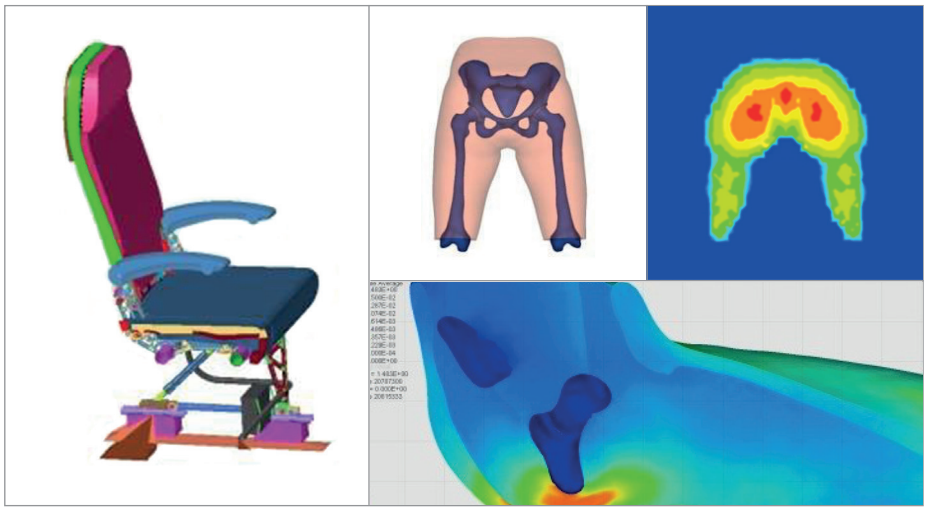
Altair | HyperWorks

Improvement of Aircraft Passenger Seat Comfort Through Biomechanical Models and Numerical Simulation



SAFRAN

Key Highlights

Industry
Aerospace Equipment & Systems

Challenge
Optimizing seat ergonomics to reduce passenger discomfort

Altair Solution
Employing Altair HyperWorks to develop biomechanical models that help with optimization of the seat form and structure

Benefits
- Evaluation of the overall structural behavior of seats
- Deep insights into biomechanical discomfort factors
- Mean error of the estimated maximal pressure of 16%
- Internal strain estimated with error lower than 19%

Overview

Everyone who has ever taken a long-distance flight knows how important it is for airplane seats to be as comfortable as possible. Zodiac Seats France (ZSFR - now Safran Seats), a supplier of upscale passenger seats, sets out with the goal to improve seat comfort in airplanes and developed a new kind of airplane seat that would increase passengers' comfort tremendously. To do so, Zodiac engineers used the Altair HyperWorks™ suite and biomechanical models to optimize the structural shape.

When developing airplane seats, several key factors such as ergonomics, cabin layout, and eco-design have to be taken into account. In addition to these wanted to consider environmental issues and has put eco-design and light-weighting at the forefront of its product development plans. One of the reasons for this initiative is that lighter seats help to reduce an aircraft's fuel consumption. In addition to being lighter, the seats predominantly are produced using recyclable materials.

To further improve the quality and comfort for aircraft passengers Zodiac Seats used numerical simulation and the Altair HyperWorks™ suite to design, evaluate and optimize the seats. This enabled the designers at ZSFR to evaluate the behavior of their seat structures under static and dynamic stress as well as the feasibility of thermal molding and stamping the seat components.

