

PowerACOUSTICS

CONSUMERS SIMPLY DON'T WANT TO HEAR IT

J. D. Power and Associates' initial quality surveys indicate that wind noise is consistently the number one consumer complaint, directly impacting consumer brand loyalty and vehicle sales. Reducing interior noise levels to achieve occupant comfort is therefore at the forefront of acoustic engineers' concerns. A significant amount of engineering time and product cost is spent on acoustic testing and fixes to achieve the interior noise targets required for highly rated, quality competitive products.

In the past few years, great strides have been made in reducing powertrain, road, and tire noise leaving wind noise as the dominant noise source during high speed travel, and thus an increasingly important area for ground transportation acoustic engineers to address.

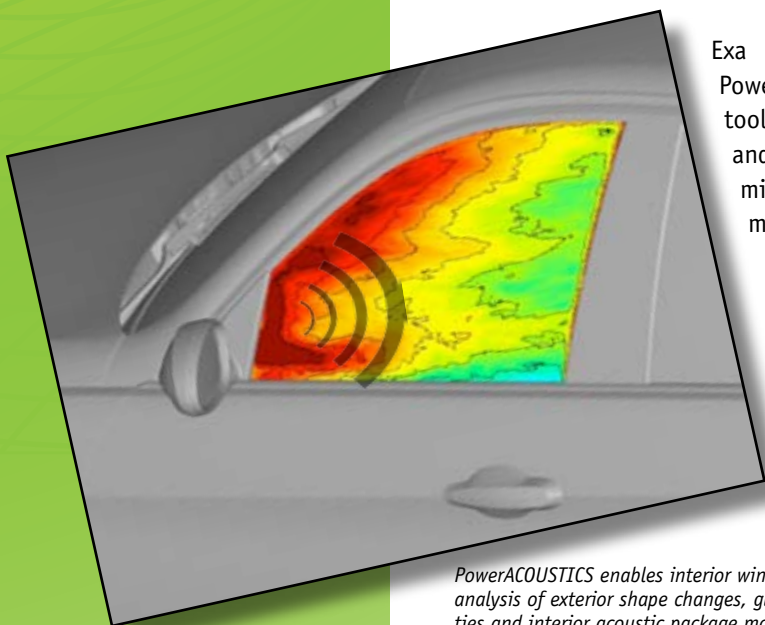
SEEING & HEARING NOISE BEFORE IT HAPPENS: A CHALLENGE

Interior noise levels are typically not assessed until late in the development process when prototypes are built. This is often too late to make significant changes to the product design—requiring late stage design re-work or sound package upgrades such as thicker and/or laminated glass, adding significant cost and weight.

Acoustics engineers face numerous challenges: acoustic wind tunnel tests are expensive, flow visualization and noise source identification are difficult, and testing is not possible until physical prototypes are available. A numerical simulation approach is highly desirable for early design assessment. However, most available numerical solvers do not provide accurate prediction of complex transient turbulent flow, required for effective acoustic simulation. Exa's unique transient and compressible flow solver technology allows engineers to simulate and visualize the flow-induced sources of noise and resulting transient pressure loading on the external surfaces.

Exa now provides a complete digital solution with PowerACOUSTICS™, the only validated interior noise prediction tool for external air flow. PowerACOUSTICS enables aeroacoustics and noise control engineers to efficiently collaborate to optimize the vehicle exterior shape and sound package design to meet interior noise targets.

PowerACOUSTICS, paired with Exa's PowerFLOW, enables accurate pressure fluctuation prediction, noise source identification, wind noise transmission to interior, and sound package parameter study capabilities—all with an extensively tested and validated solution.



PowerACOUSTICS enables interior wind noise analysis of exterior shape changes, glass properties and interior acoustic package modifications to minimize sound at an occupant's ear.

LISTEN TO YOUR SIMULATIONS

Compare design alternatives using PowerACOUSTICS' audio signal synthesis. Easily convert your SPL files from your simulation into .wav files. Isolate and evaluate data by listening to each probe location and comparing sound clips.

ASSESS WIND NOISE PERFORMANCE THROUGHOUT THE DEVELOPMENT LIFECYCLE

Exterior wind-generated pressure load data from PowerFLOW is seamlessly combined with PowerACOUSTICS' structural-acoustics solver to provide the wind noise contribution to the sound at the vehicle occupant's location. The ability to simulate interior noise early in the product development workflow enables acoustic engineers to analyze and address wind noise issues throughout the development process, from early shape design trade-off analyses through resolving issues found at final prototype testing.

EXPLORE POTENTIAL SOUND PACKAGE COST & WEIGHT SAVINGS

Rapidly evaluate the impact on interior noise of various sound package configuration options to help meet wind noise targets—at minimized cost and weight.

