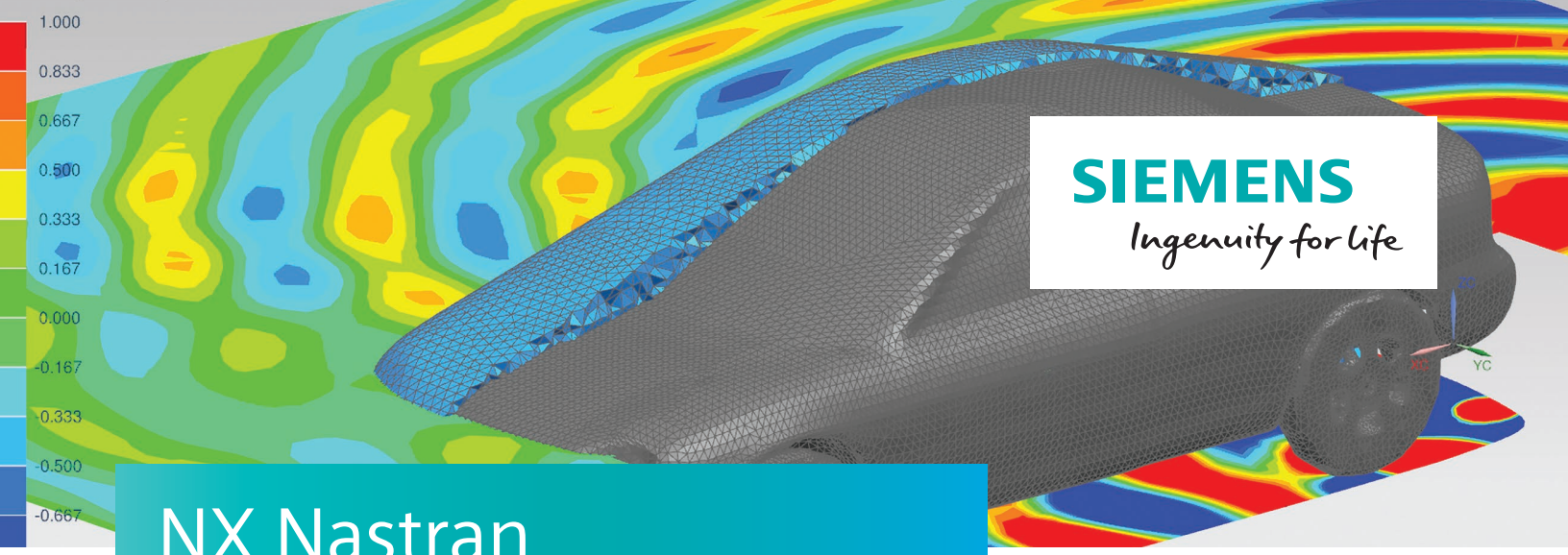


NX Nastran Advanced Acoustics

Enabling weakly and fully coupled vibro-acoustic simulations

Benefits

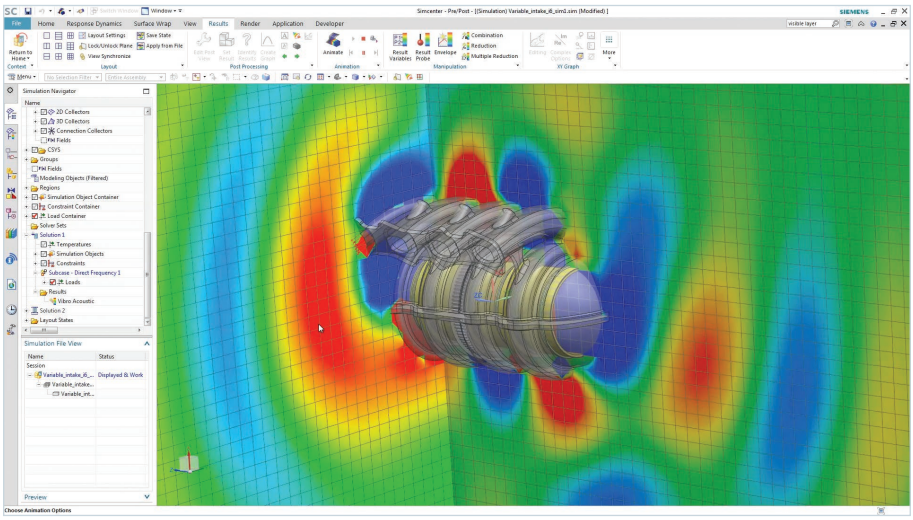
- Perform both weakly and fully coupled vibro-acoustic simulations
- Simulate acoustic problems faster and more efficiently with the next generation FEMAO solver
- Simulate acoustic performance for interior, exterior or mixed interior-exterior problems
- Correctly apply anechoic (perfectly absorbing, without reflection) boundary conditions
- Include porous (rigid and limp elastic frames) trim materials in both acoustic and vibro-acoustic analysis
- Request results of isolated grid or microphone points at any location
- Define infinite planes to simulate acoustic radiation from vibrating structures in the vicinity of reflecting ground and wall surfaces

Summary

NX™ Nastran® software Advanced Acoustics module extends the capabilities of NX Nastran for simulating exterior noise propagation from a vibrating surface using embedded automatically matched layer (AML) technology. NX Nastran is part of the Simcenter™ portfolio of simulation tools, and is used to solve structural, dynamics and acoustics simulation problems. The NX Nastran Advanced Acoustics module enables fully coupled vibro-acoustic analysis of both interior and exterior acoustic problems in NX Nastran.

