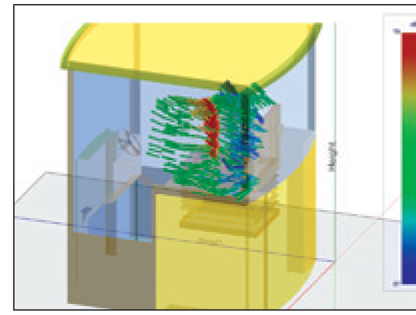
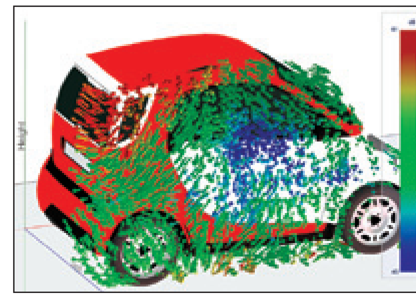
S&V OBSERVER

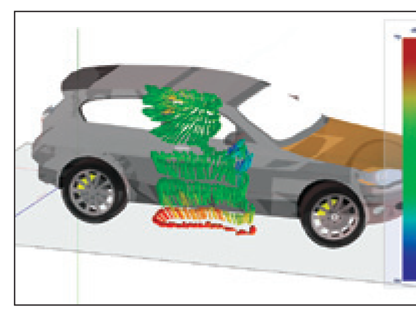
Quickly Visualizing and Mapping Sound in 3D



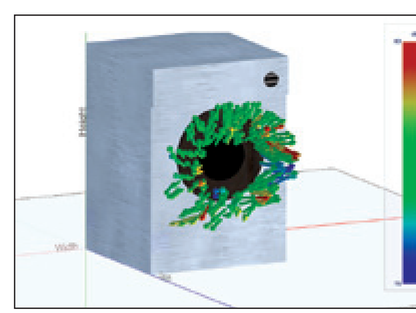
Sound sources in a tractor cab.



Interior/exterior noise measurements on all sides of car.



Measuring transmission loss on a car door.



Seal leaks around door of a clothes dryer.

Whether consumers buy a car, a household appliance or a drill, the product's noise level may influence their purchasing decision and will definitely impact customer satisfaction. This trend, together with growing awareness about noise pollution and regulatory pressures, have made acoustic performance a key competitive factor in product development. To support acoustical engineers in their increasingly challenging task, Siemens PLM Software developed LMS Soundbrush – the first technology ever to visualize sound in 3D while measuring.

Different Measurements, Varying Techniques. Analyzing and, consequently, improving acoustic performance requires different types of measurements. Engineers will, for example, scan the surface of a hydraulic pump to investigate what factors contribute to the noise it emits. Leak detection, for its part, is about investigating the ability of a casing or housing to shield noise sources within or outside the unit. To look into sound propagation, engineers have to determine how sound sources interact and propagate away from the source.

The range of techniques used for these measurements is just as diverse as the measurements themselves. A simple microphone can help identify critical peaks or frequency ranges. To gain deeper insight into the location of sound sources, engineers rely on more advanced techniques like sound intensity probes, often combined with scanning techniques that use wire-frame grids or even robots. Finally, array techniques based on beam-forming or acoustic holography methods help localize sources by back propagation onto a surface.

From Sound to Source in Minutes. The methods described above are accurate and efficient, yet they require significant set-up time, acoustical expertise and expensive equipment. But a new generation of acoustic troubleshooting tools, like the patented LMS Soundbrush, is different. LMS Soundbrush is an exceptionally user-friendly tool that allows even less-experienced users to identify sound sources quickly. The set-up is simple – click the antenna with acoustic sensor onto the probe, plug the USB probe and the camera into a PC and launch the intuitive software. In no time, users can then start moving the probe around the test object to capture acoustic measurements and visualize sound sources in 3D.

How it Works. 3D visualization makes LMS Soundbrush unique. At the heart of the solution is the patented optical position-tracking technology, which is integrated into the probe, combined with either a sound pressure microphone or a 3D sound intensity sensor (antenna). The antenna contains measurement sensors and embedded memory for automatic configuration and calibration. The probe has an illuminated 45-mm-diameter sphere that is continuously tracked by a camera to provide the probe's positions. Inside, inertial sensors continuously measure its orientation around three axes. Together with the positions measured by the camera and the offset of the antenna sensors stored in the embedded memory, this allows the software to represent in real time the acoustic signals at the sensor location in terms of both position and orientation.

Quickly Interpreting the Data. The acoustic measurement data are immediately shown in 3D on the computer screen while "brushing" the sound field. Sound pressure is displayed as point clouds, while acoustic intensity is visualized as intensity vector plots. All resulting data can be viewed from any possible angle. Users can freely rotate the test object and zoom in on a specific hot spot or run a section plane through the measurement data to make an interpolated contour plot. This easy, real-time visualization allows an immediate and quick interpretation of the measurement data to enable efficient acoustic troubleshooting.

