product's performed with augmented intelligence.

Altair is a global technology company that provides software and cloud solutions in the areas of product development, high performance computing (HPC) and data analytics. Altair enables organizations across broad industry segments to compete more effectively in a connected world while creating a more sustainable future.

To learn more, please visit www.altair.com