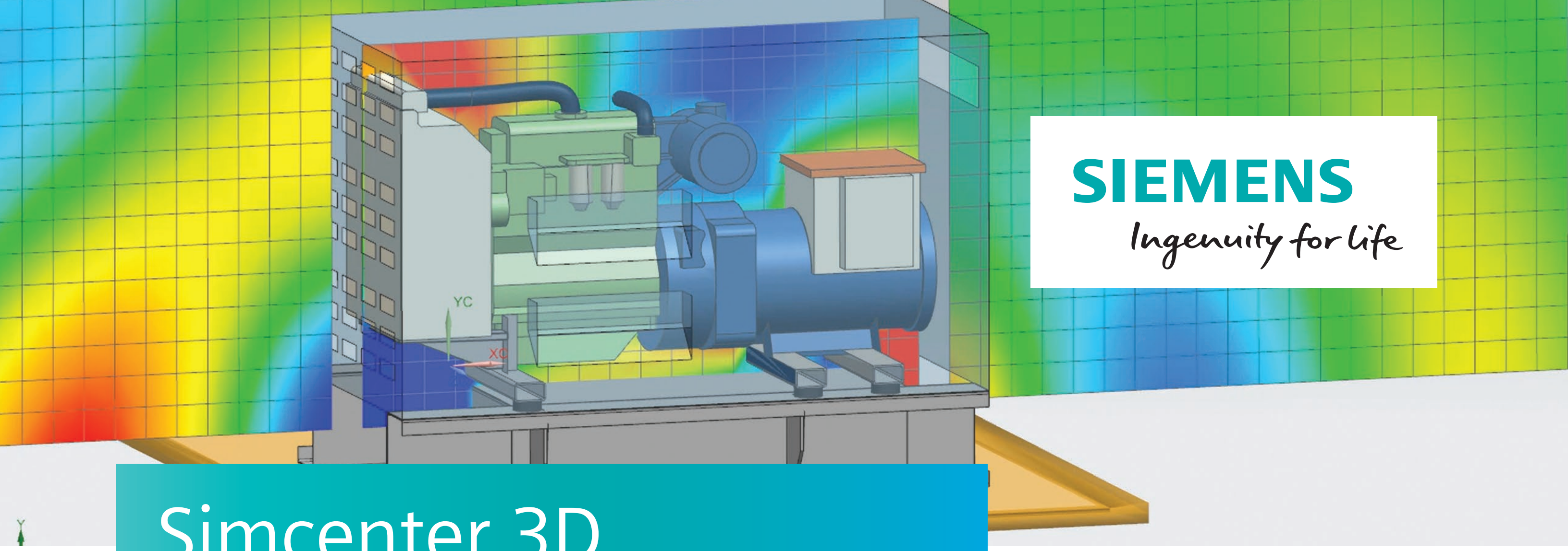

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Simcenter 3D Acoustics BEM solver

Using fast and efficient boundary element method solvers to answer acoustic issues

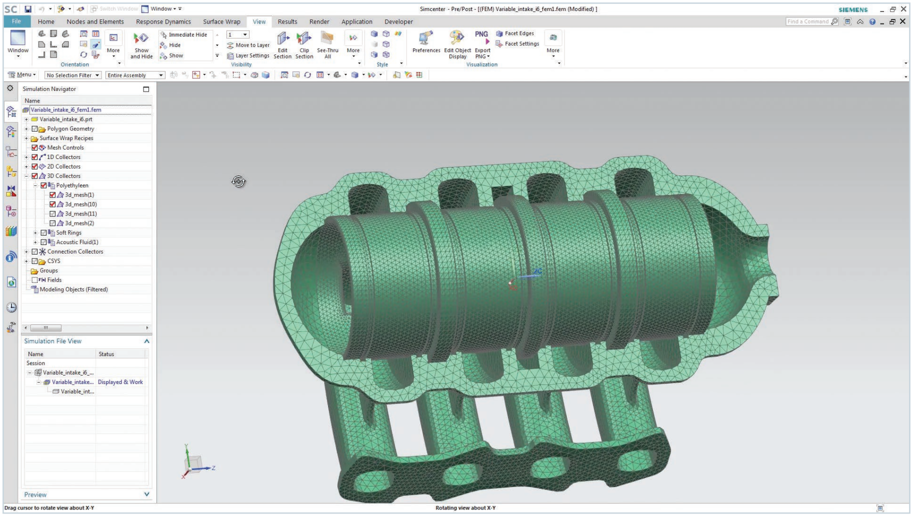
Benefits

- Solve infinite domain acoustic problems
- Use fast and efficient BEM solvers
- Choose between a direct and indirect BEM formulation
- Provide support for weakly or strongly coupled vibro-acoustics and uncoupled acoustics

