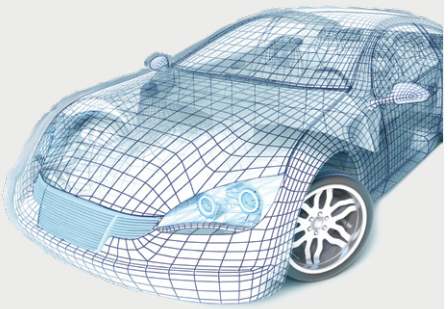
SOLUTION BRIEF

Acoustic Simulation for Seal Components

Modeling & Simulating Transmission Loss



Design Challenge

In the automotive industry, seal components are extensively used in applications such as between different structures or inside the car main body. Seals can play an important role in the acoustic performance of complex systems for several reasons:

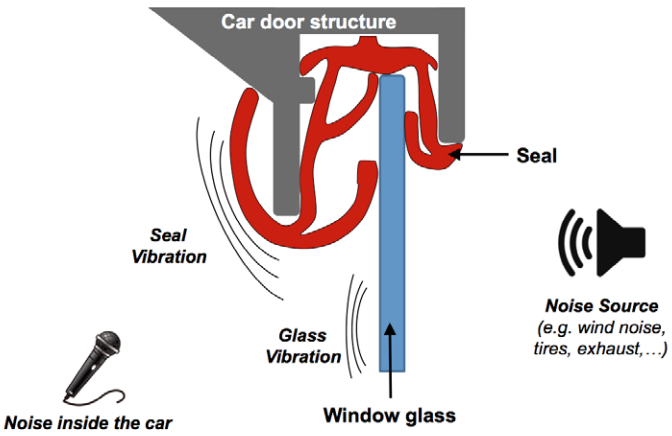
- Seals can be the most efficient propagation path between an exterior noise source and the interior car environment (e.g. above 1-2 kHz). As a consequence, the performance of the seal will drive the global acoustic performance of the door.
- Seals supporting the side windows are the key component controlling the damping at the critical (a.k.a. coincidence) frequency of the glass panel.
- Seals adequately located and designed allow control of the acoustic propagation and the acoustic resonance inside the car pillars.

Workflow and FEA Interoperability

MSC's nonlinear simulation solution, Marc, can compute the large displacement of a seal due to the door or window closing event, or due to the seal installation. Based on this deformed shape, Actran can accurately compute the acoustic propagation through the seal (by assuming the surrounding structures rigid) or through the complete system (e.g. seal and window). Multiple excitations can be used, such as a diffuse sound field, a set of acoustic wave superposition as well sources from the exhaust, the powertrain or the side mirror aeroacoustics. The output of the analysis can be the Transmission Loss indicator or any other acoustic quantifier. Through these outputs, the acoustic performance of different seal designs can be investigated and ranked.

Excitations

- Random Excitations such as a Diffuse Sound Field
- Any external excitation:
  - Exhaust
  - Powertrain
  - Aeroacoustics
- Acoustic Excitations:
  - Plane waves
  - Monopoles



Key Software Features

- Acoustic Finite Elements for cavity and exterior acoustics modeling
- Acoustic Infinite Elements or Adaptive Perfectly Match Layers (APML) for modeling the far field anechoic condition
- Structure elements library: solids, shells, composites, laminated structures, membranes, beams, springs, rigid connections, etc.
- Poro-elastic element library based on the BIOT theory for modeling bulk reacting materials
- Nastran to Actran translator (NAS2ACT) to convert Nastran structure models into Actran models
- Import of structure modes calculated by Nastran
- Acoustic dissipation mechanisms such as visco-thermal losses, acoustic absorption
- Random excitations on structure including diffuse sound field, turbulent boundary layer and more
- Plane, spherical and cylindrical wave sources
- Acoustic pressure, velocity and admittance boundary conditions
- Mechanical and kinematic excitations
- Full support of non-congruent meshes
- MUMPS and Krylov solvers for fast frequency response analysis
- Rich post-processing capabilities: frequency response plots, maps, sound directivity, directive microphones, animations and more.

