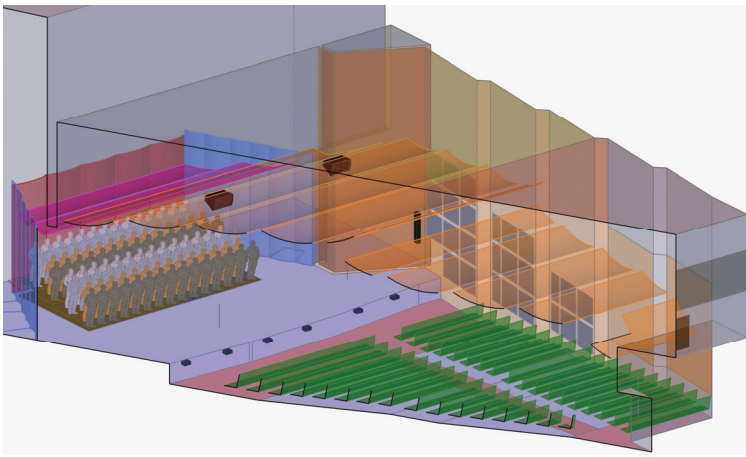


KOLANO AND SAHA ENGINEERS, INC.
CONSULTANTS IN ACOUSTICS, NOISE AND VIBRATION



CAPABILITIES:

- Architectural Acoustics and Building Noise Control
- Automotive Noise and Vibration
- Community and Environmental Noise
- Industrial Plant Noise
- Product Noise



Acoustic Modeling of an Auditorium

Architectural

Room acoustics, sound systems, and HVAC/mechanical equipment are all targets for K&SE architectural investigations and corrective designs. The firm serves a diversity of clients—hospitals, educational facilities, large corporations, public institutions, as well as architectural, construction and mechanical firms. Projects vary in complexity, and range from mechanical equipment noise to designing performing arts auditoria and audio/video systems.

Automotive

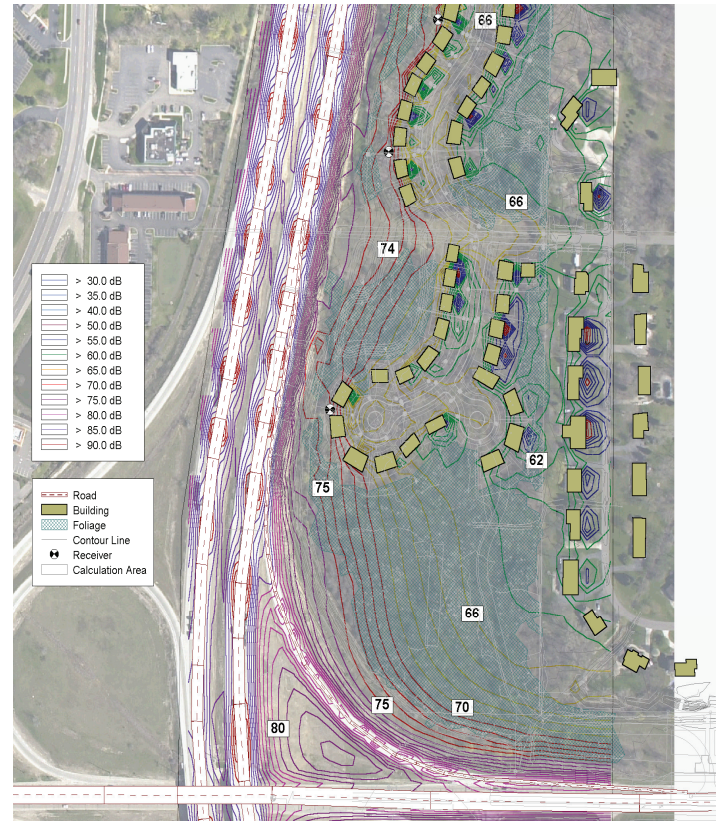
K&SE's acoustical consulting for OEMs and their suppliers touch many activities: customer satisfaction, competitive vehicle evaluations, preparing criteria for vehicle noise controls, vehicle noise diagnostics, and developing acoustical packages. The firm routinely conducts component testing, acoustical material performance analysis, in-vehicle objective and subjective studies, assists suppliers in developing better products and provides acoustics seminars and training.