Comfort is Key

With world-renowned expertise in business class, Safran Seats (formerly ZSFR) designs, certifies and assembles innovative, customizable and high-added-value products. The division draws on a strong international presence and provides its expertise to customers from all markets. Employing several teams of designers,

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Safran Seats Customer Story

"At our Research and Technologies departments, we use Altair software every day to evaluate the structure of our seats under static and dynamic loads and to assess the feasibility to use thermal molding and stamping within the manufacturing of the seat components. In the future, we will also employ Altair software for the optimization of foam thickness, characteristics, and weight to further optimize the seat architecture while still keeping the comfort criteria in mind"

Jeremy Cailleteau
R&D Engineer
Safran Seats

their products offer state-of-the-art design that incorporates high-tech equipment and reflects the determination to find solutions to three fundamental challenges of the seat market:

- Continuous improvement in passenger seat comfort and ergonomics
- Offering differentiation to its airline company customers with customizable products
- Ongoing research to optimize the available cabin space

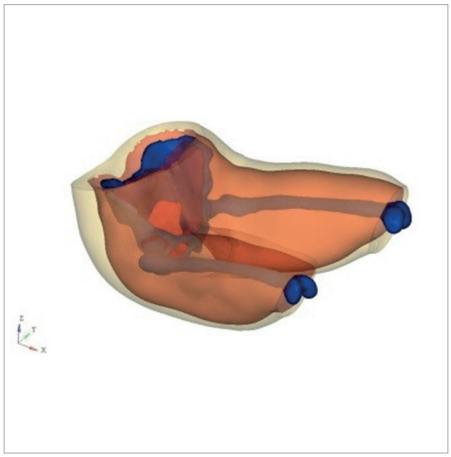
Improving Seat Ergonomics to Reduce Passenger Discomfort

A major concern for the company is the optimization of the comfort of aircraft passengers. In addition, the airplane seat market is highly competitive and new; high-quality seats have to be brought to market as quickly as possible. To assess the ergonomic quality of a seat, the engineers needed a tool with which they could simulate all biomechanical discomfort sources for factors such as internal thighs soft tissue compression for a seated passenger.

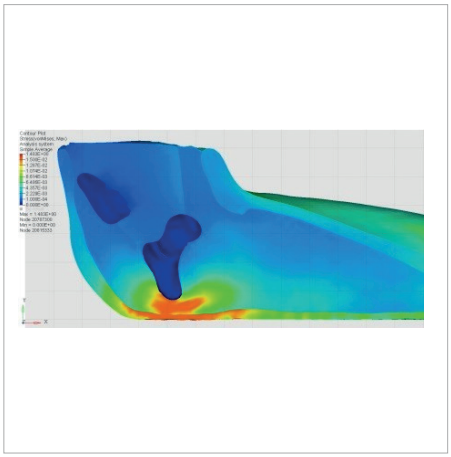
Evaluating the Seat Design with Biomechanical Models

Numerical simulation to evaluate seat designs is a good approach to introduce a fast and efficient optimization process for factors such as internal thighs soft tissue compression for a seated passenger. Designers relied on the Altair HyperWorks suite to simulate the biomechanical factors. Soft tissue compression, the factor under investigation, can be estimated by applying two parameters: the external contact pressure and the direct tissue strain. To handle this simulation engineers created two kinds of models with which they could estimate each of the discomfort factors. By employing the Altair solutions and incorporating the relation between simulation outputs and the several discomfort factors, the tool was able to deliver a quantification of the ergonomic quality. With these results and insights,the engineers were able to optimize the seat design and material,

