



Modal Analysis: The Silent Deal-Breaker

What you don't hear is just as important as what you do. Whether it's the quiet hum of an electric vehicle, the steady thrum of an aircraft engine, or the smooth operation of industrial machinery, controlling unwanted noise and vibration isn't just about comfort, it's about performance, safety, and brand reputation.

This is where NVH (Noise, Vibration, and Harshness) analysis steps in, and at its heart lies one of the most critical tools: modal analysis.

Understanding NVH and Modal Analysis:

NVH analysis examines how a product responds to dynamic forces, how it vibrates, how sound is transmitted, and how it feels to the end user. Modal analysis specifically studies the natural frequencies, damping, and mode shapes of a structure. Modal analysis doesn't just diagnose, it predicts.

Why this matters?

- Every component has a "natural frequency" at which it resonates. If operational forces match this frequency, vibrations amplify drastically, leading to noise, fatigue, or even failure.
- In automotive, a poorly tuned suspension system can make road noise unbearable at certain speeds.
- In aerospace, unaddressed resonance can cause structural fatigue, increasing maintenance costs and safety risks.

Studies show that more than 30% of NVH issues in vehicles stem from resonance-related problems that could have been identified earlier with proper modal analysis.

In manufacturing, proactive modal analysis has been shown to cut downtime due to vibration-related failures by up to 25%.

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NVH Using Simcenter Testlab

At the right frequency, even the smallest signal can move the heaviest structure.



(Source: aerospacetestinginternationals.com)

Why is it so crucial?

By knowing how a structure will behave before it's built, engineers can make design changes early, when they are 10x cheaper than post-production fixes. For decision-makers, this means fewer recalls, stronger market reputation, and a smoother path to compliance with global noise and vibration regulations.

How NVH Analysis Helps Industries Save Costs:

When a machine is noisy or vibrates excessively, the problem is rarely just about comfort—it's about money. From warranty claims to energy loss, NVH problems can erode profits in ways that are often overlooked.

The Financial Impact:

- **Warranty & Recall Costs:** A major automaker in 2021 faced \$50 million in recall expenses due to NVH issues in a new SUV model.
- **Energy Efficiency Loss:** Studies show that machines with uncontrolled vibration can consume 5–10% more energy over their lifetime.
- **Unplanned Downtime:** In heavy machinery, vibration-related failures can cause downtime costing \$5,000–\$20,000 per hour, depending on the industry.

How NVH Analysis Cuts These Costs

- 1) **Early Problem Detection** – Identifies root causes in prototypes, avoiding costly fixes after launch.
- 2) **Optimized Material Use** – By tuning structures to avoid resonance, manufacturers can reduce over-engineering and save on material costs.
- 3) **Extended Product Life** – Lower vibration means less fatigue, fewer replacements, and lower maintenance budgets.

According to industry benchmarks, every \$1 invested in NVH optimization can save \$7–\$10 in lifecycle costs. This is especially relevant for decision-makers focused on sustainability, as better NVH performance often aligns with energy efficiency goals.

By addressing noise and vibration at the design stage, industries can avoid unexpected costs, protect brand reputation, and deliver higher-value products to customers. For decision-makers, the real question is no longer whether NVH analysis is necessary, but how quickly it can be integrated across projects to unlock long-term savings and competitive advantage. Hence, in a market where margins are thin and customer expectations are rising, mastering NVH isn't just cost-saving, it's survival.

NVH Analysis Using Simcenter Testlab:

NVH testing is not just about detecting problems, it's about understanding the physics behind them and making informed design choices. Siemens' Simcenter Testlab is one of the industry's most powerful tools for this purpose.

Simcenter Testlab is not just another testing tool; it is a comprehensive data acquisition and analytics platform that integrates seamlessly with simulation workflows. It enables engineers to collect high-quality data from sensors, microphones, and accelerometers, process it in real time, and transform it into actionable insights. More importantly, it combines testing and simulation in a single environment, allowing companies to validate designs faster, reduce costly prototypes, and ensure compliance with strict noise and safety regulations.