NX Nastran Advanced Acoustics AML technology facilitates efficient modeling of the exterior acoustic domain.

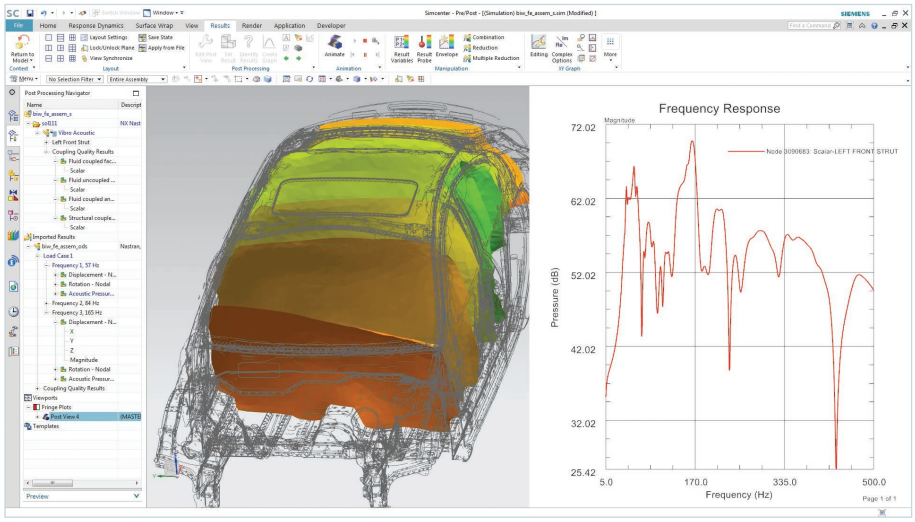
In addition to applying a dedicated radiation boundary condition, analyzing an exterior radiation problem requires predicting acoustic results at locations exterior to the finite element (FE) domain. With AML, NX Nastran supports the calculation of results on microphone meshes outside the meshed fluid. AML can also be used as anechoic boundary condition to represent a nonreflective termination of ducts, often used in the context of duct transmission loss analysis. It also supports panel transmission loss analysis, in which it is used to represent unbounded fluids on both sides of a structural panel.



NX Nastran Advanced Acoustics

In addition to AML technology, embedded in NX Nastran Advanced Acoustics is a finite element method adaptive order (FEMAO). This solver will adapt the element order of fluid elements automatically depending on each element's size, its acoustic properties and computation frequency. As such, it guarantees constant accuracy and a variable optimal model size, thereby ensuring optimal solving time for each frequency.

For modeling porous materials, which are used as acoustic absorbers for passive noise reduction, you can apply the following material models: Craggs, Delany-Bazely-Miki and Johnson-Champoux-Allard.



Nonreflecting boundary condition
Using AML technology enables you to simulate a nonreflecting boundary condition, and it is applied on the acoustic mesh outer surface (on element faces). During the solving, the AML is converted into a virtual perfectly matched layer (PML) with 3D elements for every solution frequency. In these layers, incident acoustic waves are numerically absorbed, eliminating reflection inside the computational domain.

You can use AML for exterior acoustics to model a free (unbounded) field condition. When simulating exterior noise from a vibrating component using finite elements, a limited layer of fluid elements around the structure suffices to represent the entire free field. By using AML as a radiation boundary condition on the outer boundary of this layer, you can do this effectively. The AML mimics an infinite exterior continuation of the fluid domain. This technology dramatically reduces the number of fluid degrees-of-freedom (DOF), as a fluid mesh with an AML boundary only requires a thin fluid layer that can remain close to the radiating surface to accurately simulate the free field.

AML is also suitable for duct acoustics where it can be used at a duct-end section to impose anechoic termination, making the duct acoustically infinite, which is typically required for acoustic transmission loss studies.

You can also use nonhomogeneous materials in the AML region to account for gradients in material properties. NX Nastran can also be used to accept the specifications of multiple AML boundary conditions.

Infinite planes
When the sound-radiating structure is located on a hard floor, for instance in a semi-anechoic chamber, the floor becomes a reflective boundary. Using NX Nastran enables this to be modeled as a symmetry-type rigid infinite plane.

