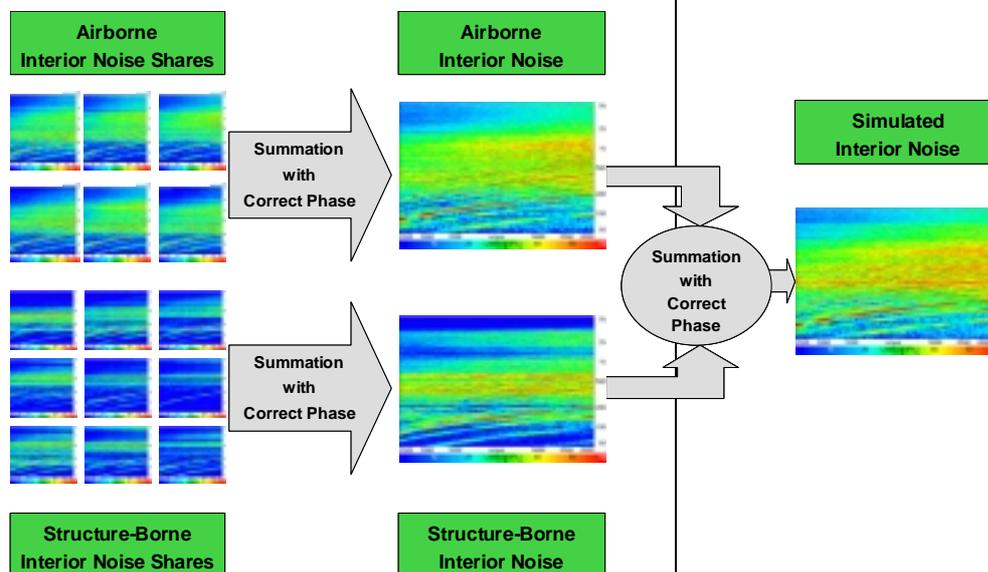


## Vehicle NVH Development Interior Noise Simulation

*In order to satisfy consumer expectations, the interior vehicle noise characteristics need to be refined for various operating conditions of the vehicle. FEV uses a proprietary "interior noise simulation" methodology for interior vehicle noise refinement.*

**Engine noise** represents a significant portion of the overall interior noise in a vehicle. Well before an engine is operated in the vehicle, potentially annoying interior noise shares, their causes, and transfer paths can be identified by using FEV's technique for interior sound synthesis.

Accordingly, radiated noise and mount vibration measurements are conducted simultaneously in an engine test cell under various test conditions. These data are filtered using typical vehicle transfer functions (measured or from a database) for airborne and structureborne noise paths and combined with the right phase information to synthesize interior vehicle noise.



This analysis is carried out in the time domain so that all phase information from various paths is preserved and the simulated interior sound can be analyzed both **subjectively** (by listening to it) and objectively.

The interior sound simulation technique is also used to perform **noise path analysis** on an existing vehicle. Measured powertrain level data and structureborne/airborne noise transfer functions are used to synthesize the interior noise. In addition, the interior noise can be decomposed into the dominant airborne and structureborne paths.

- **Engine Noise Refinement**
  - Early Powertrain Optimization for Specific Vehicle Programs
  - Corporate Sound Design
- **Subjective Evaluations**
- **Noise Path Analysis**
  - Airborne Noise Share
  - Structureborne Noise Share
- **Troubleshooting Interior Noise Problems**
- **Combination with CAE Analysis**
  - Intake Orifice Noise
  - Exhaust Tailpipe Noise
  - Mount Vibration

The following figure shows an example where the synthesized interior noise is decomposed into structureborne and airborne contributions. Furthermore, the airborne noise is decomposed into six paths (corresponding to six engine sides) and the structureborne noise into nine paths (corresponding to three engine mounts and three directions for each mount). This methodology provides an excellent fingerprint of the vehicle's engine-induced noise. Such analysis can aid **troubleshooting** and resolution of any undiagnosed problems and fine-tuning.

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