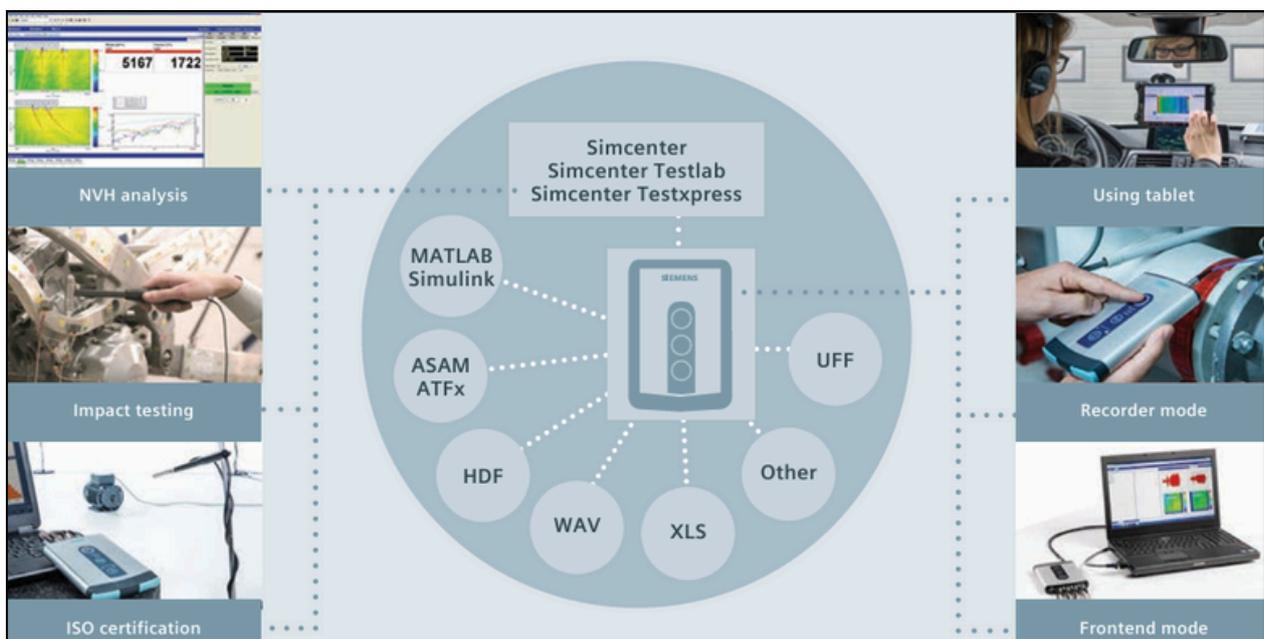
With its capability to handle large data sets, advanced modal analysis, and integration with digital twins, Simcenter Testlab gives manufacturers a competitive edge in developing quieter, safer, and more efficient products. For decision-makers in automotive, aerospace, and heavy machinery, adopting Simcenter Testlab isn't just about solving noise problems, it's about future-proofing their innovation pipeline.

What Simcenter Testlab Does:

Simcenter Testlab combines high-speed data acquisition with advanced analytics to give engineers a complete view of a product's NVH behavior.

Key capabilities include:

- Modal Analysis – Find natural frequencies and mode shapes quickly.
- Operational NVH Analysis – Understand how noise and vibration behave under real-world conditions.
- Sound Quality Analysis – Go beyond numbers to assess customer perception.
- Durability Testing – Correlate vibration profiles with structural fatigue.
- Integrated Data Acquisition and Processing - Handle hundreds of channels of acoustic and vibration data in real time.
- Durability and Transfer Path Analysis (TPA) - Pinpoints the exact path through which vibrations or noise travel (e.g., from engine mounts to cabin).
- Scalability and Digital Twin Integration - Fully compatible with simulation tools like Simcenter 3D, Amesim, or even CFD/FEA platforms.



(Source: Siemens)