REDUCE DEPENDENCE ON PROTOTYPE WIND TUNNEL TESTING

PowerFLOW coupled with PowerACOUSTICS provides a digital aeroacoustic wind tunnel which is cost effective relative to test and provides enhanced capability through detailed visual insight into how design features and changes impact the noise sources. (see back cover)

RELIABLE, VALIDATED SOLUTION

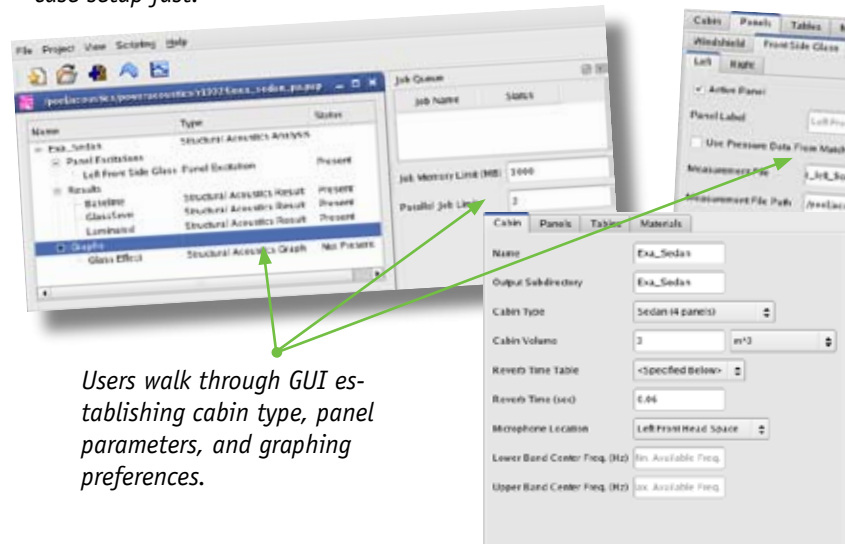
Exa's well-recognized aeroacoustics technology team has extensively validated PowerACOUSTICS predictions against experimental data, and has developed best practices embedded in application templates for ease-of-use.

INTERIOR NOISE PREDICTION EASILY INTEGRATES INTO YOUR PRODUCT DEVELOPMENT

PowerACOUSTICS seamlessly integrates into the workflow throughout the product development process. It can cooperate with aerodynamics and packaging colleagues to rank design themes, optimize interior noise, and can be used to screen shape design variables, for example, on side mirrors, thus reducing the need for wind tunnel testing, the flow visualization provided by PowerFLOW and panel contribution analysis can be implemented late in development.

PREDICT INTERIOR WIND NOISE

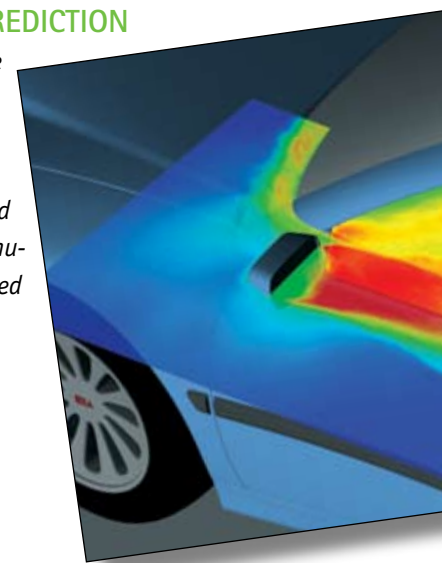
Fully embedded SEA solver makes it easy to predict noise spectra at occupant locations. The SEA solver can be generated by exterior wind pressure fluctuations. Easy to use graphical user interface allows for quick case setup fast.



Users walk through GUI establishing cabin type, panel parameters, and graphing preferences.

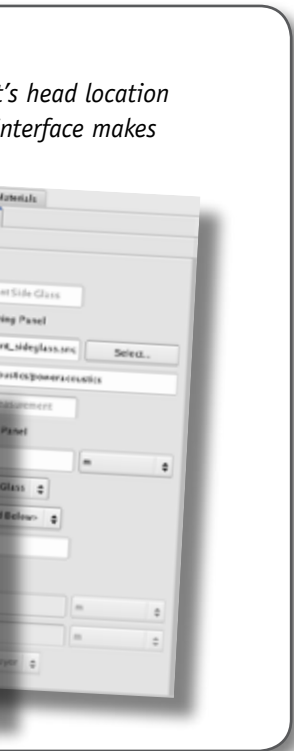
PRESSURE FLUCTUATION PREDICTION

Exa's PowerFLOW provides accurate exterior pressure fluctuations on the greenhouse panels for load input to PowerACOUSTICS. These pressure fluctuations are calculated on fully detailed geometry and simulations may also easily be performed in yawed flow conditions.



