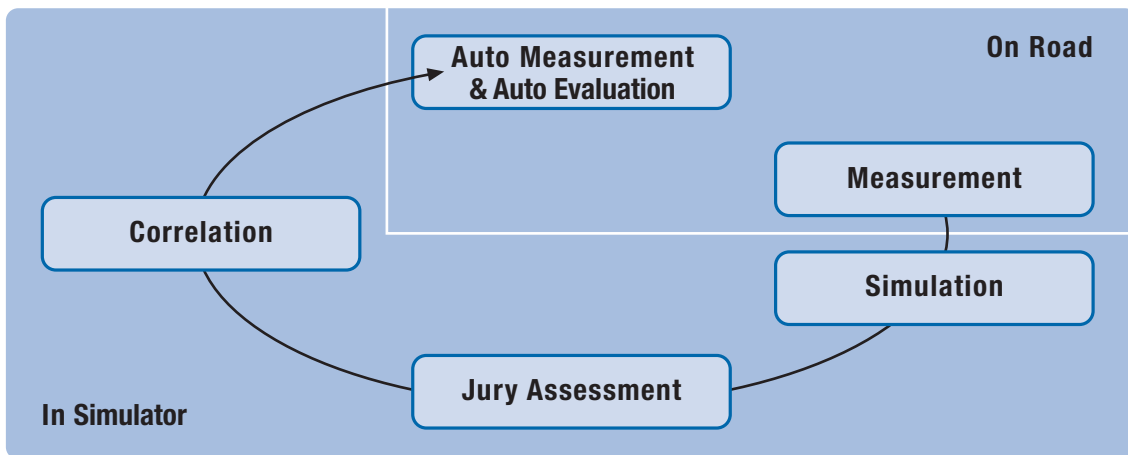


Application Note

Closing the NVH Loop: *Automating Impact Harshness Measurement & Evaluation*

Subjective evaluations of cars can be inconsistent, time consuming and labour intensive, even when the most experienced NVH and Ride & Handling engineers participate. This Application Note demonstrates the feasibility of replacing the engineers' traditional subjective evaluations with an 'intelligent' system that automates the data acquisition, numerical processing, reporting and management of data. The methodology requires a high-quality NVH simulator and experienced jurors to ensure the benefits of the subjective/objective correlation process are maximised. The end result is a rigorous, repeatable and reproducible process which can be operated by non-experts.



m+p international provides innovative software with the very latest acquisition hardware to provide an integrated Windows/Office environment to acquire, analyse and report comprehensive NVH data including structural and acoustic analysis. The emphasis in the development of their systems is portability, ease of use and versatility. Capabilities relevant to this project included:

- Throughput recording
- Spectral analysis
- Order analysis
- Octave analysis
- Sound quality analysis
- Browser style data management
- Customisable user interface
- Customisable data processing

A leading OEM undertook a research project supported by Sound & Vibration Technology Ltd (SVT) – www.sovibtech.com – which concentrated on the development of metrics to quantify the ride comfort and impact harshness of cars. The aim was to develop objective methods of measuring, analysing and reporting road measurements to provide subjective results. The following variables were included in the correlation study undertaken with a large jury sample:

- Various car types
- Vehicle speeds
- Road surfaces for ride comfort and for impact harshness



The project used SVT's Full Vehicle NVH Simulator which is based around a typical family saloon as shown on the left. The vehicle is driven exactly as it would be driven on the road because the stimuli are driver-in-loop. This means that the noise, vibration, visuals and steering feel all respond in real-time to:

- Road Speed
- Road Surface
- Throttle Position
- Gear selected
- Engine Speed
- Clutch
- Steering
- Brakes

The Full Vehicle Simulator satisfies the requirements of **CONTEXT** because the driving skills and concentration required are comparable to a real vehicle. The requirements of **INTERACTIVITY** are achieved because the controls are identical to a real vehicle, even to the extent of using a real key to start the virtual engine.

The simulator enabled parameters which are dependent on the road to be varied independently in the simulator, as follows:

- Noise and seat, floor and steering wheel vibration
- Front and rear impact severity
- Spectral content

Consistency in typical subjective road assessments of impact harshness is difficult to achieve. The use of the NVH Simulator eliminates variables by ensuring that all the assessors (drivers) are subjected to exactly the same noise and vibration stimuli. During the NVH Simulator correlation process over 1700 subjective ratings were made by a team of expert engineers on the road and then repeated in the NVH Simulator. Nearly 80% of the assessments were within 1 subjective rating score (on a 1 to 10 scale) of the road assessment.

Modified noise and vibration stimuli were developed using subjective assessments by the expert engineers in the NVH Simulator. The results of these evaluations were verified using non-expert assessors.

The final stage of the project was to calculate a series of noise and vibration metrics for the stimuli which most closely followed the preferences identified in the jury appraisals. Examples of the metrics calculated include amplitude based methods such as dB, RMS, VDV, crest factor as well as more advanced temporal and spectral sound quality metrics such as transient loudness, intelligibility and sharpness. Additional metrics were calculated using the ISO vibration weighting curves.

The vehicle OEM chose m+p international (UK) Ltd to embed the metrics developed by SVT into a portable system for objective measurements to provide subjective results. The following challenges presented themselves for developing the data acquisition system:

- Portable system
- Driver operation
- Simultaneous acquisition of noise and vibration data from 16 channels
- Logical data acquisition interface with faulty signal detection
- Straightforward data management
- Automatic metric calculation
- Online & Offline capability
- Automatic reporting
- Option to add GPS vehicle identification in the future

The following screenshots from the portable in-car acquisition system show major features of the acquisition and analysis process:



This process can be applied to any NVH evaluations including idle shake, driveability, road noise, wind noise, exhaust noise, etc.

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