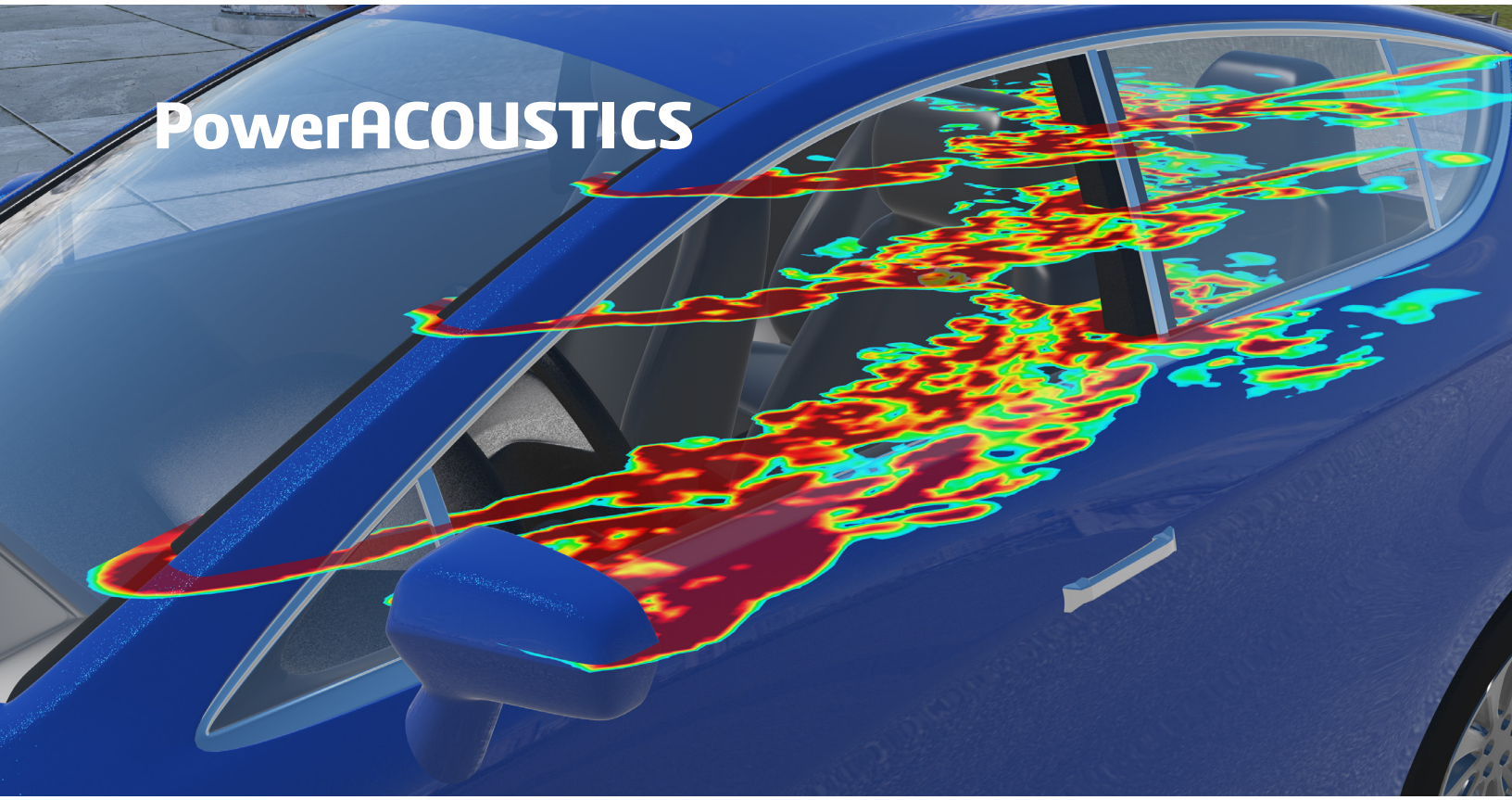
SIMULIA

3DEXPERIENCE®

PowerACOUSTICS



DIGITAL PROTOTYPING

PowerFLOW coupled with PowerACOUSTICS modules gives access to digital acoustic and aeroacoustic facilities which are cost effective. This solution provides enhanced capabilities through detailed visual insight into how design details and changes impact the noise levels and quality.

EVALUATING NOISE QUALITY

Design alternatives can be compared using audio signal synthesis. Instead of looking only at plots and graphs with eyes, noise can be analyzed directly with ears. This helps both acoustic engineers and non-experts to get a better perception of the noise quality and evaluate the importance of design modifications.

MATCHING NOISE REGULATIONS

Assess noise design performances of cars, heavy equipment, trains or aircrafts against regulatory requirements to improve ability to design products that pass physical tests the first time.