Community

Outdoor noise and vibration problems that impact people and cause annoyance fall within K&SE community noise activities. With precision measurements and technically advanced analysis and modeling capabilities, K&SE serves the community, businesses and municipalities to help prevent and solve noise issues. The firm also provides expert testimony at zoning board meetings and in the court room on issues where noise and/or vibration are critical.

Product

K&SE is frequently asked to evaluate products for noise or vibration potential and to recommend modifications. These tasks have included diagnosing/reducing the noise of refrigerators, dishwashers, laundry washers, vacuum cleaners, and measuring noise & vibration of shipboard motor-pumps.



Predicted traffic noise levels impacting a proposed residential site.

Sophisticated Tools

Kolano and Saha Engineers' sound and vibration activities are supported by sophisticated equipment and advanced modeling software. K&SE facilities include an ISO/IEC 17025 accredited acoustics laboratory, multi-channel spectrum analyzers, a small volume reverberation room, a small anechoic chamber, a full-size reverberation room with an anechoic termination chamber and adjoining large hemi-anechoic chamber. These allow the firm to conduct studies to determine appropriate noise and vibration reduction solutions.

K&SE uses EASE, an advanced software package, to evaluate room acoustics and design sound reinforcement systems. This package features speedy in-depth analysis capabilities, a comprehensive database, and three-dimensional graphics. The firm is using the package to help clients design optimal sound systems for churches, auditoriums, theaters, and similar applications.



K&STLE KαBIN - Self Contained Acoustic Test Facility



Laboratory Based Vehicle Test

AUTOMOTIVE NVH Test Procedures & Methods

On-Road Vehicle Testing

On-road vehicle testing is conducted to objectively quantify specific NVH issues related to powertrain, road, and wind noise sources. Vehicles are driven under various operating conditions and specific road surfaces. With precision instrumentation, detailed testing & data analysis are conducted to study both airborne and structure-borne noise paths for acoustic energy propagation from the source to the receiver. This includes but is not limited to:

- Identify and diagnose noise paths
- Develop feasible sound package systems
- Evaluate alternate sound package systems which address a specific noise problem or concern

Laboratory Based Vehicle Testing

A reverberation room based full-vehicle stationary airborne noise test procedure has been developed to evaluate the strength of different noise paths and the acoustical performance of sound package materials. This methodology has been found to provide excellent agreement with on-road tests.

A hemi-anechoic based full-vehicle stationary noise test allows the evaluation of the performance of a component (body panel) or sound package treatment in a vehicle.

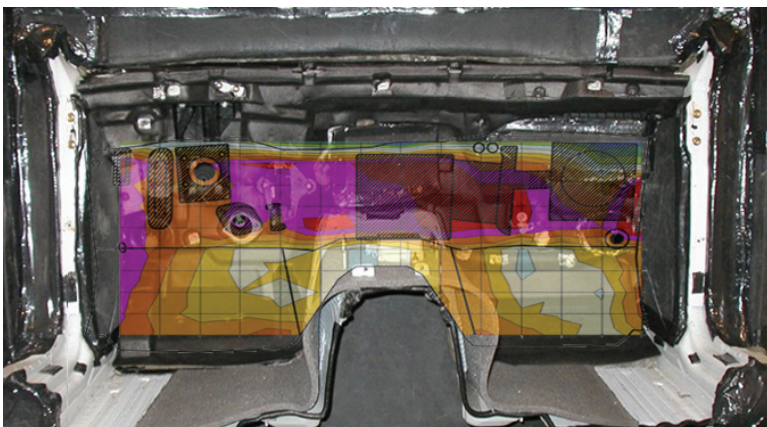
Laboratory Based Component Study

This is conducted to evaluate the airborne and structure-borne noise reduction performance of different sound package systems that are used in vehicles. The vehicle body element (i.e., door, dash, floor panel, cab panel) and sound package system are installed in an opening between the reverberation source room and the hemi-anechoic receiving room. This approach provides an understanding of the importance and rank ordering of various noise paths, establishing and/or verifying noise targets, and developing or optimizing sound package treatments.

