

# Enhance NVH&T Performance on New or Existing Platforms

From excavators to high-tech combines, modern construction and farming equipment can turn a quiet worksite into a noisy environment. This noise can be an unpleasant background nuisance to nearby residents, and even potentially dangerous to operators.

The solution: design-in vibration and acoustic damping from the ground up. Aearo Technologies LLC uses an engineered system approach to treat all noise sources and pathways to create the optimal package for your equipment.

## ▶ Enhancing NVH&T Performance

For agriculture and construction equipment manufacturers who want to improve their in-cabin noise and vibration performance on their equipment, our methodology can help!

## ▶ NVH Simulations and Testing

Aearo Technologies can conduct in-depth testing to analyze transfer paths of noise and vibration throughout the cab. Transfer Path Analysis and other tests are performed in a hemi-anechoic chamber at our Acoustic Technology Center (ATC).

### Three main tests are recommended:

1. Total radiated power test using intensity scanning (ISO9614-3 or Sound Power (ISO 3741 to USI 3747)
2. Structural or component excitation using a laser doppler vibrometer
3. Total cab structural response using hammer force input

### Each test is conducted in three different situations:

1. Testing of current NVH package
2. Testing of system without NVH treatment (Might include computer modeling to determine the optimal acoustic solution in the quickest manner)
3. Testing of various package options with E-A-R materials

Throughout a project, the same tests can be repeated for each solution package installed on the cab. This allows for the evaluation of each material iteration's acoustic and structureborne vibration performance using the most effective test method. In addition, the relative performance of each solution package can be quantified by way of transfer functions between their test and previous results.

## ▶ Results and Recommendations

There are typically a variety of contributing factors to the NVH characteristics of a mechanism. The best results will emerge when the equipment cab is treated as one system – instead of treating problem areas individually.

Good-Better-Best solution package options are made available to customers at the conclusion of a project. This will allow the customer to select a solution that meets both performance and cost targets for the project. This methodology will also enable us to work together with the customer in the future to continually improve their acoustics and develop new materials to fit their specific engineering requirements.

## ▶ Thermal Testing

Thermal characteristics are another issue of importance in the cab. At Aearo Technologies, we can conduct in-house testing in our ATC facility to accomplish the following:

- Evaluate the overall thermal rating and R-value of the cab at steady-state conditions
- Determine system hot spots
- Determine what areas to treat to alleviate any future issues

In conclusion, Aearo Technologies is a full service supplier of products and services to help support and enhance your NVH&T performance.

## Aearo's Acoustic Technology Center

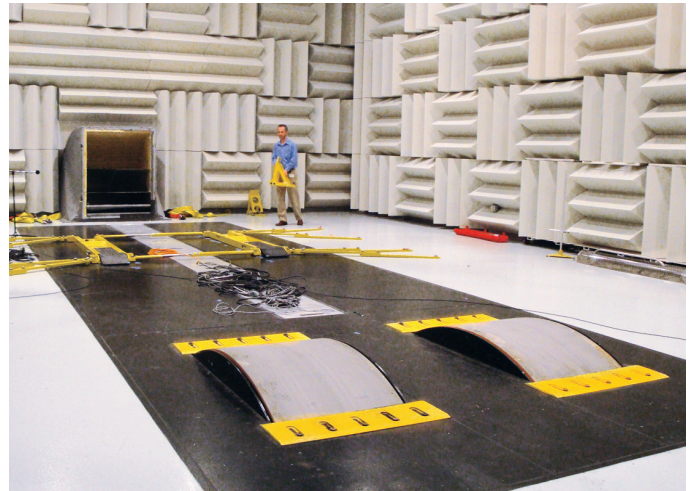
### Complex System Evaluation Leads to Efficient Acoustic and Thermal Packages

Decibel level and sound quality is a very important differentiator for an OEM. Our Acoustic Technology Center meets our customers' goals by identifying thermal and acoustic problems, developing a solution package, modeling results, and validating outcomes in agriculture equipment.

Our methodology is simple, but the process itself is intricate and complex.