SEEING NOISE SOURCES

Identifying the origin of noise issues is complex, requiring time and expertise. PowerACOUSTICS FIND module gives simple access to this knowledge by pinpointing noise areas inside or outside the system and drives the design optimization.

Inceptra®

DASSAULT SYSTEMES

DESIGNING QUIETER VEHICLES AND MATCHING NOISE TARGETS

Exterior wind-generated turbulent and acoustic loads from PowerFLOW are seamlessly combined using PowerACOUSTICS' Noise Transmission Module (NTM) to provide wind noise contributions at the occupant's head location inside the cabin. PowerACOUSTICS capabilities are used to pinpoint exterior design failures, rank the quality of vehicle designs, evaluate the impact of wind speed and yaw angle and explore the impact of different acoustic packages.

Matching prescribed vehicle interior noise targets, achieving the right acoustic signature or satisfying community noise regulations imposed by government are becoming increasingly important for ground transportation manufacturers across many industries. For example, cabin wind, HVAC and fan noises are still reported as the main source of complaints by automotive consumers.

While developing products, acoustic engineers face many challenges. Measuring wind noise in acoustic wind tunnels is expensive and only possible when physical prototypes are available. These tests are often too late in the development process to make significant changes to the design. Frequently, because acoustic problems are not found early enough in the design process, late stage design re-work or the addition of absorbing and insulating materials is required — adding significant cost and weight to the product.

Noise can be heard but not seen. It is a daunting task for engineers to figure out experimentally the cause of acoustic problems inherently related to geometric details and invisible turbulent flow vortices. A numerical simulation approach appears as the best, and maybe only, solution for early design assessments. In the later stages of development, simulation is a solution that can efficiently complement or even replace testing, enabling the detection of possible noise failures and the overall optimization of the final design.

Most available numerical Computational Fluid Dynamics/ Computational Aeroacoustics (CFD/CAA) solvers do not provide sufficiently accurate predictions of transient turbulent flow nor satisfy the turnaround times required for today's product development. PowerFLOW is a unique, transient and compressible flow solver, validated through numerous industrial and academic activities and documented in hundreds of technical publications. It offers a complete and fast solution for most aeroacoustic problems.

PowerFLOW simulates transient flow behaviors in fluids and on solid surfaces while capturing and propagating the turbulence noise produced inside and outside flow regions. It includes the ability to simulate the true rotation of fans or blowers and has a patented technology that enables the accurate modeling of absorbing materials, called Acoustic Porous Medium (APM).

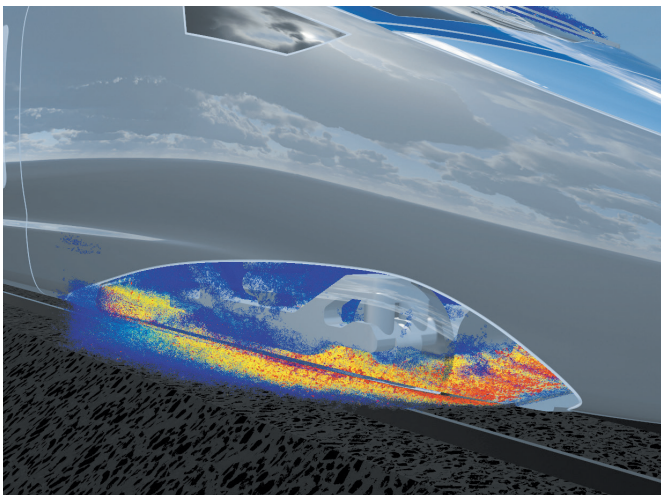
PowerFLOW itself can be used as a pure acoustic solver, leading to accurate acoustic propagation and diffraction effects in the highest frequency ranges. PowerFLOW results, consisting of transient pressure and velocity fields, enable pinpointing of noise sources when processed with PowerACOUSTICS®, SIMULIA'S flagship aeroacoustics post-processing product. PowerACOUSTICS offers various cutting-edge solutions of great value for aeroacoustic applications.

PowerACOUSTICS is Comprised of Four Modules

- **Signal Processing Module (SPM)** to analyze signals from PowerFLOW in the Fourier and time domains and to generate audio signals providing a direct aural evaluation of the noise quality. This module is provided with the PowerACOUSTICS' license.
- **Noise Transmission Module (NTM)** to evaluate interior wind noise levels including noise transmission through the greenhouse and underbody panels as well as the seals of cars, trucks or heavy equipment. This module is optional.
- **Far-Field Noise module (FFN)** to assess community noise levels and noise metrics produced by moving or fixed trains, planes or heavy equipment and machinery. This module is optional.
- **Flow-Induced Noise Detection module (FIND)** to easily and intuitively pinpoint the origin of flow noise issues on any geometry and to quantify their radiated power. This module is optional.

