

Predicting & Eliminating Squeak & Rattle Noise at FIAT



Key Highlights

Industry
Automotive

Challenge
Accurately simulate squeak and rattle noise in a passenger car

Altair Solution
Deployment and ramp up of Altair's Squeak & Rattle Director

Benefits

- Accelerated development time
- Improved product quality

FIAT is one of the world's largest vehicle manufacturers with operations around the globe and a history going back as far as 1899. Although the company is based in Italy, FIAT has invested in the South American market for many years, building engineering and manufacturing facilities in several countries in the continent. FIAT's Belo Horizonte facility in Brazil houses an experienced engineering team which is responsible for the development of region specific vehicles. Part of this responsibility includes the study of noise, vibration and harshness (NVH) in the vehicles and the effect this has on the ride quality of the FIAT range.

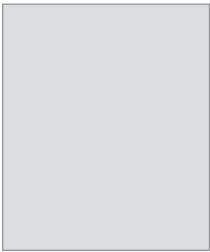
Squeak and Rattle are two phenomena which occur when two parts of an assembly are in relative motion due to a specific

excitation load. When two parts are initially separated by a gap but rapidly come into contact with each other, a rattling noise is created. On the other hand, a squeak noise might be heard when two parts are initially in contact and a sufficiently large relative displacement is caused at the interface between them.

Challenge: Predict Squeak & Rattle Noise Before Physical Hardware

For car makers, squeak and rattle phenomena represent a significant problem as many customers will interpret the noise as a general lack of quality in the product. The industry is therefore eager to better understand and predict these phenomena so interior noise can be reduced and ride quality can be improved.

FIAT Success Story



"The Squeak & Rattle Director allows us to input different data, like design and manufacturing tolerances, in order to improve the output of our analysis and therefore have more valuable inputs to the project."

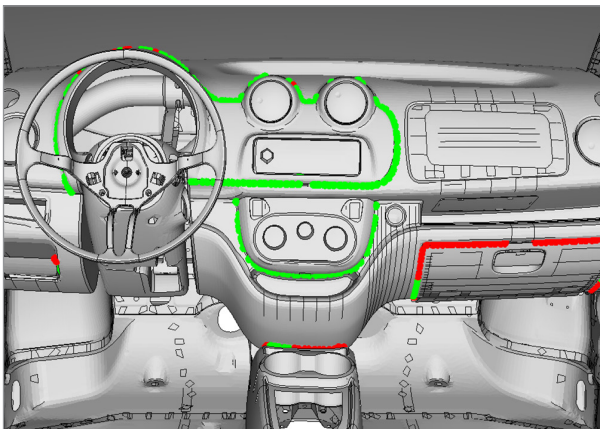
Tiago Simao
Senior CAE Engineer – Chassis & NVH
FIAT Brazil

FIAT have studied the potential for squeak and rattle noise in its vehicles for many years but previously this was only achieved by testing physical components that were produced using near final designs. If any noise issues were discovered, the team could only apply quick fixes to solve them which could be a time consuming and often very costly exercise. Utilizing a simulation approach, where interior noise is analyzed ahead of physical testing, can reduce the need for fixes late in the development process.

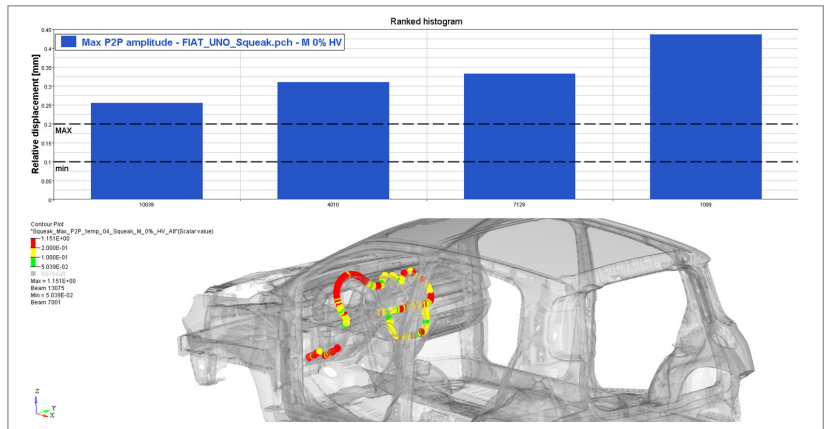
In an effort to reduce development time and minimize these additional correction costs, FIAT's NVH Department wanted to explore the potential of studying squeak and rattle during the virtual design stage. FIAT's NVH experts were looking for a simulation based methodology that was implemented inside a tool which they could build a new design process around. The solution had to enable fast, robust and flexible pre- and post-processing, with significant customization capabilities.

