

## **Advanced measurement technologies and innovative analyses to meet NVH-challenges for alternative drives**

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Sound quality of vehicles has become very important for car manufacturers. It is interpreted as among the most relevant factors regarding perceived product quality and is important in gaining market advantage. The general sound quality of vehicles was gradually improved over the years. However, today the development cycles in the automotive industry are constantly reduced to meet the customers' demands and to react quickly to market needs. In addition, new drive and fuel concepts, tightened ecological specifications, extension of infotainment systems in cars, increase of vehicle classes and increasing diversification (increasing market for niche vehicles), etc. challenge the acoustic engineers trying to develop a pleasant, adequate, harmonious passenger cabin sound. Another aspect concerns the general pressure for reducing emission and fuel consumption, which lead to vehicle weight reductions through material changes also resulting in new noise and vibration conflicts.

Furthermore, in the context of alternative powertrains and engine concepts, the new objective is to detect and implement the vehicle sound, tailored to suit the auditory expectations and needs of the target group. New questions must be answered: What are appropriate sounds for hybrid or electric vehicles? How are new vehicle sounds perceived and judged? How can customer-oriented, client-specific target sounds be determined? Which sounds are needed to fulfil the driving task, and so on?

Thus, advanced methods and tools are necessary which cope with the increasing complexity of NVH-problems and conflicts and at the same time which cope with the growing expectations regarding the acoustical comfort. Moreover, it is exceedingly important to have already detailed and reliable information about NVH-issues in early design phases to guarantee high quality standards. This requires the use of sophisticated simulation techniques, which allow for the virtual construction and testing of subsystems and/or the whole car in early development stages. Only then, high quality standard with respect to noise and vibration can be achieved. The virtual testing is very important especially with respect to alternative drive concepts (hybrid cars, electric cars, hydrogen fuel cell cars), where complete new NVH-problems and challenges occur which have to be adequately managed right from the beginning. In this context, it is important to mention that the challenge is that all noise contributions from different sources lead to a harmonious, well-balanced overall sound. The optimization of single sources alone does not automatically result in an ideal overall vehicle sound.

The paper highlights modern and innovative NVH measurement technologies as well as presents solutions of recent NVH tasks and challenges. Furthermore, future prospects and developments in the field of automotive acoustics are considered and discussed.

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