Material Study

Material studies are conducted to determine the acoustical properties of various type of materials suitable for automotive applications, and then to determine how to improve the acoustic performance of the material to meet a particular application or requirement. Such studies involve measurement of:

- Sound transmission loss
- Sound absorption coefficients
- Vibration damping performance
- Vibration isolation performance



Vehicle Dash Noise STL — Sound Intensity Color Overlay

Body Cavity Filler Study

A square channel, which simulates a body cavity (such as vehicle pillars and rockers), is used to determine the acoustical performance of body filler materials. This procedure can compare different materials or assess the effectiveness of material expansion and sealing in the pinch-well areas.

Acoustical Gravelometer

This is a test fixture which rank orders the acoustical performance of underbody "deadener" materials used to reduce interior noise caused by exterior stone and water impingement. Glass spheres randomly impact the test panel to simulate a repeatable excitation of gravel and rain. This fixture was originally developed and built for an OEM.

Vibration Damping Fixture

Body panel construction and damping materials are tested in panel configuration that simulates the vehicle. Test panels are mounted in a rigid fixture while a shaker provides vibration excitation. This test procedure provides vibration damping performance in terms of vibration levels, loss factor, and structure-borne noise.



Modal Study of a Vehicle Body Panel System

K&SE NVH Test Facility

Full-Size Reverberation Room (200m³)

Small Volume Reverberation Room (25m³) - K&STLE KαBIN®

Hemi-Anechoic Chamber

Small Anechoic Chamber

Anechoic Termination

Standard Tests

ASTM C522/ISO 9053 – Airflow Resistance

ASTM E1050/ISO 10534 – Normal Incidence Sound Absorption

SAE J2883 – Small Reverb Room Sound Absorption

ASTM C423/ISO 354 – Random Incidence Sound Absorption

SAE J1400 – Small Sample Sound Transmission Loss

SAE J2846 – Body Cavity Filler Insertion Loss

SAE J1637/ASTM E756 – Oberst Bar (Vibration Damping)

ISO 16940 – Vibration Damping - Mechanical Impedance

ISO 3741/ANSI 12.51 – Sound Power Level

ASTM E2611 – Normal Incidence Sound Transmission Loss

ASTM E2249 – Sound Intensity Based Transmission Loss

SERVICES:

- Architectural Acoustics and Building Noise Control
 - Field/Laboratory Measurements
 - HVAC and Mechanical Equipment Noise and Vibration
 - Condominium & Studio Sound Isolation
 - Room Acoustics & Music Rooms
 - EASE Modeling and Analysis
 - Audio/Video System Design & Specification
 - Speech Privacy & Sound Masking
 - Acoustic Test Facility Design and Consulting
- Automotive Noise and Vibration
 - Noise Source Diagnostics/Path Analysis
 - Sound Package Development
 - Acoustical Material Optimization
 - On-Road/In-Vehicle Testing
 - Component Testing
 - Material Performance Evaluation
 - Subjective (Jury) Evaluations
 - Acoustics Seminars & In-House Training
- Community/Environmental Noise
 - Noise Level Monitoring and Control
 - Equipment and Facility Noise Predictions
 - Traffic Noise Assessment
 - Municipal Noise Ordinances
 - Ground Vibration Measurements & Diagnostic Studies
 - Expert Testimony
- Industrial Plant Noise
 - Engineering Noise Control Recommendations/Design
 - Noise Control Research
- Product Noise
 - Laboratory Noise Measurements/Analysis
 - Noise Source Diagnostics
 - Noise Control Recommendations
 - Acoustical Package Optimization



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