THE SOLUTION FOR YOUR ACOUSTIC AND VIBRATION-RELATED TASKS
**Benefit from our Expertise and Experience!**

**Your Advantage**
- Put our comprehensive knowledge and experience to work.
- Free up capacity by outsourcing tasks.
- Benefit from our professional, targeted working methods.
- Gain flexibility with your schedule while keeping costs under control.

**Our Services**

**Consulting**
- We manage entire projects.
- We develop new methods and techniques for you.

**Engineering**
- We support projects with our engineering know-how using HEAD acoustics technology and expertise.

**Measurements**
- We support you with measurements – at our facilities or on-site.

**Application Areas**
- Passenger vehicles and trucks
- Buses
- Rail vehicles
- Machine tools
- Household appliances
- and many others

**Our Experience**
- Professional supervision by our staff of consulting engineers with extensive project experience.
- Proficiency with advanced methods for measurement, analysis and simulation.
- Efficient utilization of the entire range of software and hardware products from HEAD acoustics.
- Continuously updated knowledge base from research, science and industry.
- Participation in national and international research projects.

**Project Training and Courses**

Maximize your consulting project benefits by including a training course!

**Subject Areas**
The contents of the training depend on your individual requirements and tasks.
Examples of possible training subjects:
- Sound design and sound optimization
- Psychoacoustics
- Optimal use of the ArtemiS multi-analysis software
- and many others

**Your Advantage**
- Learn state-of-the-art methods in a joint project.
- Improve your expertise in using the products from HEAD acoustics.
- Ensure successful training with small group sizes and supervision by experienced engineers.
- The theory is taught through application to your project.
- Project completion and training occur at the same time for maximum efficiency.
> **Binaural Transfer Path Analysis (BTPA)**

BTPA is used for determining complex transfer functions of multiple sound and vibration insertion points to one or several receivers.

**Application Areas of BTPA / BTPS**
- Identification of sources of interfering noise
- Product optimization and sound design
- Specification of acoustics requirements for subsystems
- Model-based auralization based on measured or calculated transfer functions
- Development of modification possibilities
- Estimation of optimization potential via acoustic comparisons
- Inclusion of simulation data

**Benchmark Test**

Compare your vehicles to your competitors using our large database of transfer functions that covers a wide range of vehicles and vehicle classes.

> **Binaural Transfer Path Synthesis (BTPS)**

The aurally accurate synthesis of entire or partial sounds is based on measured and/or calculated excitation signals and the results of the BTPA.

**A Practical Example: BTPA / BTPS for Door Actuation Sounds**

BTPA and BTPS can be used, for example, to examine door actuation sounds.

Since the system properties change during the process of opening or closing the door, a **time-variant** transfer path model is used, allowing for a very realistic synthesis.

Synthesis results: specific loudness of door lock (left) and striker (center) in comparison to the entire door opening sound (right); the transfer paths of the highlighted interfering noise patterns are clearly visible.

Original door sound (left) and sound after a modification (right). Disturbing high-frequency components have been reduced significantly!
Floor, dashboard, front ceiling, rear ceiling, left side, right side, rear seat ...

**Which panel contributes most to an annoying noise pattern inside a car?**

With the Binaural Panel Contribution Analysis (BPCA), an “alternative window method”, relevant panels regarding the radiation of annoying noise patterns are determined. The individual airborne sound contributions of each partial panel can be measured and auralized separately. The result is a simulation model based on measured data. The results of the simulation can be auralized directly.

**Application Possibilities**

- Identification of relevant panels
- Creating a synthesis model based on measured data
- Auralization and assessment of modification possibilities (sensitivity analysis)
- Estimation of optimization potential via acoustic comparisons
- Optimization (insulation factor, weight) of the noise insulation system

The individual airborne sound contributions of each partial panel can be auralized and assessed separately.
Modal analysis and operational deflection shape analysis (ODS)

What is the dynamic behavior of a vibratory system?
- **Modal analysis** enables a characterization of the dynamic behavior (resonance frequencies, modes of vibration).
- Based on its modal parameters, the vibration behavior of a system can be simulated and optimized regarding its acoustic effects.

Which modes of vibration occur during operation?
- **Operational deflection shape analysis** examines and visualizes the dynamic behavior of an installed component in its original system environment.
- This provides an insight into the origins of acoustic problems.

The representation of the resonance quantities is done in the time domain – two-dimensional (top) and three-dimensional (bottom).

Laser scanning vibrometry for non-contact measurement of vibration.

Head Visor – online identification of sound sources in real time

**HEAD VISOR** is a microphone array with three cameras for the
- localization,
- visualization,
- quantification and
- auralization of sound sources.

HEAD Consult NVH offers measurements and analyses in our NVH laboratories or on-site.

Learn more about our innovation in the area of microphone array technology under www.head-visor.com!
What is an appropriate sound?

To clarify this question, we perform custom-tailored listening tests for you:
- Ranking
- Paired comparisons
- Category judgment
- Semantic differential

With HEAD SQuare, consisting of hardware and software components, we realize a wide range of test designs.

Sound Metrics
In order to assess specific sound patterns, we create suitable metrics for you that allow an objective representation of the subjective judgment.

H3S allows interactive sound design while driving on the road!

Application Examples
Sound design in a realistic scenario
- Switch between different engine types while driving.
- Judge the acoustic effect of modifications (e.g. of the engine mount).
- Listen to different types of tires.
- Use Explorative Vehicle Evaluation (EVE) for the definition of target sounds.

With the mobile H3S, any car can be turned into an NVH driving simulator!
Multiple Coherence Filtering
From the interior noise of a vehicle, the wind and tire noise components (e.g. front drive train) can be determined by means of coherence-based analysis.

BTPA-based Method
With BTPA, airborne and structure-borne sound components can be analyzed even more precisely. By determining the transfer paths from the tires into the vehicle interior and to the artificial head, the individual components of the interior noise can be analyzed and auralized separately.

Sources of road noise:
- Airborne sound
- Structure-borne sound

Testing Facilities
At our headquarters in Herzogenrath, Germany, we operate numerous testing facilities and measurement rooms for solving acoustic tasks successfully:
- Four-wheel chassis dynamometer, semi-anechoic
- Semi-anechoic chamber with carlift for entire vehicles
- Three-dimensional measurement room, fully anechoic, for measurements of small components
- Engine and aggregate test bench
- Dynamic component test bench

On the mount test stand, the properties (dynamic stiffness, transmission impedance, 4-pole matrix) of aggregate and chassis mounts can be determined.

Our semi-anechoic chamber for entire vehicles offers lots of room for innovative measurements.

Our four-wheel chassis dynamometer can be used for vehicles with front, rear or four-wheel drive.
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