Sound Sources Inside Tractor Cab. In this example, the LMS Soundbrush is used to investigate sound flow and sources inside a tractor cab. Acoustic measurements were taken in the front and back of the cab. It was noticed that the sound always flowed from the back to the front and deflected to the top and the bottom at the glass windshield. As the main noise source entered the cabin from the back, a more detailed scan was performed while the engine ran at top speed.

Most of the noise appeared to enter the cab at the door. While investigating the reason for this leak, an unexpected leak in the door sealing was discovered. Once the leak had been closed, a new measurement was carried out. By shielding the door from the outside noise with a rubber seal, the maximum noise levels had dropped by 5 dB. LMS Soundbrush was used to further investigate some leaks at the top corner of the door to try to optimize the closure and the rubber seal.

Interior and Exterior Measurements on All Sides of a Car. LMS Soundbrush enables users to visualize sound fields even in complex 3D volumes like car interiors. Test engineers used the LMS Soundbrush to localize vehicle acoustic leaks on all sides of a car with a detachable roof, both inside and outside. While measuring exterior sound sources, the testers generated a pink noise signal inside the car. At the right side of the car, LMS Soundbrush revealed that the sound intensity was highest where the isolation is lowest; that is, the rear and front wheel bays and the back canvas of the detachable roof. Brushing at the back and top of the car confirmed this finding – the sound insulation of the canvas appeared to be least efficient in blocking the transfer noise.

Measuring Transmission Loss on a Car Door. In the following example, LMS Soundbrush was used to find weak spots (acoustic leaks) in a door trim panel. For the test, a complete car door was mounted in an opening between two test chambers. Using white noise excitation in the reverberant source room, the transmitted noise at the receiving side of the door was measured – once with and once without the side panel.

The comparison yielded some surprising results. While the speaker area and the window clearly were the main sources of noise of the original door, the measurements indicated that the window transmitted more noise after removing the panels. The 3D visualization revealed the reason – by removing the door panel, an extra gap is created in front of the window. This causes a high vertical component of the noise, which reflects against the window and shows up as if the window itself was transmitting more noise. Without the 3D vector visualization these effects could not have been discovered and explained.

Seal Leaks Around the Door of a Clothes Dryer. LMS Soundbrush was deployed to investigate if a tumble dryer sufficiently insulates noise sources from the inside. By scanning different sides of the dryer, some interesting findings were discovered.

Side panel measurements revealed sound sources both at the bottom right and the bottom left back side of the dryer, which appeared attributable to the hot-air exhaust and an unused exhaust opening. Measurements on the front side showed sound sources around the door and at the bottom of the dryer. When comparing measurement results in the frequency range from 100 to 200 Hz, the dryer bottom appeared to cause the most noise.

Finally, the dryer door seal was investigated. A filtered 200-Hz peak revealed two sound sources, indicating that the hinge and lock of the dryer door closed less firmly, thus causing noise to leak. LMS Soundbrush allowed engineers to quickly scan different sides of the dryer in a single measurement session, The LMS Soundbrush measurement took half a day, where other methods typically required two days or more.

For more information on LMS Soundbrush and other LMS Testing Solutions, please visit: www.plm.automation.siemens.com/en_us/products/lms/testing.

Dytran MEMS Sensors Cover Many Applications

Dytran Instruments, Inc. is an industry leading designer and manufacturer of piezoelectric and DC MEMS sensors to support a variety of testing applications. Since its founding in 1980, Dytran has engaged in the successful design of piezoelectric sensing technologies, including dynamic accelerometers, pressure transducers and force sensors, to support a variety of demanding customer applications and program requirements. In response to a growing number of customer requests for expanded accelerometer offerings to support low-frequency vibration applications, Dytran is continuously updating its sensor portfolio to include new ranges of DC MEMS single and triaxial accelerometer models.

USB Vibration Measurement System. Included among the new DC MEMS sensors now available from Dytran is the VibraScout™ vibration measurement system, which includes a USB digital triaxial accelerometer combining a MEMS accelerometer with a microcontroller to create an intelligent sensor.

The VibraScout system consists of a USB triaxial DC response accelerometer, 15-foot, 4-pin to USB cable assembly, VibraScout data acquisition software, and VibraScout Windows compatible postprocessor software on CD (no license required). In addition to the vibration measurement system, the only required hardware is a personal computer and a USB port.

The accelerometer model features power from a PC bus, and as a result, no additional external power supply is required. The software package supplied with each system allows for real time, three-directional acceleration acquisition (including static inclination) along with real-time temperature monitoring.

The standard USB protocol handles all the sensor communications with the PC and provides the following information: storage of acceleration and temperature information; real-time scrolling plots of acceleration data with display of min, max and mean; real-time logging of data to delimited file for importing into Excel; both auto and smart triggering modes; digital filters to improve signal/noise ratio; real-time data compression to fast Fourier transform (FFT); and many more.

Offered with a 16-g range, the variable capacitance (VC) accelerometer combines an integrated VC chip in a hermetically sealed titanium housing weighing 17 grams and is offered with a low-end frequency response down to DC (0 Hz) and an upper frequency range of 1,100 Hz. Units are rugged to 10,000-g shock and operate from +3.8 to +6.0 VDC power.