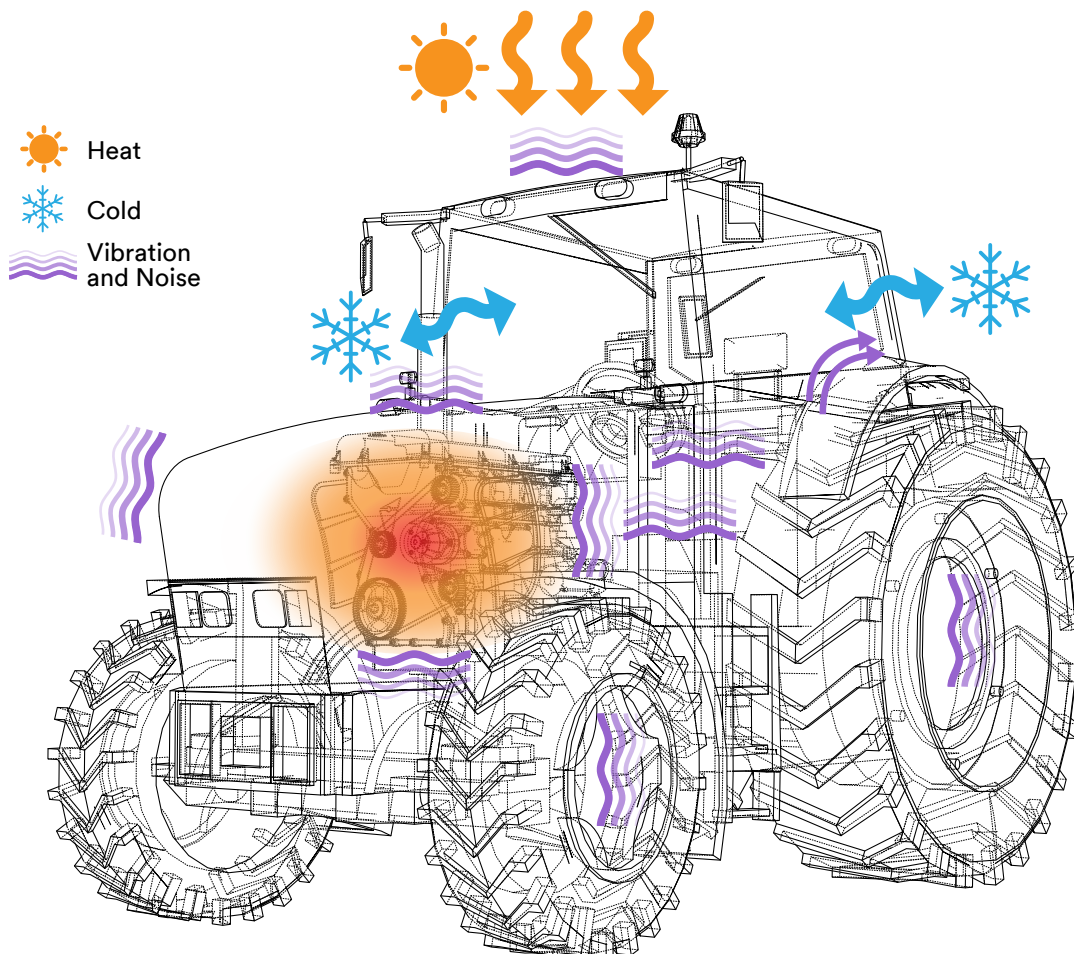
**Concept → Model → Verify → Produce**

The initial step is to definitively understand all the potential noise levels and sources. This information is generated by a variety of testing in our hemi-anechoic dynamometer room, hemi-anechoic room or one of our reverberant chambers. These rooms allow for measurement of either entire systems or components within the system. This assessment determines exactly what area in the cab needs to be treated to develop the most efficient and economical treatments.



The specialized Acoustic Technology Center at Aearo Technologies pinpoints application problems, allows for solution development and model outcomes, and can validate results--all under one roof.

Contact us to learn how we can help you analyze and optimize the thermal and acoustic performance of your equipment.



## Transfer Path Analysis (TPA)

The Acoustic Technology Center technicians focus on **Transfer Path Analysis (TPA)** to determine the paths that noise and vibration take from actively vibrating components (such as engines, gears, and accessories) and tracing those vibrations throughout the combine's structures. Using TPA, the technicians are able to determine the key noise and vibration path through the system and pinpoint the pathways that contributed in minor ways.

Once this testing is complete, the engineering team makes changes to the source and path to reduce the noise and vibration permeating through the system. By understanding the main source of the noise and vibration, the team is able to make changes more efficiently and effectively to the system. This ensures an optimal solution with a cost-effective kit.