Summary

The Simcenter™ 3D Acoustics boundary element method (BEM) solver enables you to predict the acoustic response in both enclosed and unbounded domains. Simcenter 3D, which is part of the Simcenter™ portfolio, only requires a mesh on the surface that surrounds the fluid domain, which results in a low number of degrees-of-freedom (DOF). The available BEM solvers automatically switch between in-core and out-of-core solutions, depending on the size of the problem and available computer resources. Acoustic BEM models can be excited by acoustic sound sources in the domain (such as acoustic monopoles, dipoles and plane waves), imposed surface velocities or surface pressures on the boundary. Acoustic damping is introduced by acoustic absorbers, represented as surface impedance on the fluid's boundary. Strong coupling of the acoustic BEM mesh with structural meshes is allowed through mode set representation of the structure. Structural vibrations can be imposed to the BEM fluid as well through weak vibro-acoustic coupling.

Acoustic damping is introduced by acoustic absorbers, represented as surface impedance on the fluid's boundary. Symmetry and anti-symmetry planes can also be applied to the model, in order to mimic large reflective surfaces for instance. This method can yield acoustic results at any microphone



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position and supports the application of panel contribution and structural modal contribution analysis to gain insight into the noise generation mechanisms. Transfer admittance relating acoustic pressures and velocities between two sides of the surface is available; for example, to represent perforated sheets and filters.

Model properties

Materials and elements

The acoustic fluid is modeled using acoustic mesh and properties, such as sound velocity and fluid density. You can define these properties using constant or frequency-dependent characteristics. The software also supports complex sound velocity; for example, by introducing damping in the acoustic fluid. The mass density for the direct acoustic BEM method can be a complex number.

The acoustic mesh consists of linear or parabolic 2D shell elements (triangular and quad). Model corrections for free edges and junction edges occur automatically in the solver and do not require user action. The solver also provides the maximum frequency for which the BEM elements are valid.

Wall absorption

Absorbent walls and panels can be added to the model using constant or frequency-dependent complex surface impedance or admittance. Simcenter 3D Acoustics BEM supports discontinuous definition of impedance/admittance for indirect BEM.

Infinite planes

Up to three infinite planes parallel to the global XY, YZ or ZX plane can be added to represent a reflective ground, water surface or other infinite wall type. Both symmetric (zero velocity boundary condition) and antisymmetric (zero pressure boundary condition) are supported.

Panels

Panels can be defined on the structural model for panel contribution analysis in the postprocessing phase of vibro-acoustic analysis.

Microphones

Microphone meshes can be made of isolated nodes, 2D shell or 3D solid elements. The microphone meshes in the model setup do not contribute or influence the vibro-acoustic solution. They are merely observer probes in locations you wish to inspect acoustic results for, such as pressure, velocity, intensity, or, in the case of surface microphone meshes, the acoustic power flowing through such a surface. There are no limitations on the number of microphones or their location.

Acoustic loads

Acoustic monopoles can be defined in a complex and constant or frequency-dependent format. Monopoles can be located anywhere. Similarly, acoustic dipoles can be defined in a complex and constant or frequency-dependent format. They can also be located anywhere, and the user is able to specify the direction of the dipoles by magnitude/direction or components.

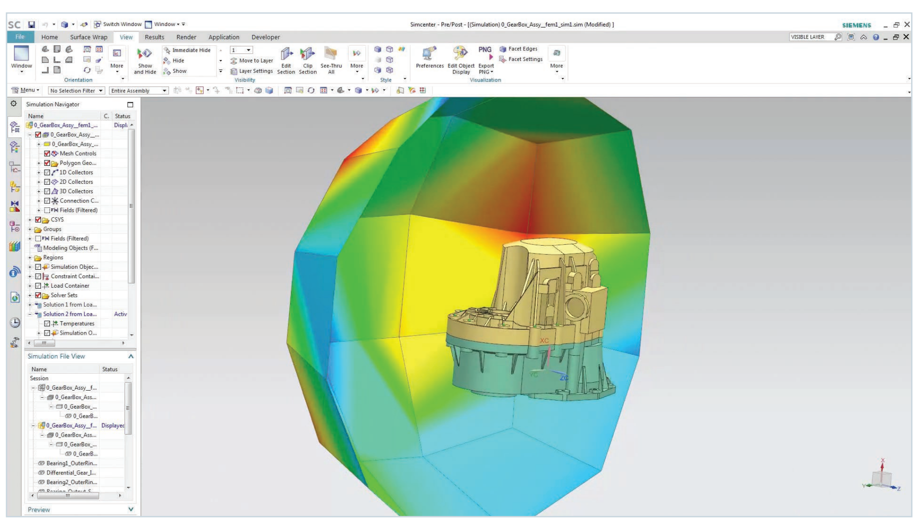
Acoustic plane waves can also be defined in a complex and constant or frequency-dependent format. Located anywhere in space, the user specifies their direction of propagation.

