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GFaI's Acoustic Camera spherical array is one of several products used to measure in-vehicle noise.

The workday ends as the cell phone rings and the boss yells something just as the elevator doors clank shut. From inside the elevator, the outside world seems rather noiseless, and that quiet environment is highly sought-after in other enclosed spaces, most notably vehicle interiors.

In order to rid a vehicle cabin of unwanted noise, it is necessary to know how the sound arrived at the interior destination, which is why many companies feature a variety of NVH detection tools. The following paragraphs provide a snapshot of what some suppliers are offering in their acoustic product portfolio as well as how some businesses are adjusting their technical sound strategies.

Acoustic mapping has long been an NVH testing staple, but the ability to do so in-vehicle is picking up momentum via beamforming technology. Germany-based GFaI Tech's Acoustic Camera provides a method for noise field mapping. "This is a great device for finding a number of noise issues, like squeak and rattle," said Dennis Sulisz, Sales Engineer for Sage Technologies, the North American sales outlet for the device that is distributed in North America by SenSound. GFaI's Acoustic Camera is a carbon-fiber globe comprised of one USB camera and dozens of microphones, typically ranging between 32 and 1000. "Because the sphere is acoustically transparent, it doesn't affect the sound fields of the car interior that's being measured. We're also able to provide time-domain beamforming, which enables the capture and mapping of transient noises," said Sulisz. In early 2008, the device will incorporate rotating equipment analysis software. "That will enable users to analyze HVAC noise, powertrain noise, seat motors, *etc.* as those devices change operating speeds," Sulisz said.

Bruel & Kjaer's Spherical Beamformer is a solid globe that can be placed inside a vehicle for acoustic mapping. "The device is able to capture a 180° by 360° sound map. That information is then digitally stitched together and unwrapped into a 2-D presentation on a computer screen," said mechanical engineer Tony Frazer, Array Acoustics Solution Manager for Bruel & Kjaer in Canton, MI. The 19.5-cm (7.7-in) globe, about the size of a human head, contains 36 microphones and 11 USB cameras. "This device provides a very fast method of obtaining a contour map. In about five minutes, you can acquire the data and display the sound map," said Frazer. The Spherical Beamformer was market-launched in late 2006. "The second-generation product will have software updates, which will enable real-time monitoring as well as non-stationary measurements, such as an engine run-up or on-road testing—which, for example, can be done to determine where noise is entering a vehicle when other vehicles pass by," said Frazer.

Keeping vehicle drive-by noise at bay is one benefit of being inside a vehicle with

properly set closure panels, and a wireless sensor from Inora Technologies can determine an incorrect seal margin. "Inora's WISEgap sensor is for measuring the hidden gaps around doors and other closure panels. The measurements can be done as a static test, such as verifying that the seal gaps match the specifications, or the measurements can be done as a dynamic test, like an on-road test to detect an inadequate closure panel seal, which could lead to water leakage, wind noise, or other problems," said Nate Enstrom, Sales Engineer with Inora in Michigan. In early 2008, the WISEgap 2.4 gets market-released. This sensor will be smaller (30 x 15 x 5 mm [1.2 x 0.6 x 0.6 in]) than the current 40 x 15 x 5-mm (1.6 x 0.6 x 0.6-in) sensor, "so it can be more easily located in hard-to-reach areas," said Enstrom, adding that the 2.4 sensor will have a 2.4 GHz frequency, unlike the present sensor's 916 MHz, so "the new sensor will match a worldwide standard for wireless communications."

Improving communications with customers was a contributing reason for PCB Piezotronics forming an automotive sensors division. The company, which designs and manufactures force, torque, load, strain, pressure, acoustic, and vibration sensors, recently launched the automotive unit with Jeff Case—Former Chief Program Engineer at Ricardo North America—as the division's leader. "The goal is to grow the global market for automotive business across all PCB product lines, which is one reason PCB products will now be marketed by application areas—such as powertrain development, vehicle component and durability, sound, and vibration," said Case. With approximately 15% of overall business tied to NVH, sound and vibration "is PCB's most important application area, so we're definitely focused on how we can grow and evolve to match our customers' needs," Case said.

Polytec intends to make one testing job a quicker and easier task. "The traditional way to measure torsional vibration of a crankshaft is to use sensors in opposing directions in order to calculate the angular vibration, which means custom-machining an aluminum insert in order to mount the sensors. It's just a time-consuming setup process," said Mike Stone, Applications Engineer for Polytec in Michigan. Polytec's recently introduced RLV-5500 Rotational Laser Vibrometer—consisting of a sensor head with two lasers, a controller with BNC-outlet, and three BNC outputs (angular velocity, angular displacement, and rpm)—reduces the traditional setup time with no post-processing and no mass loading. "The RLV-5500 helps minimize torsional vibrations when developing a crankshaft, which in turn means no noise transfer to the vehicle interior," said Stone.

A new technical center gives passenger vehicle makers, Class 5 through 8 engine manufacturers, as well as suppliers a place to conduct an array of powertrain tests. "The facility design group was comprised entirely of people with NVH experience, so there's a level of noise suppression in the test cells—even the heavy-duty test cells—that allow for sound localization," said Michael Pierz, Laboratory Director for the Meiden Technical Center North America in Northville, MI. Unique dynamometers underscore the attention to NVH inside the 88,000-ft² (8175-m²) building. "Because of Meiden's liquid-cooled dynamometers, we can test the entire driveline dynamics in one cell, and that means you can get the load and the inertia to be the same as it would with an on-the-road vehicle but without a noise influence," said Pierz.

Noise influencers can be pinpointed with the aid of new software from National Instruments. The Sound and Vibration Assistant, a stand-alone program, enables the user to acquire signals, generate signals, obtain frequency response measurements as well as perform other acoustic and vibration analysis functions. "A test engineer could use the Sound and Vibration Assistant along with National Instruments' data acquisition hardware in order to have a portable, flexible, easy-to-use system for in-vehicle NVH testing," said Chris Fronda, Product Marketing Engineer for Sound and Vibration at National Instruments.

Kami Buchholz