RELIABLE AND EXTENSIVELY VALIDATED SOLUTIONS

SIMULIA PowerACOUSTICS is a well-recognized aeroacoustics technology has been extensively validated by internal experts, academic partners and existing customers, as well as through collaborative projects and consortia. Validation studies were performed in numerous high-quality wind tunnel and acoustic facilities, including detailed flow comparison and interior wind noise evaluation on dozens of car designs over ranges of testing conditions (flow speeds, yaw angles), as well as noise comparisons at microphones in the near-field and in the far-field. Best practices leveraging acoustic expertise are embedded in various application templates for ease-of-use and accuracy.



FIND noise sources visualization on the side of the bogie of a Standard Train.

NOISE TRANSMISSION

Interior Wind Noise Predictions Through Greenhouse and Underbody Panels and Seals

- Predict noise spectra at occupant's head generated by exterior wind noise transmitting through vehicle structure
- Include turbulent and acoustic contributions produced by the exterior wind noise excitations
- Fully integrated solution including validated and tailorable vehicle cabin templates handled with an embedded Statistical Energy Analysis (SEA) solver
- Ability to export panel contributions to third party SEA solvers to leverage outputs results into in-house NVH processes

Interior Wind Noise Quality Evaluation

- Play the wind noise contributions inside the cabin and evaluate importance of ear's positions
- Derive noise metrics such dB, dBA, sones, or Articulation Index (AI) to evaluate the noise quality
- Analyze contributions from greenhouse and underbody panels and seals
- Ability to import non-simulated noise contributions obtained from acoustic testing such road, tire and engine noises

Design & Sound Package Parameter Studies

- Evaluate and compare the performances of different side mirrors, A-pillars, hood and appendages designs
- Evaluate the relative importance of each noise contributors to target the main problems
- Setup and vary panels and cabin properties to evaluate impact on interior noise levels
- Quantify effect of changes to panels and interior absorption properties

Reliable and Validated Solution

- Exterior wind noise best practices combined with Noise Transmission Module has been extensively validated
- Users can confidently rely on the accuracy and the robustness of the results to develop quieter vehicle

SIGNAL PROCESSING

Full Featured Temporal and Fourier Space Signal Processing

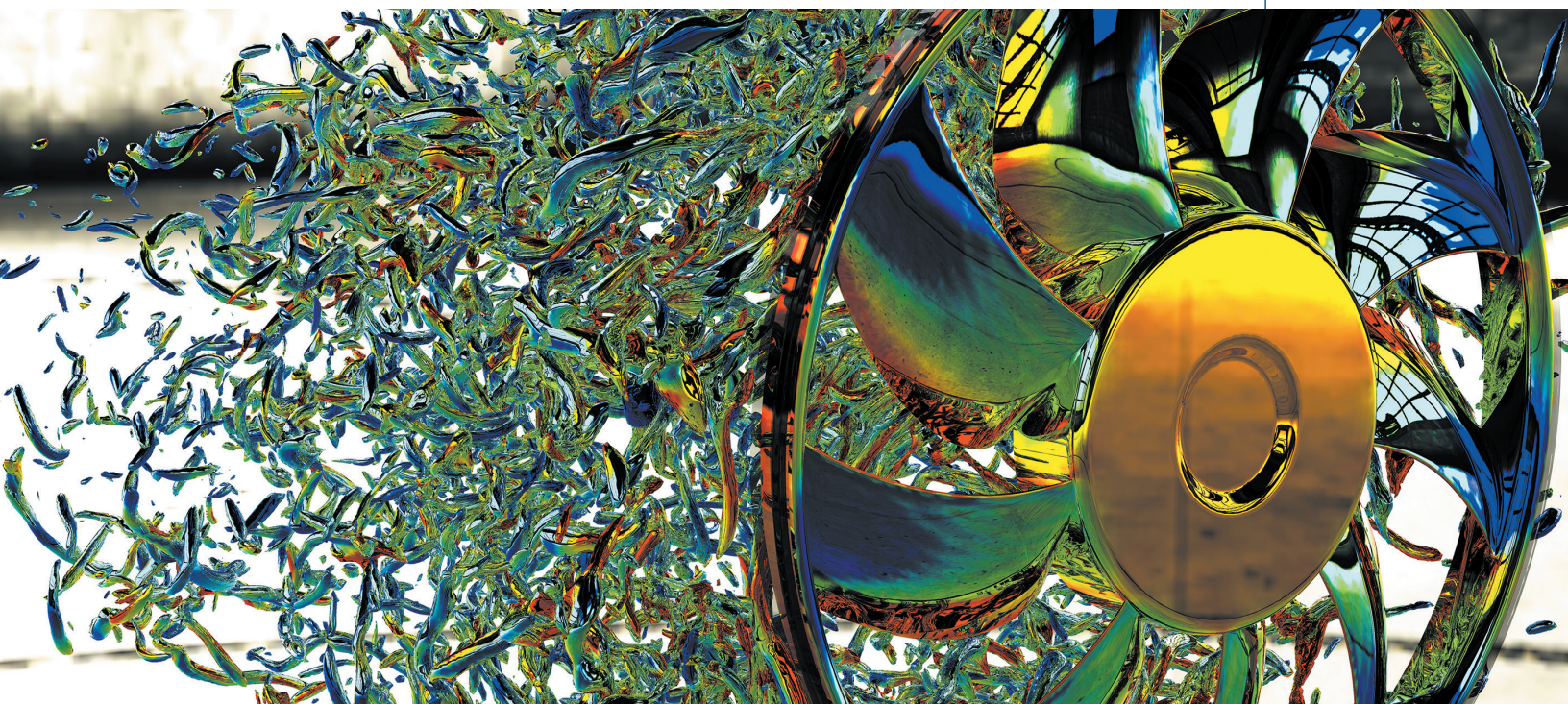
- Complete and advanced analyses of transient results on probes
- Evaluate noise metrics, cross-correlation, coherence and dozens of advanced quantities

