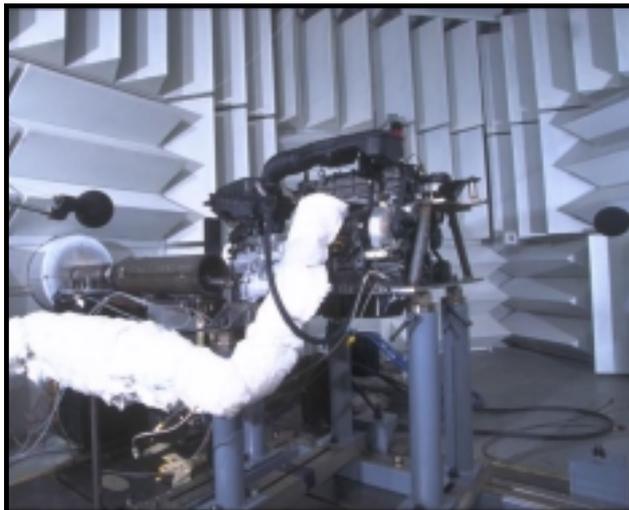


Powertrain NVH Development Overview

Customer perception of vehicle quality is closely related to its noise and vibration characteristics. The NVH behavior of the vehicle is significantly influenced by the powertrain. FEV maintains core expertise in the field of powertrain NVH development.

FEV utilizes empirical and CAE tools at various stages of the engine development process. One of the first steps is **target setting**. Extensive databases of competitive powertrains are used as well as **powertrain benchmarking** to develop targets and assist in identifying key design features that will ensure a strong basis for any new engine concept.



Specialized CAE tools have been developed to assist in the design of a new engine. In the early design stages of an engine, CAE tools are used to optimize the **engine structural dynamics** for minimized noise radiation. During the early stages of engine development, prototype hardware is evaluated in FEV's state-of-the-art hemi-anechoic test chambers. The first stage of development testing is **NVH weakness identification**. Utilizing the databases and targets set at the beginning of the program as well as extensive powertrain experience, FEV is able to evaluate the status of the powertrain, and identify critical areas that are detrimental to the overall NVH character of the powertrain.

FEV employs advanced measurement techniques to assist in the identification of the critical components while **troubleshooting** NVH concerns. These techniques focus

- NVH Target Setting
- Powertrain Level Benchmarking
- Troubleshooting
- Mechanical Noise Refinement
 - Valve train
 - Piston slap
 - Injection system
 - Chain, belt and gear drive
 - Cranktrain
- Combustion Noise
- Structural NVH Optimization
- Geartrain NVH
- Transient Noise Refinement

on the various excitation mechanisms, such as combustion noise, and various mechanical noise excitations.

Once a NVH weakness or problem is identified, FEV implements **advanced CAE tools** to analyze the effect of various design parameters on the component or system in question. Through extensive analysis, FEV is able to recommend effective production feasible modifications.

NVH refinement is required to ensure a best-in-class powertrain for radiated noise as well as sound quality. FEV has been involved in the refinement of numerous powertrains with many different applications, from economic to luxury, from fuel efficient to high output, and from gasoline to diesel applications. With this extensive experience, FEV is able to assist, or take complete responsibility in refining the NVH characteristics of any powertrain.

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