DUCT DEVELOPMENT PROCESS

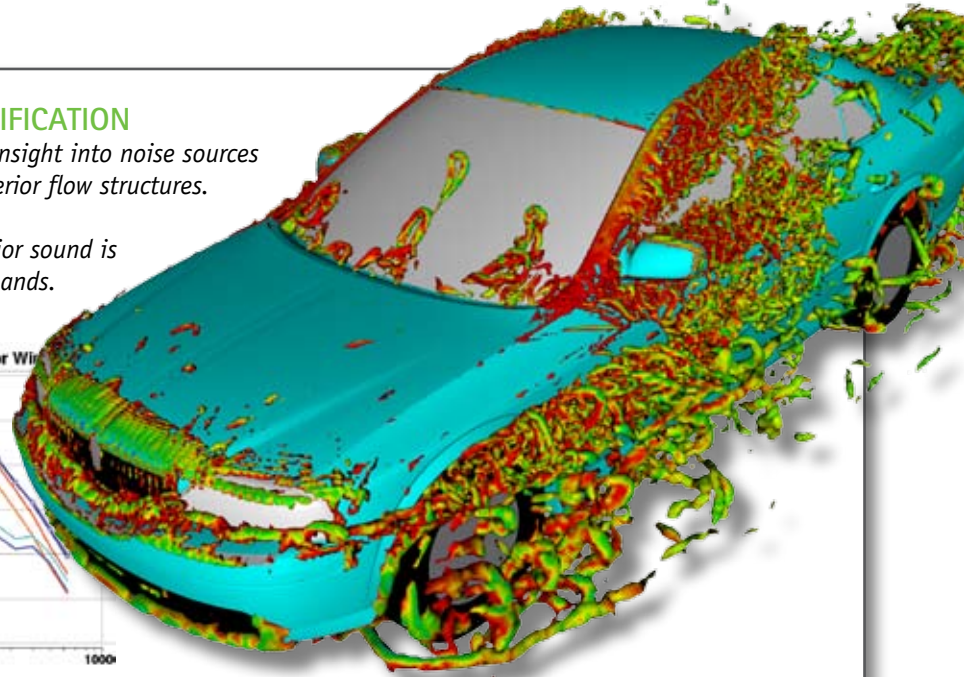
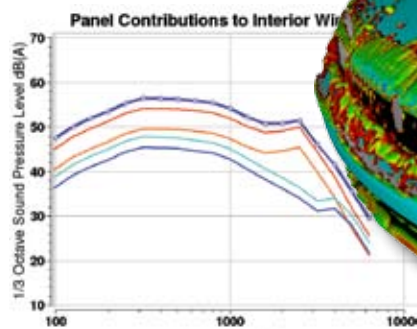
development life cycle. With the new capability to simulate interior noise during early-stage design trade-off studies, wind noise engineers can now optimize exterior shape across attributes and participate in target setting for sound package. Later in the development process, PowerACOUSTICS can reduce the amount of testing traditionally performed in aeroacoustic wind tunnels. Finally, in resolving issues that may come up during final prototype analysis from PowerACOUSTICS make it easier to understand why a particular fix is effective, raising confidence during the decision-making process



NOISE SOURCE IDENTIFICATION

PowerACOUSTICS provides insight into noise sources resulting from complex exterior flow structures.

Panel contribution to interior sound is graphed across frequency bands.



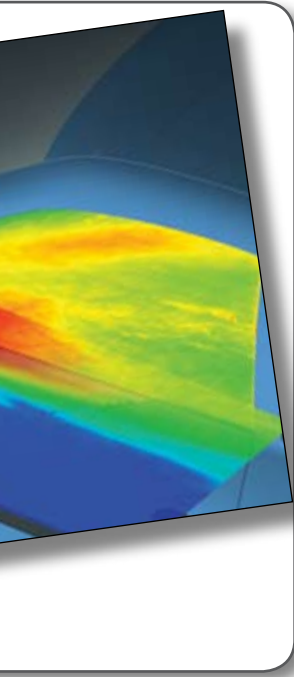
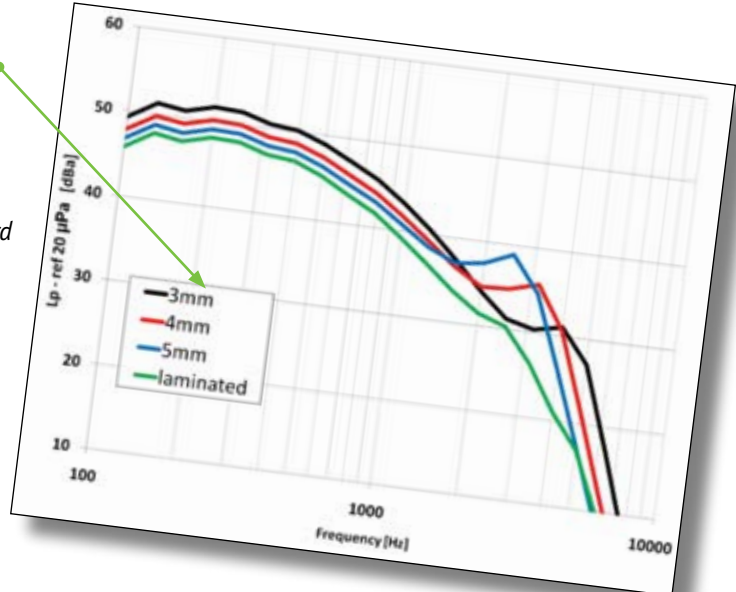
SOUND PACKAGE PARAMETER STUDIES

