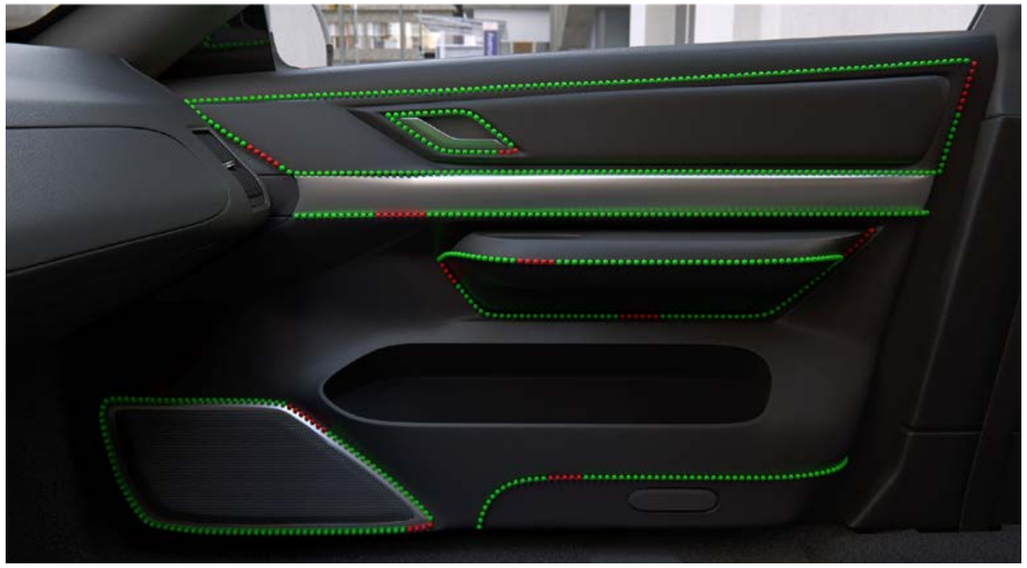
THE HIDDEN CHALLENGES OF A FANTASTIC "IN-CAR" SOUND EXPERIENCE…

Speaker systems are practically mandatory in automobiles today as they are a big part of the modern features that resonate with quality, user experience and luxury.



In today's development process, OEMs and Tiers tend to work together in defining the right specification for their speaker systems to be integrated into car instrument panels and doors. For an optimum integration with less issues, systems are tested alone and during integration to work out the right power outputs, acoustic performances, and mechanical properties. This process is made much more efficient using multiphysics simulation to predict the behavior of a loudspeaker.

Take the case of a speaker in the passenger door of a car. It is important to ensure that the vibroacoustic and structural loads induced by a wide range of operating modes will not damage the door trim structure.

To do so, analysts can simulate the soundtracks through structural dynamics (Figure 1) and electromagnetics (Figures 2) to extract all the assessment criteria required: forces at attachment points, deformations, stresses.

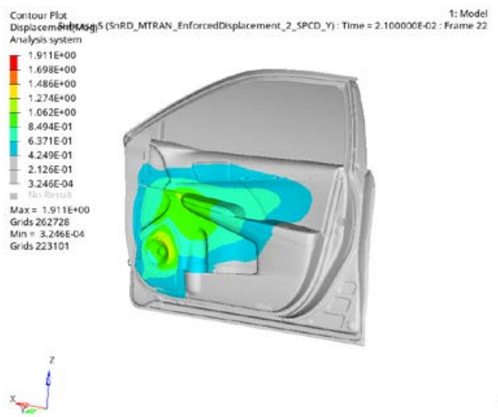


Figure 1 Structural Response on Interior Trim Panels caused by Excitation of Speaker.

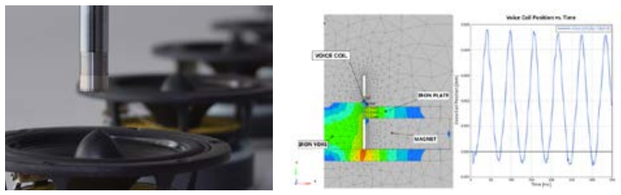


Figure 2 Replicating a Physical Test of a Speaker through an Electromagnetic Simulation of a 2D model to Extract Position of Voice Coil vs Time used as Load for the Structural Vibration Simulation

Ensuring structural integrity is not the only challenge. Perceived quality is becoming a more dominant force dictating design and feature choices. The interior design, cabin noise as well as sound quality are key elements in the driver's overall experience. Most of these are addressed in the noise, vibration and harshness (NVH) domain. While most is subjective, many can be objectivized and measured. An example is the annoying issues we all can relate to: buzz, squeak, and rattles (BSR). It is one of the main reasons for car owner dissatisfaction and high warranty costs.