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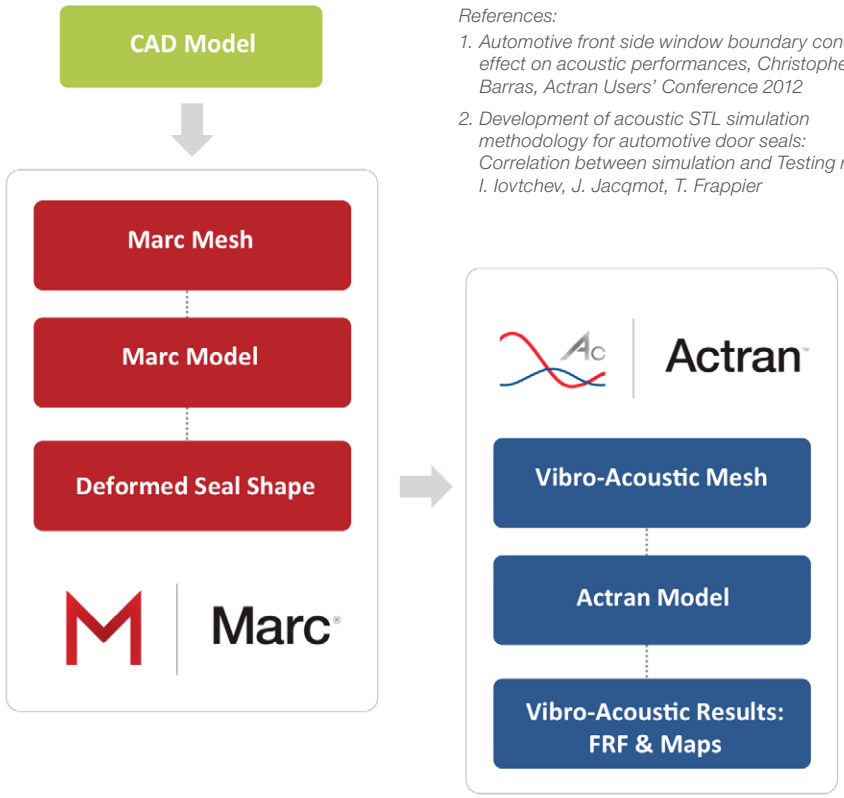
System Response Analysis

Actran outputs all the required quantities to perform a complete analysis of the system response:

- Acoustic performance in terms of Transmission Loss index
- Power balance statements: incident, radiated and dissipated power
- Acoustic pressure in the near and far field
- Structural displacement

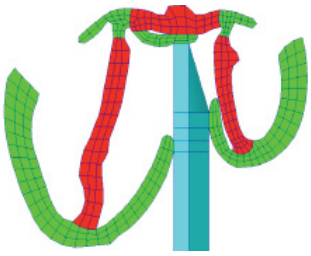
Trusted Solution for the Seal Industry

Actran is a commercial finite element code designed specifically for simulating acoustics, vibro-acoustics and aero-acoustics. It can be used to accurately model structural vibrations, fluid-structure interactions, and turbulence noise propagation. Actran has been relied upon by engineers for 18 years and is used by more than 350 companies and research institutions around the world.

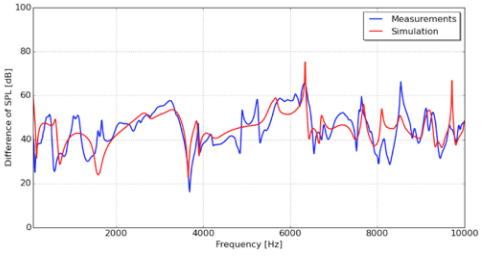


References:

1. *Automotive front side window boundary conditions effect on acoustic performances, Christophe Barras, Actran Users' Conference 2012*
2. *Development of acoustic STL simulation methodology for automotive door seals: Correlation between simulation and Testing results, I. Iovtchev, J. Jacqmot, T. Frappier*



Seal deformation due to the glass, image courtesy of Hutchinson [1]



Correlation between Acoustic Simulation and Measurements. Image courtesy of Cooper Standard [2]

Actran Software Suite

Actran is a complete acoustic, vibro-acoustic and aero-acoustic CAE software suite. Empowered by the technologies of finite/infinite element methods (FE/IFE), as well as the Discontinuous Galerkin Method (DGM), Actran provides a rich library of materials, elements, boundary conditions, solution schemes and solvers. Actran is a high accuracy, high performance and high productivity modeling tool suiting the needs of the most demanding engineers, researchers, teachers and students for solving the most challenging acoustic problems.

Free Field Technologies (FFT)

Free Field Technologies is focused on three main areas:

- Developing Actran software for acoustic, aero-acoustic and vibro-acoustic simulation;
- Providing technical services, support, training and delivering acoustic engineering projects;
- Researching innovative technologies and methods of acoustic analysis in order to remain the leader in acoustic modeling.

Free Field Technologies has more than 350 customers around the world active in the Automotive, Aerospace, Shipbuilding, Electronic and Heavy Equipment industries as well as in the Educational and Research sectors.

FFT is a wholly owned subsidiary of MSC Software Corporation.

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