A diffuse field can be applied by distributed random plane wave sources as well.

Acoustic boundary conditions

Enforced acoustic pressure can be applied to elements. In case of indirect BEM, they can be applied to a single side or both sides of the element. It can be defined in a complex format, and both constant and frequency-dependent definitions are supported.

Normal acoustic velocities can be applied to the BEM model as well. These represent a structural panel velocity that is directly defined on the acoustic model. In case no surface impedance is applied to the same elements, these panel velocities equal the acoustic (particle) velocity. The panel velocity is assumed to be spatially uniform across the elements to which it is applied.



Structural boundary conditions

Indirect BEM can be used to handle spatially varying panel vibrations that are transferred from a structure to the fluid by a vibro-acoustic coupling. The vibrations can be provided as displacements, velocities or accelerations on structural elements. These can be on a structural mesh that is incompatible with the acoustic BEM mesh. The solver projects the panel vibrations on the acoustic model. Only the effect of the structure on the fluid (weak coupling) is then taken into account. To control mapping, you can define a selection of elements on both the structure and fluid side as well as a search distance. Afterwards, the quality of mapping can be evaluated from the results file.

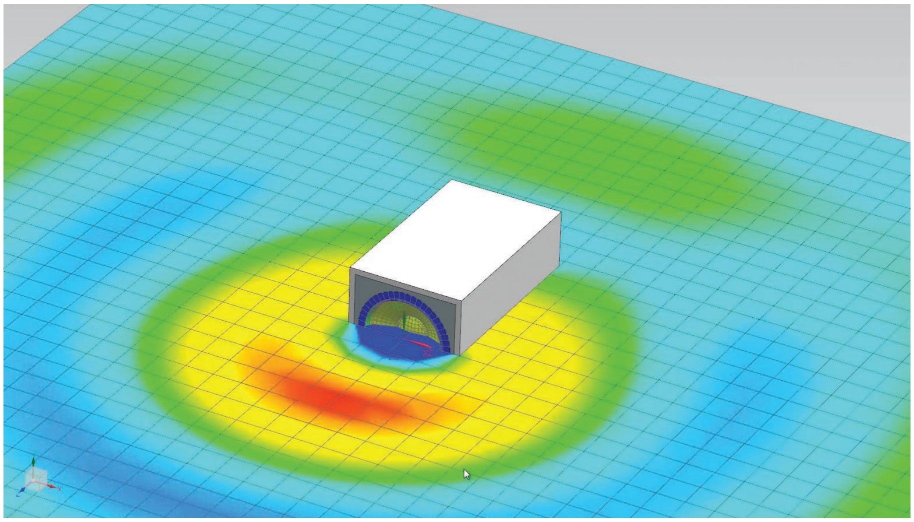
Another approach relies on mode sets: modal representations of the structural mesh allow you to excite the structure with structural force loads and couple the structure with the acoustic mesh in both a weakly and strongly coupled sense.

Solutions

Direct and indirect acoustic uncoupled solutions are supported as well as indirect vibro-acoustic, weakly-coupled and strongly-coupled solutions. If necessary, the user can easily modify the BEM integration quadrature settings. The results can be calculated on a large variety of frequency axes (linear, log, octave, one-third octave, one-twelfth octave, or individual frequencies). Multiple subcases can be defined; for instance, supporting various revolutions per minute (RPM) or multi-order analysis for rotating machinery.

Supported results in vector (SORT1) format

- Scattered or total field
- Pressure, (particle) velocity, acoustic intensity at microphone points
- Pressure, normal velocity and normal intensity on acoustic mesh (only for direct BEM)



- Structural displacement, velocity and acceleration (only for coupled indirect BEM)

Supported results in function (SORT2) format

- Scattered or total field
- Pressure at microphone points
- Panel contributions to pressure at microphone points (only for coupled indirect BEM)
- Structural modal contributions to pressure at microphone points (only for coupled indirect BEM)
- Acoustic power with a group of 2D microphone elements
- Panel contributions to acoustic power (only for coupled indirect BEM)
- Structural modal contributions to acoustic power (only for coupled indirect BEM)
- Structural displacement, velocity and acceleration (only for coupled indirect BEM)

Parallelization

- Simcenter 3D Acoustics BEM solver enables you to solve problems using up to four parallel processes
- When combined with Simcenter 3D Acoustics High Performance Computing software, the user can obtain full scalability running on multiple (more than four) central processing units (CPU) systems or clusters

Siemens PLM Software
www.siemens.com/plm

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3308

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