2-D and 3-D Filtering Operations

- Highlight sources of problems at specific frequencies by creating for instance band-filtered animations
- Extract hidden acoustic fields from turbulent regions using the Acoustic Wavenumber Filter (AWF) technique

Communication of Results

- Generate audio signals to better evaluate quality and designs
- Visualize 3-D images and animations with PowerVIZ® including realistic rendering capabilities to better connect physical mechanisms to geometry details



FAR-FIELD NOISE

Accurate Far-Field Noise Predictions for Community noise evaluations

- Noise can be evaluated as far as needed from the sources going beyond PowerFLOW simulation domains
- Leverage a fully coupled far-field noise solver based on Ffowcs-Williams and Hawkings (FW-H) acoustic analogy
- Evaluate ground reflections and absorption effects based on source image formulation

Predictions of Fly-Over, Pass-By and Wind Tunnel Configurations

- Predict noise from landing planes and gears, passing-by trains or construction equipment
- Solid and permeable surface formulations are available using solid or virtual surfaces as inputs

Access to Noise and Digital Certification Metrics

- FAA, ISO, DIN standard procedures can be applied to FFN pressure signals

Insight on Noise Source Locations

- Perform contribution analysis from any source regions
- Output far-field microphone signals can be plugged into inverse methods algorithms to locate noise source

FLOW-INDUCED NOISE DETECTION

Intuitive and Easy-to-Use Aeroacoustics Design Tool

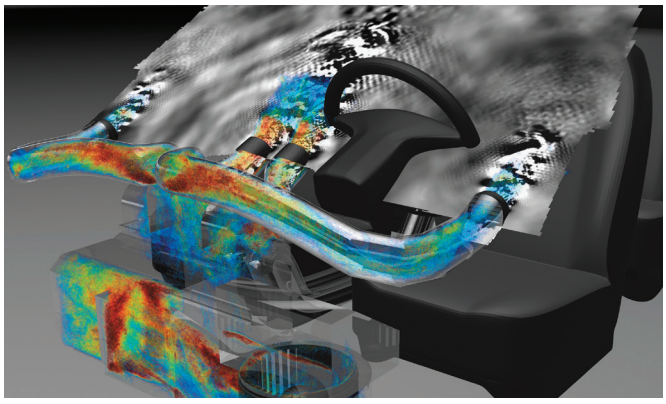
- Identify and quantify broadband flow noise sources in or around any geometries
- Guide engineers to most important issues to efficiently reduce noise levels

3-D Acoustic Sources Visualization and Clustering

- Spatial representation of noise source field with PowerVIZ® including realistic rendering capabilities
- Clustering of noise sources to identify individual source regions

Prioritize Candidate Design Features to be Optimized

- Identify geometry details responsible for noise by connecting sources to geometry failures
- Source acoustics power can be used as objective functions to drive optimization studies



FIND noise sources visualization inside Standard Vehicle HVAC systems (color scale). Visualization of flow and acoustics in the cabin using time-derivative of pressure (grey scale)

Our **3D**EXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

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Dassault Systèmes Platinum Partner

Inceptra

North America Headquarters
1900 N. Commerce Parkway, Weston, Florida, 33326 USA
Phone (954) 442-5400
Inceptra.com

Americas
Dassault Systèmes
175 Wyman Street
Waltham, Massachusetts
02451-1223
USA

Europe/Middle East/Africa
Dassault Systèmes
10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex
France

Asia-Pacific
Dassault Systèmes K.K.
ThinkPark Tower
2-1-1 Osaki, Shinagawa-ku,
Tokyo 141-6020
Japan

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