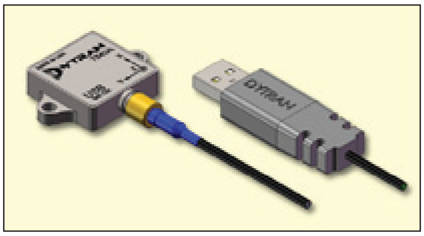
The VibraScout postprocessor software is designed to provide a user with the tools to apply nonlinear interpolation to resample raw data that are recorded with VibraScout software at higher frequencies to improve signal resolution. Data are valid only up to 1.1 kHz after applying the postprocessing. This mathematical interpolation is performed using the Whittaker-Shannon interpolation technique to reproduce the recorded real signals with proper amplitude.

Features of the VibraScout postprocessor software include: plot recorded data from the software; zoom and select a specific timeframe of recorded data for post processing; reproduce interpolated oversampled data to provide better resolution of vibration signals; multiple file types to export to including ASCII, time history JPG files, TDMS binary files of time history data readable in Microsoft Excel, PSD and FFT plots in JPG file format; and display of recorded average temperature.

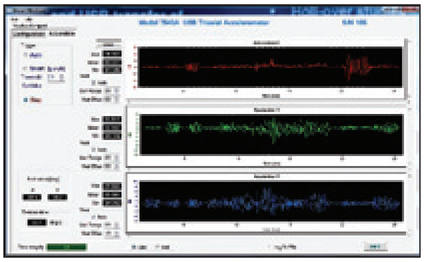
The VibraScout USB vibration measurement system was designed for a variety of low-to-medium-frequency vibration applications where portability is critical, including quick, easy, in-field data collection; noise, vibration and harshness (NVH); static angular measurements; ride quality; vibration measurement and diagnosis at rotating machinery.

An application programming interface (API) is available for customers who would like to build custom applications for the VibraScout. The API provides support for any NET-compatible client applications. Custom application development is also available. Please contact Dytran directly for further information.

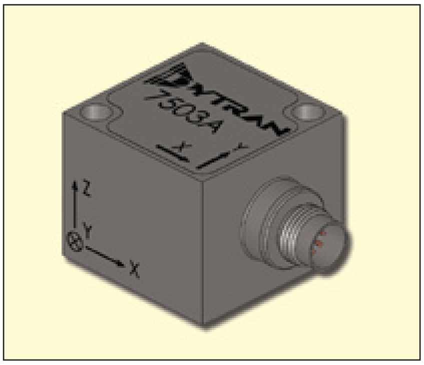
DC MEMS Accelerometers. In addition to the VibraScout, Dytran has developed a broad range of DC MEMS accelerometers for a variety of automotive testing applications. Among the most popular models is the 7500A series, a family of high-precision, single-axis accelerometers, combining an integrated VC accelerometer chip with high-drive, low-impedance buffer for low-level acceleration measurements.



VibraScout USB triaxial MEMS vibration measurement system.



Typical display of the vibraScout postprocessor software



Dytran 7503A MEMS accelerometer.

The 7500A series features a low-end frequency responsez of 0 Hz and an upper frequency response between 400 and 2,500 Hz. This module contains a MEMS capacitive sensing element, a custom integrated circuit amplifier, low-noise electronics and differential output, housed in hermetically sealed lightweight titanium, with a 1/4-28 four-pin radial connector. For high-precision triaxial vibration monitoring, Dytran has recently introduced the 7503A series. Units exhibit similar performance characteristics as the 7500A and are available in ranges from 2 g to 400 g.

Designed to be used as a drop-in replacement for piezoresistive units in new or existing zero-to-medium-frequency instrumentation applications, Dytran has developed the 7600B series. Available in six models with ranges from 5 to 200 g, the 7600B series incorporates a MEMS capacitive sensing element and an advanced ASIC to simulate piezoresistive bridge operation, as well as an integrated VC accelerometer chip with high-drive, low-impedance buffering.

Units respond to both DC and AC acceleration. On-board regulation minimizes supply voltage variation effects, making them relatively insensitive to temperature changes and thermal gradients. The 7600B unit utilize the same power supply as piezoresistive and strain gage sensors, allowing them to operate as stand-alone differential output accelerometers or in place of piezoresistive bridge-type accelerometers.

In addition to the DC MEMS accelerometers described here, Dytran's broad product offering includes piezoelectric and DC MEMS accelerometers, dynamic force and pressure sensors, impulse hammers, cables, accessories and support electronics. Dytran offers vertically integrated custom manufacturing capabilities that include an in-house CNC machine shop running three shifts, an in-house design engineering center, and a dedicated R&D and engineering laboratory.

At an AS9100 and ISO9001:2008-certified facility, the company offers the necessary expertise to design and manufacture custom sensor and cable assemblies to meet the requirements of precise custom or automotive test program specifications, including connectors and calibrations with short leads times. Calibration services are also A2LA accredited to the ISO17025 standard, ensuring the quality and uniformity of sensors and instrumentation, all tested according to rigorous in-house standards.

For more information on VibraScout and other Dytran products, please visit: www.dytran.com.