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Establishing the dream of zero physical vehicle prototypes - Inspiring approaches for Virtual NVH prediction

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Plenary Abstract

Automotive OEMs and suppliers alike are continuously looking at reducing development cost and the recent pandemic has only put even more pressure on them from a financial perspective. The need to be more predictive in early stages of development isn't new at all. Terminology as front-loading through simulation or shift-left are quite familiar. There is quite a big push to reduce the number of prototypes and some have even set forward the goal of building zero prototypes. Whether that is achievable or not is up for debate but it is clear that the number of vehicles that will be available for verification and validation will be limited.

When it comes to noise and vibration this is just another element to complicate life. Roughly 10 to 15 years ago, it would be very common for engineering teams in automotive OEMs to dismiss NVH as a crucial attribute when it comes to electric vehicles because they are intrinsically quieter. Now, the story is very different. The lack of engine noise has proven to be the source of many concerns. With that background noise gone, many other noise sources have come to the foreground with road noise and wind noise being the most prominent but miscellaneous noises coming from HVAC, power steering, wipers, and potentially many others are joining in to create an often undesirable ambient.

The goal we have to set forward is therefore to increase the predictivity of NVH from the various noise sources from as early as possible in development and minimize troubleshooting in late development stages. In this presentation we want to provide a couple of technologies that contribute significantly to answering this goal.

The first one is the capability to build full vehicle models from sub-system and component models and predict the resulting noise characteristics. The sub-system and component models can be coming from test or simulation and are stored in a central database for easy re-use in different vehicle models. Core to this all is the possibility to characterize 'source' components in a vehicle-independent way based on the concept of blocked forces and/or free velocities. This effectively extends the well-known FRF-based sub-structuring technique beyond passive components that are described purely by FRFs to include components that actually put loads into the system. This technology in combination with a practical user experience to build vehicle variants in a convenient way allows for early design space exploration and higher confidence toward final NVH quality.

The second is the use of data analytics and AI on the extensive historical test data that is available in most if not all automotive companies. Data analytics is not a new concept, from information to insight to optimization. This process has been followed and put in place for a very long time. The overall data science procedure is a five-step process.

The first stage is the generation of the data, which, in the case of test, is the recording phase but it could just as well be simulated dat. The key is consistency of data: labeling of channels/sensors and conditions for example. The second (data exploration) and third (data engineering) stage are very much related to each other. These are the stages where domain expertise is required in terms of setting the right goals or KPIs (key performance indicators) that are to be extracted from the data. The fourth stage is building the AI model, optimizing parameters and evaluating the results. Finally, the model can be exploited to predict NVH characteristics of future vehicles and to support design decisions very early in the development process.