Solution: Apply Simulation Technology to Identify Risk Areas

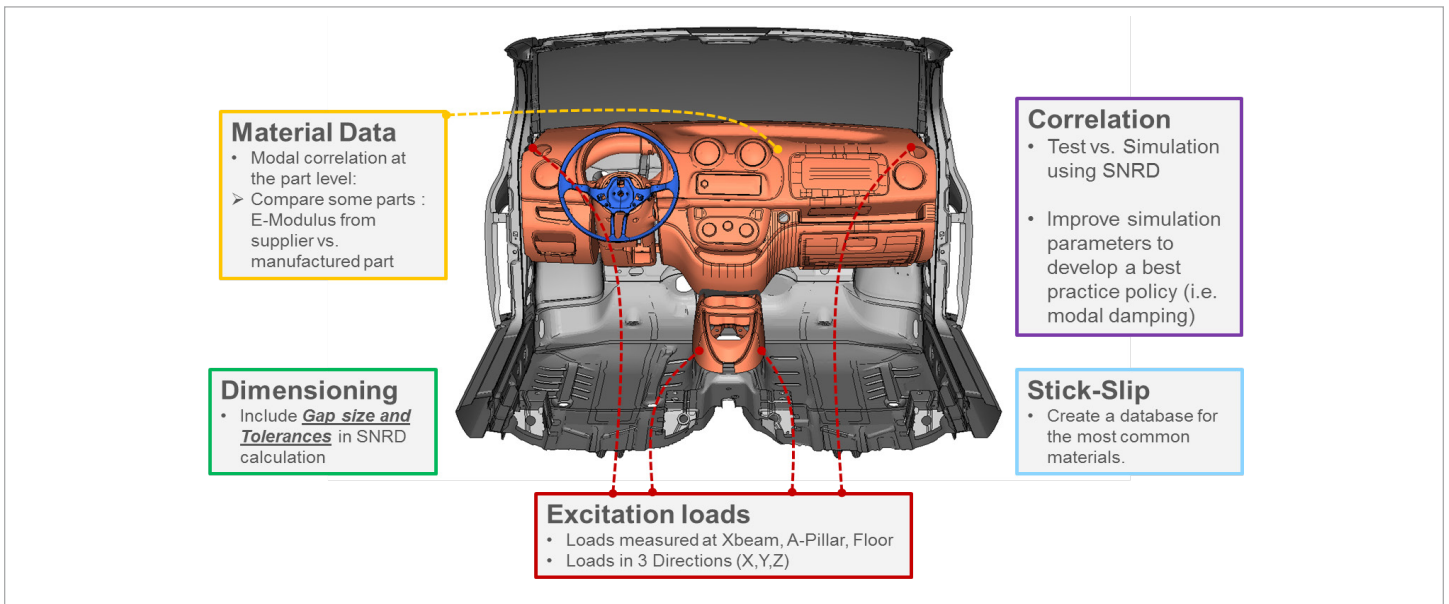
Tiago Simao, CAE NVH expert at FIAT and his team, chose Altair ProductDesign a partner to perform a pilot project to investigate squeak and rattle. The project focused on studying issues on the FIAT UNO, a vehicle made exclusively for the South American market. To perform the project, Altair ProductDesign worked with FIAT's NVH group to implement Altair's Squeak and Rattle Director (SNRD).



Risk analysis of Rattle occurrence using information about nominal gaps and tolerances



Risk analysis of Squeak occurrence using Stick Slip data for each pair of materials



From Verification to Prediction - FIAT improves the inputs for the simulation process

The SNRD is a comprehensive set of software automations that rapidly identify and analyze design alternatives to eliminate the root causes of squeak and rattle in assemblies. With customization from the Altair ProductDesign team, the solution provides a semi-automated approach to determine relative component displacements in the time domain that can lead to undesired noise.