PowerACOUSTICS allows acoustics engineers to rapidly set up glass and cabin properties for interior noise spectra calculations.

Evaluate the effect of various noise dampening options such as varied monolithic glass thicknesses versus laminated glass in seconds.

Easily identify the contribution from each panel to the overall sound heard by the occupant.

Listen to each simulated sound with the audio signal generation feature.



ENHANCED DESIGN PROCESS

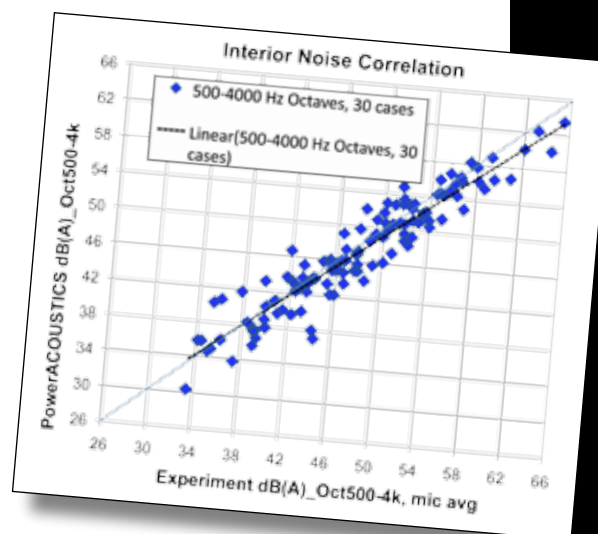
Compressed development cycles and pressure on engineering expenses has greatly reduced the number of high quality prototypes available for accurate assessment with aeroacoustic wind tunnel testing. PowerACOUSTICS coupled with PowerFLOW provides aeroacoustics and interior noise performance information early enough to impact design and reduce the amount of late design changes and physical testing. Automated visualization analysis of PowerFLOW results gives insight into the flow behaviors responsible for the exterior pressure loads—something not even possible with a wind tunnel test.

Capability	PowerFLOW & PowerACOUSTICS	Acoustic Wind Tunnel
Assess wind noise before prototypes are built	✓	✗
Analyze individual panel contributions to interior sound levels	✓	? (difficult to measure)
Determine and visualize wall pressure loads on panels	✓ (unlimited number of virtual probes, total surface coverage)	✓ (limited number of probes & probes may affect acoustics)
Easily graph, compare, and archive interior noise results	✓	✓ (difficult & time consuming)
Visualize flow-induced noise sources	✓	? (beamforming, mics, etc)
Perform iterative testing quickly to find optimal design combinations	✓ (numerous combinations of test configurations may be run to find optimal solutions)	✓ (efficient for assessing small changes from base shape)
Same model used for acoustic, aerodynamic and thermal testing	✓ (one model, numerous results)	✗ (typically separate prototypes built for aerodynamic testing)
Acoustic microphone/probe placement in difficult areas (underbody, interior)	✓ (virtual probes are placed in any location throughout the vehicle and fluid)	? (some areas difficult to access)

RELIABLE, VALIDATED SOLUTION

Based on extensive validation, PowerACOUSTICS' users may confidently rely on results and proceed with design recommendations to reduce noise levels.

The cross plot (right) demonstrates excellent correlation of predicted interior wind noise from PowerACOUSTICS versus experimental results for the 500 to 4000Hz octave bands from 27 test cases.



CONTACT INFO

Corporate Headquarters:

Exa Corporation
55 Network Drive
Burlington, MA 01803
U.S.A.

1 781/564-0200
1 781/564-0299 - FAX
www.exa.com
info@exa.com

Exa has offices in: France, United Kingdom, Germany, United States, Japan and Korea and distributors in China and India.

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