Model shape evolution with BMI

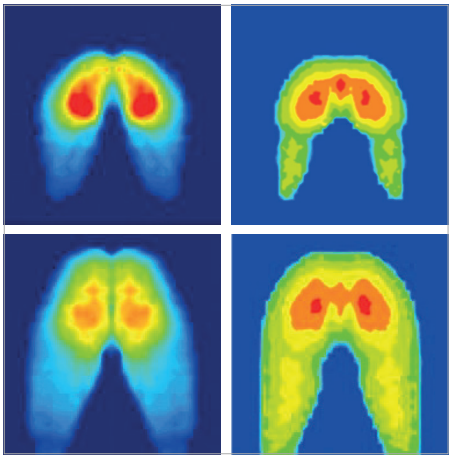


Biomechanical human model of the lower body

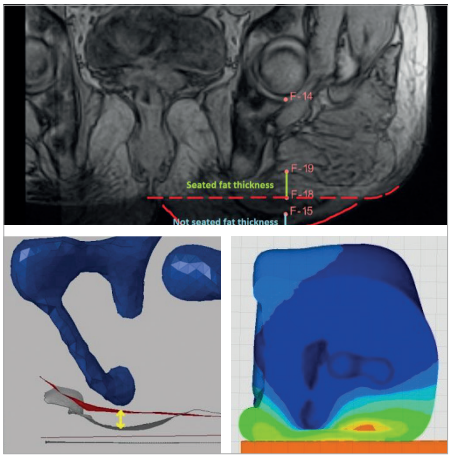


Simulation results included the soft tissue compression, estimated by the external contact pressure and the direct tissue strain

Experiment with motion capture



Comparison of measured (left) and simulated (right) pressure for two subjects



A detailed model of a 50th percentile male has been built from MRI images

hence the potential discomfort of the passengers sitting in these seats could be reduced. In summary, the models created with the Altair HyperWorks suite enabled the engineers to evaluate the structural behavior and gain valuable insights for the following topics:

- Creation of a general model to estimate the contact pressure
- A parametric model of a human, containing the bones and soft tissue structure of the pelvic-thigh area was developed from statistical shape analysis.

The database of the model was created using scan data of 36 people. Thanks to this approach, any anthropometry can be simulated to receive the seat contact pressure and make a first assessment of the seat's ergonomics.

Detailed Model for Internal Strain Estimation

A detailed model of a 50th percentile male has been built from MRI images. This model contains the accurate anatomy of all muscular and fat tissues. With this model, the internal strain in the different tissue layers can be approximated giving an estimation of loads applied to the tissue.

Contact Pressure Validation

The parametric model has been validated by comparing seat pressure and experimentally measured seat pressure on a set of 12 people. This was simulated with Altair Radioss™ solver. With this model, it was possible to predict the contact pressure with a mean error of the estimated maximal pressure of 16% over the 12 subjects.

Strain Validation with MRI

The detailed model has been validated by comparing the soft tissue strain simulated and measured with MRI. The strain has been measured for different load cases and several locations. The model provided a good approach to simulate the strain when sitting, with error rates lower than 19%.

Faster Development Thanks to Deeper Insights

Using the Altair HyperWorks Suite of products, formerly known Zodiac Seats was able to gain deep insight into various fields of interest, such as contact pressure or structural strain. In particular, Altair software enabled the design team to evaluate the overall behavior of the seat structure under static and dynamic stress as well as thermal molding and stamping feasibility. Furthermore, by developing biomechanical models with Altair HyperWorks, they were able to achieve a mean error of the estimated maximal pressure of 16% and an internal strain estimated with an error lower than 19%. In addition to providing deeper insights, numerical simulation helped the engineers to resolve development issues quickly and efficiently. Due to their high-level of satisfaction with the results, Safran Seats will continue to employ Altair tools in the future to optimize foam thickness, characteristics, and weight to further improve the comfort of aircraft passenger seats. Increasing the use of simulation, in particular, the Altair HyperWorks Suite, will lead their engineers to faster development and hence to a shorter time to market.

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About Altair (Nasdaq: ALTR)

Altair transforms design and decision making by applying simulation, machine learning and optimization throughout product lifecycles. Our broad portfolio of simulation technology and patented units-based software licensing model enable Simulation-Driven Innovation™ for our customers. With more than 2,000 employees, Altair is headquartered in Troy, Michigan, USA and operates 81 offices throughout 25 countries. Altair serves more than 5,000 customers across broad industry segments.

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About Altair HyperWorks™

HyperWorks is the most comprehensive open-architecture simulation platform, offering technologies to design and optimize high performance, efficient and innovative products. HyperWorks includes modeling, analysis and optimization for structures, fluids, multi-body dynamics, electromagnetics and antenna placement, model-based development, and multiphysics. Users have full access to a wide suite of design, engineering, visualization, and data management solutions from Altair and its technology partners.

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