Similarly, in underwater acoustic simulations, the water surface can be modeled as a pressure-release or zero-pressure surface. You can use an antisymmetry-type infinite plane to model such a surface. Reflections from the infinite plane are then accounted for by computing far-field results.

Microphone meshes
Microphone meshes (sometimes also referred to as field-point meshes) define the locations where acoustic results – such as acoustic pressure, velocity, intensity and acoustic power – have to be computed.

You can view results as contour plots on 2D and 3D meshes. You can use a 2D surface mesh to calculate the acoustic output power through the surface. If this one entirely surrounds the radiating structure, the resulting power equals the total radiated acoustic output power of the vibrating structure.

You can also define individual microphones in any position inside or outside the FE domain to plot acoustic pressure curves.

Acoustic loads
You can use acoustic sources and loads such as:

- Monopoles
- Dipoles
- Plane waves
- Distributed plane waves (to generate a diffuse field)
- Panel normal velocity

Transfer admittance and acoustic continuity
Using transfer admittance, you can capture acoustic transfer relation between two fluids separated by a perforated wall/sheet.

With acoustic continuity, you can connect different acoustic mesh domains;

for instance, to apply incident sources to inhomogeneous fluid models.

Rigid and limp porous material support
Porous materials such as mineral wool, glass fiber and high-porosity foams absorb sound in the pores by viscous and thermal dissipation of acoustic energy. The acoustic wave propagation in these materials requires dedicated material models. NX Nastran Advanced Acoustics supports the following:

- Craggs (rigid frame)
- Delany, Bazely and Miki (limp and rigid frames)
- Johnson, Champoux and Allard (limp and rigid frames)

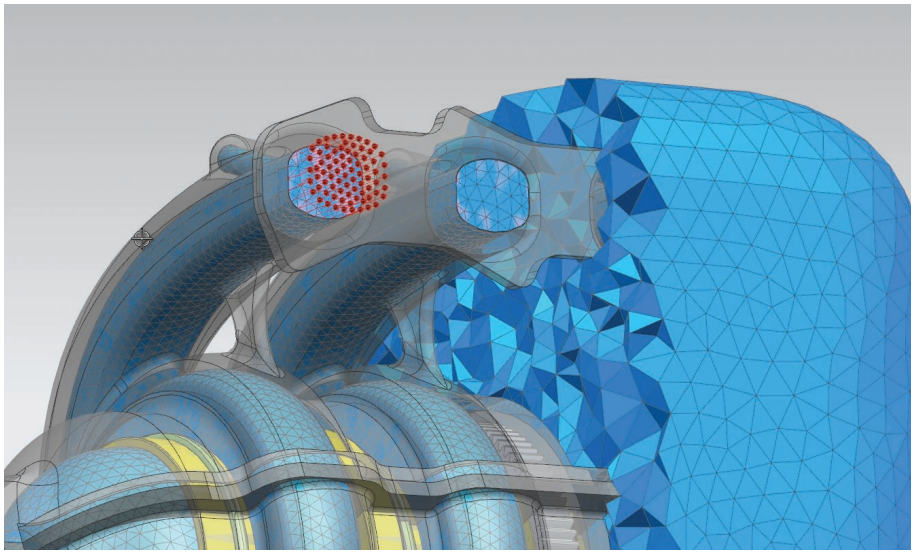
FEMAO
FEMAO is the next-generation FEM acoustic solver to support uncoupled acoustics and direct coupled (SOL108) solutions.

Using FEMAO provides faster acoustic and vibro-acoustic simulations with more control over accuracy using coarser acoustic meshes fed by high-order shape functions. The high-order shape functions used are automatically adapted by the solver. The usage of coarser meshes then leads to leaner models in pre- and postprocessing. The solution with FEMAO is two to ten times faster compared to FEM AML since FEMAO provides results that are faster at lower frequencies, and more efficient at higher frequencies.

FEMAO supports:

Acoustic loads and boundary conditions combination of

- Monopole (ACPOLE1)
- Dipole (ACPOLE2)
- Plane wave (ACPLNW)
- Panel normal velocity (ACPNVEL)



- Enforced acoustic pressure (ACPRESS)
- Admittance/impedance absorber (CAABSF/PAABSF1)
- Transfer admittance (ACTRAD/PACTRAD)
- Acoustic continuity (ACTRAD)
- Enforced displacement (SPCD)

Result types
NX Nastran Advanced Acoustics supports a variety of result types, including:

- Pressure, acoustic particle velocity and acoustic intensity at any microphone location, either inside the FE domain or exterior to the AML region
- Radiated acoustic power that can be requested on a microphone surface mesh or AML surface
- Case control output request cards to directly retrieve Transmission Loss results from NX Nastran such as INPOWER, TRPOWER and TRLOSS

Microphone locations can be referenced as response locations for panel- and modal-contribution analysis.

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