

NVH From the Vehicle to the Lab

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1. Problem Definition: NVH in Vehicle Components

- Squeak & Rattle is a major indicator of product quality, as the smallest issue is usually easily noticeable by end user.
- Most of the S&R issues appear due to road or engine vibration.
- This is especially important for interior components, that are in direct contact with car passengers:
 - Dashboards.
 - Steering wheel / airbag module.
 - Door panels and interior trims.
 - Seats.
 - Etc.





1. Problem Definition: NVH in Vehicle Components

- Traditional real life testing require driving prototype vehicles in test tracks, on different surfaces and with climatic conditions
 - \rightarrow Final validation conditions.
- In-vehicle noise detection and analysis can be inconvenient and difficult:
 - Expensive and scarce prototype vehicles.
 - Access to vehicles dependent on constructor.
 - Difficulty in accessing component parts.
 - Influence of noise generated by other elements.





1. Problem Definition: NVH in Vehicle Components

- Real life testing avoids late detection of unwanted problems and allows right component dimensioning.
- High cost increase of modifications in late development stages.

NVH issues need to be addressed from early stages of product development. Need for realistic early testing method.





2. Proposed Solution: from the Vehicle to the Lab

- Solution: bring the problem to a more controlled and convenient space: the lab.
- Main advantages:
 - Higher and earlier availability than prototype vehicles.
 - Easier noise source detection and evaluation.
 - High repeatability.
 - Possibility of immediate evaluation of solutions.
- CTAG has performed a research program focused in vibration environment characterization and simulation.







2. Proposed Solution: from the Vehicle to the Lab





- The operating environment (road or test tracks) must be first characterized
 → Measurement of the vibration induced by the road profile in the component.
 - Component instrumentation.
 - Data acquisition in road or test track.
- Possibility of using signals corresponding to previous versions of the same platform, for analysis in early stages of development.



- Signal analysis:
 - Acceleration level evaluation.
 - Frequency range analysis.
 - Detection of road events.
 - Extraction of road segments with significant information.
 - Signal correlation for DOF number definition
 - \rightarrow Monoaxis or multiaxis vibration.

- Traditional laboratory testing works with 1-DOF vibration reproduction.
- Experience shows that most of the components show multiaxis vibration that cannot be reduced to monoaxis vibration without loss of realism.

Simulation of component dynamic behavior through multiaxis vibration shaking.





• Further analysis is possible directly in the lab, for root cause determination:

- Component resonance.
- Non-linear behavior in high acceleration events.
- Effect of loading and ageing.
- Direct evaluation of different possible solutions.





4. Application to other Development Fields in Automotive Components

- The recorded and analyzed signals can be used for additional purposes:
 - Input for numerical simulations: fatigue, NVH, etc.
 - Measurement of operating deflection shapes (ODS): real loads are considered in non-linear components.
 - Component ageing and durability: 24h a day running.
 - Fatigue analysis:
 - Evaluation of damage induced on metallic components by road vibration.
 - Reduction of test length based on cumulative damage.







5. Trend in NVH Testing of Automotive Components

- Laboratory testing using high performance multiaxis shakers allows convenient detection and analysis of noise sources in car components.
- Subjective detection and evaluation is still used on a daily basis during vehicle and laboratory NVH tests, but lacks objectivity.
- Objective detection and evaluation of squeak & rattle during multiaxis vibration presents a complex challenge, but eases data analysis.



Design and implementation of a low noise facility for objective NVH testing of components under multiaxis vibration



NVH: from the Vehicle to the Lab

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