## Laser Doppler Vibrometer

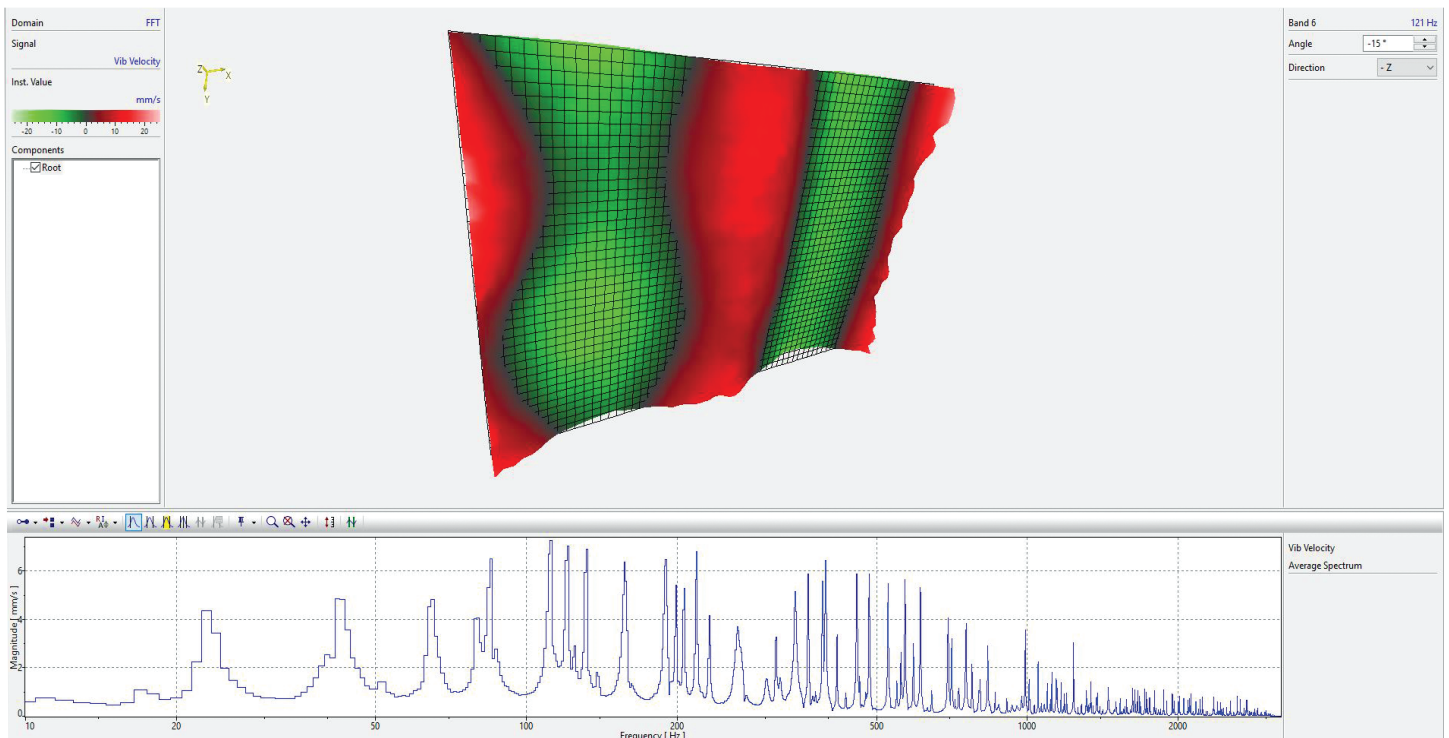
The laser vibrometer uses a laser beam to take vibrational measurements of the surface of the equipment being tested. These measurements give our technicians both the amplitude and the frequency of the vibrational energy being generated by the source. The testing generates an animated video showing the vibrations occurring in the structure and the information is put into software for further analysis. The graphic below

presents the information collected by the testing showing the amplitude and frequency of the vibration.

With this information, an engineering solution is developed with the damping material best suited for this frequency and allows the damping material to be placed in the crucial location to maximize the damping of the vibrational energy.

## Noise Source

The DS3 Dodecahedron Speaker is a lightweight, omnidirectional sound source used either outside the cab to simulate operational sounds incident on the operator or inside the cab at the driver's head location to both induce structural vibrations in the frame itself and support sound intensity measurements of the cab surface by means of acoustic reciprocity. The repeatability of this source is crucial in evaluating the effectiveness of various packages.







## Methodology for Enhanced NVH&T Performance in Agricultural and Construction Equipment

An optimal NVH&T package will be comprised of a variety of materials needed to achieve your specific goals and requirements. Aearo has a broad portfolio of thermal and acoustic products to tackle the wide range of problems that occur in construction and agriculture equipment. Here are a few materials that can be used in the kit.

### Engine Compartment

TUFCOTE™ high NRC acoustic foams and composites dissipate engine noise while their aluminized polyester film facings deflect heat away from the hood and protect the foam from dirt and grease.



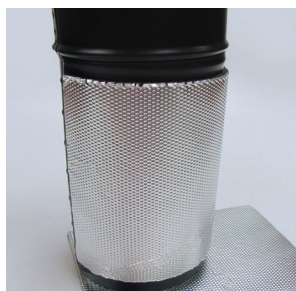
### Walls and Roof

Open cavities are filled with foam shapes and expandable foams to minimize airborne noise propagation and increase R value for comfort and energy efficiency.



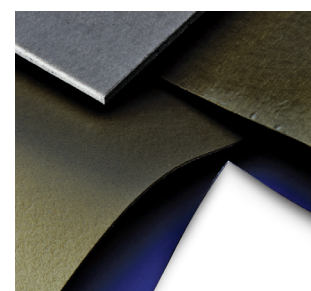
### Heat Management

TUFshield™ thermal barriers provide protection from high temperature environments to protect components and systems from unwanted thermal intrusion.



### Panels - Walls and Floor

ISODAMP™ damping materials virtually eliminate resonant structureborne vibration, preventing excessive interior noise.



### Technical Information

The technical information, recommendations, and other statements contained in this document are based upon tests or experience that Aearo Technologies believes are reliable, but the accuracy or completeness of such information is not guaranteed.

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