While BSR is mainly caused by poor road/driving conditions, a poorly integrated sound system can also trigger these issues and will drastically affect the sound quality.

Altair helps designers and engineers detect sound-system problems before any prototype is built. Using Altair's tools, different speaker designs can be simulated in their final environment. In addition to evaluating the structural integrity of the assembly, analysts can also assess the BSR performance for multiple scenarios, including blasting music from the speakers while driving.

The root cause for squeak and rattle is a relative motion between two parts along an interface. Risks can be objectively quantified by tracking this relative motion over time and referencing it to nominal physical data, such as gap, dimension, and tolerance data (GD&T), and stick-slip properties for material pairs. Altair's solution does not only detect BSR issues, it also easily identifies the root cause and utilizes structural optimization to find a solution all within a streamlined, automated workflow.

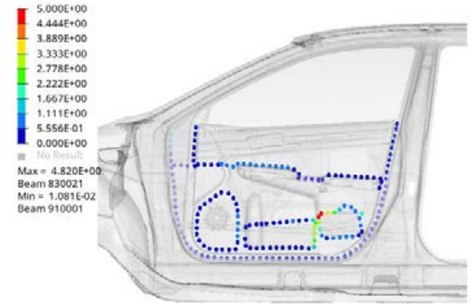


Figure 3 Relative Displacement along Interfaces while Driving.

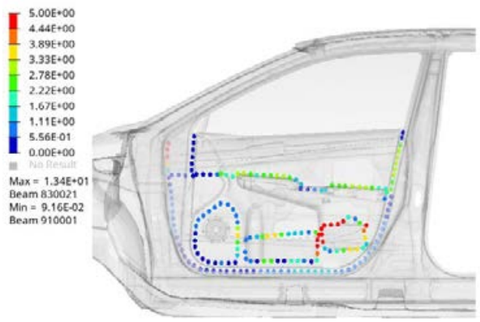


Figure 4 Relative Displacements along Interfaces while Driving and Listening to Music

In vibroacoustic analysis, sound pressure levels are evaluated to assess the acoustic performance and how it is being affected by squeak and rattle. Figure 6 shows the effect a rattle has on the sound pressure level, i.e. directly affecting the sound quality.

As a rattle between parts of a speaker only occurs when the speaker is operational, detecting sound that will interfere with the undesired noise is practically impossible to replicate and evaluate without simulation.

Simulation does not only replace costly physical testing, it enables many different scenarios to be explored easily to meet challenges never thought possible while constantly pushing limits to achieve optimal designs.

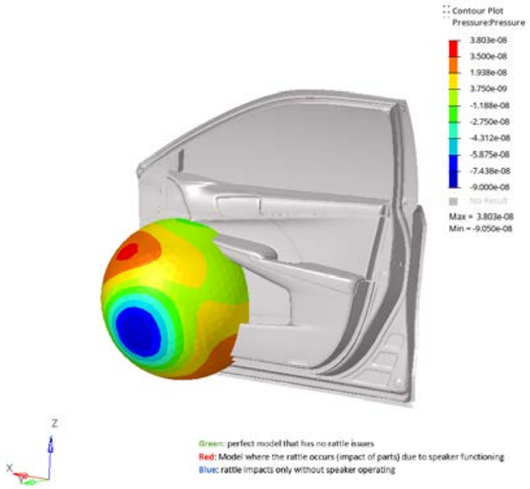


Figure 5 Vibroacoustic Simulation of a Door-mounted Speaker

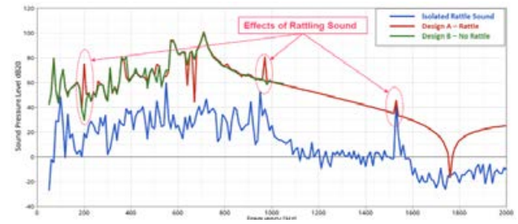


Figure 6 Sound Pressure Levels of Speaker with and without Consideration of Rattle Issues

To learn how Altair technologies can help attain the best combination of sound, vibration, and perceived quality performance, visit:
https://www.altair.com/squeak-and-rattle-director-applications/

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