Example: Automotive EV Development

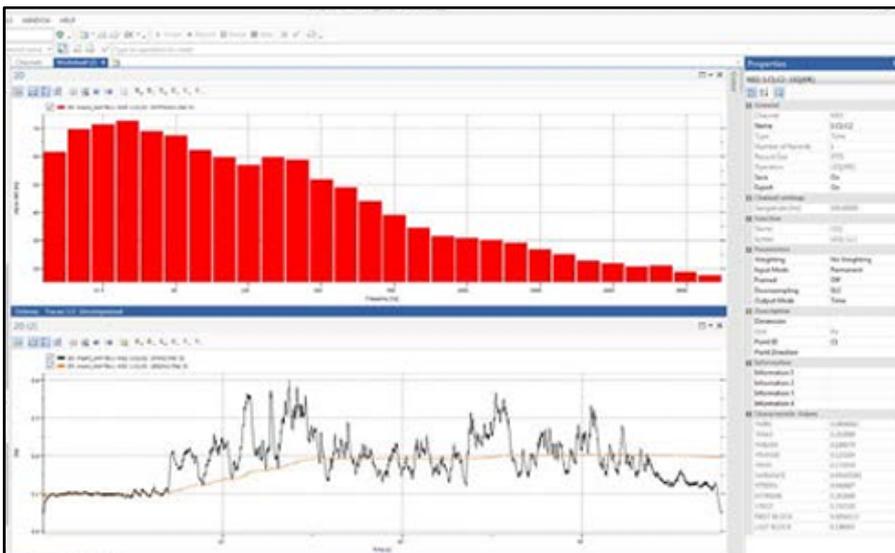
The rise of Electric Vehicles (EVs) has put NVH analysis under a spotlight. Unlike traditional cars with combustion engines that mask many noises, EVs are quieter by design, making even the smallest vibrations, gear whines, or road-induced noises more noticeable to drivers. This means that achieving acoustic comfort is no longer just a premium feature but a must-have for customer satisfaction.

A leading automotive OEM (Original Equipment Manufacturer) adopted Simcenter Testlab to address NVH challenges in their EV platform. Using advanced modal analysis and acoustic testing, engineers identified sources of high-frequency noise originating from the electric drivetrain and inverter system. Traditionally, such detection would require multiple physical prototypes, each costing over \$500,000 and taking months to build. With Simcenter Testlab, the OEM was able to cut prototype needs by 30% and reduce test cycles by 25%, saving both time and millions in R&D expenditure.

What made the difference was the integration of digital twins into the workflow. Engineers combined real-world data from Simcenter Testlab with virtual simulations to predict how structural modifications—like redesigned battery mounts or acoustic insulation would impact cabin noise. This allowed quick design iterations without waiting for physical parts. The result was a quieter cabin environment with a 15% improvement in perceived sound quality, verified through customer test groups before market release.

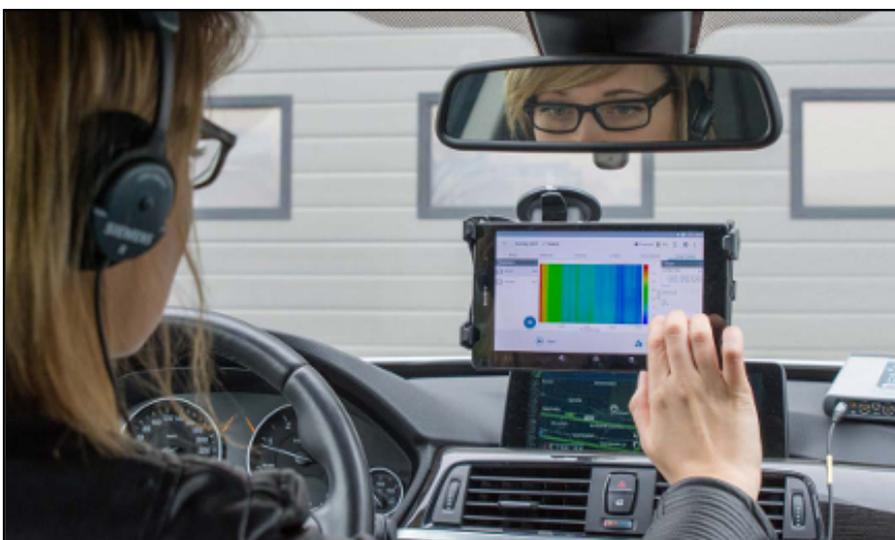
Beyond cost and performance, the company also ensured compliance with strict regulatory noise limits for EVs (such as the EU requirement for Acoustic Vehicle Alerting Systems). Simcenter Testlab gave them confidence not only in meeting standards but also in differentiating their vehicles with a smooth, premium sound experience that aligns with brand identity.

This case illustrates why NVH testing and simulation with Simcenter Testlab is a strategic tool for EV makers—it helps them bring quieter, safer, and more comfortable vehicles to market faster, while staying ahead of customer expectations and global regulations.



Octaves Analyzer:

The Octaves Analyzer in Simcenter Testlab allows engineers to evaluate noise and vibration data in octave and third-octave bands, which align with how the human ear perceives sound.



Sound Quality Assessment:

The Sound Quality Assessment combines binaural measurements with customer perception studies, helping OEMs refine vehicle sounds, reducing unwanted noise while enhancing the signature sound of EVs.

(Source: Siemens)

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