A four day workshop and training sessions were held onsite at FIAT's Belo Horizonte site by Altair Domain Expert, Ismail Benhayoun. This dedicated session facilitated a fast ramp-up of the NVH team's knowledge of the SNRD and helped Altair to identify FIAT's specific design process that the solution could be tailored to.

SNRD enabled FIAT's NVH specialists to import linear models for their pre-existing vehicle range, including the UNO, and correlate the simulation results with the known physical test data. FIAT's test engineers were then able to assist the CAE

analysts and design teams by performing A2B comparisons between the existing models and those evaluated with the SNRD. By understanding the performance of the new concepts and quantitatively comparing those to correlated models and/or to different variants, the engineers could be more confident in their design decisions.

Results: Improved Efficiency & Product Quality

FIAT's NVH team is now routinely using the SNRD in its simulation loops with a focus on improving the performance for each system and studying the interfaces between them. The solution allows the team to identify the risk areas for squeak and rattle, and understand the effect of various deviations that could result from the manufactured parts through sensitivity studies. For example, the effect of different material properties, tolerance chains, and different road loads.

SNRD delivers valuable input for designers by enabling them to find better attachments

and boundary conditions for their parts, as well as driving the choice of materials. FIAT's NVH experts are now able to quickly and accurately study the potential for squeak and rattle phenomena to occur in their vehicles earlier in the development process. Once identified, these issues can be addressed and removed from the final design before physical hardware is produced. This in turn leads to significant cost and time savings.

"Altair's Squeak and Rattle Director is intuitive to use as a tool despite the complex computations that are performed in the background," said Tiago Simao, Senior CAE Engineer – Chassis & NVH at FIAT Brazil. "SNRD allows us to input different data, like design and manufacturing tolerances, in order to improve the output of our analysis and therefore have more valuable inputs to the project. Altair is continuously developing this solution and new features are to be implemented, which will improve our simulation capabilities and overall process."

Visit the Altair ProductDesign library of
Success Stories
at www.altairproductdesign.com

About Altair

Altair empowers client innovation and decision-making through technology that optimizes the analysis, management and visualization of business and engineering information. Privately held with more than 2,000 employees, Altair has offices throughout North America, South America, Europe and Asia/Pacific. With a 29-year-plus track record for high-end software and consulting services for engineering, computing and enterprise analytics, Altair consistently delivers a competitive advantage to customers in a broad range of industries. Altair has more than 5,000 corporate clients representing the automotive, aerospace, government and defense, and consumer products verticals. Altair also has a growing client presence in the electronics, architecture engineering and construction, and energy markets.

About Altair ProductDesign

Altair ProductDesign is a global, multi-disciplinary product development consultancy of more than 700 designers, engineers, scientists, and creative thinkers. As a wholly owned subsidiary of Altair Engineering Inc., this organization is best known for its market leadership in combining its engineering expertise with computer aided engineering (CAE) technology to deliver innovation and automate processes. Altair ProductDesign utilizes proprietary simulation and optimization technologies (such as Altair HyperWorks) to help clients bring innovative, profitable products to market on a tighter, more efficient time-scale.

www.altairproductdesign.com

About HyperWorks

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

www.altairhyperworks.com



Altair Engineering, Inc., World Headquarters: 1820 E. Big Beaver Rd., Troy, MI 48083-2031 USA
Phone: +1.248.614.2400 • Fax: +1.248.614.2411 • www.altair.com • info@altair.com

Altair®, HyperWorks®, RADIOSS™, HyperMesh®, BatchMesher™, HyperView®, HyperCrash™, HyperGraph®, HyperGraph®3D, HyperView Player®, OptiStruct®, HyperStudy®, HyperStudy®DSS, MotionView®, MotionSolve™, Altair Data Manager™, HyperWorks Process Manager™, HyperForm®, HyperXtrude®, GridWorks™, PBS Professional®, and e-Compute™ are trademarks of Altair Engineering, Inc. All other trademarks or servicemarks are the property of their respective owners.