Frontloading attribute engineering into the concept phase

LMS Engineering Services pioneers dedicated processes to reduce development time and balance multiple performance attributes in the concept phase

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Ever shorter time to market, an exploding number of vehicle variants and growing customer expectations continuously increase the competitive pressure in the automotive industry. Successful manufacturers have radically transformed their vehicle development process and have sharpened their ability to make reliable design decisions based on virtual prototype simulation.

Very early design decisions have a significant impact on the intrinsic structural and dynamic properties of the car. The concept development of the chassis, for example, will be strongly focused on delivering the desired handling for the new design. All the same, the core setup of the chassis has a major impact on ride comfort and the overall NVH performance of the vehicle. Not taking these key attributes into account might result into major difficulties in reaching vehicle-level NVH targets later on.

Through its vast experience in the automotive industry, LMS Engineering Services has developed dedicated processes and simulation technologies to simultaneously address multiple performance attributes during the concept phase. As a result, key attributes can be balanced and a series of weak spots and potential problems eliminated in the concept phase.

Optimizing driveability in the concept stage

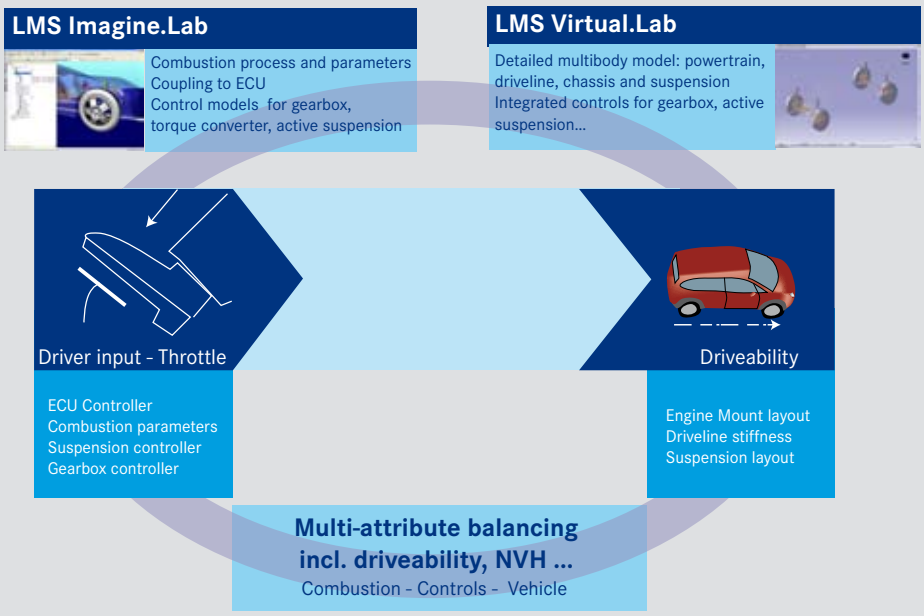
Driveability is one of the important engineering concerns in the design of a powertrain mounting system. A vehicle's driveability is characterized by the amount of low frequent body vibrations during transient throttle maneuvers like tip-in, tip-out and gear shifting. It is an important differentiator for the vehicle brand and represents a challenging engineering problem.

In multiple projects, LMS Engineering Services has deployed a simulation methodology that applies optimization loops to the design of the mounting system already in the concept phase. Additionally, however, environmental concerns such as fuel efficiency are increasing the pressure on attribute engineering departments. A new engineering challenge lies in achieving driveability targets while meeting fuel efficiency and emission requirements.

Driveability is mainly driven by the combustion process where ECU systems regulate combustion pressure to ensure maximum fuel efficiency. Taking into account driveability targets implies that combustion pressure needs to become a variable rather than a fixed parameter in the optimization process. LMS Engineering Services and the LMS Imagine division have developed a new methodology that uses predictive models of combustion pressure and includes it as a variable in the optimization process of the powertrain mounting design. The virtual combustion pressure calculation includes key components such as the engine ECU and the injection system, together with the combustion process. After the reconciliation of driveability and fuel efficiency targets, automotive development teams will have to take on the next challenge of including NVH targets in the multi-attribute optimization. LMS Engineering Services is currently developing new methodologies to meet this challenge.

Frontloading ride comfort and road noise simulation

CAE-based chassis design is typically carried out in the early concept phase of the vehicle development. At that point, vehicle dynamics is usually the only attribute taken into account. The development team optimizes chassis parameters such as hard point locations and bushing stiffness for vehicle dynamics without considering the often conflicting requirements for NVH or ride comfort. As a result, many problems related to road noise, ride comfort or other NVH domains remain to be solved in the detailed development and refinement phase.



LMS Engineering Services and the LMS Imagine division have developed a new methodology that enables the virtual prediction of combustion pressure and includes it as a variable in the optimization process of the powertrain mounting design.

LMS Engineering Services has developed dedicated processes and simulation technologies to simultaneously address multiple performance attributes during the concept phase.

A close analysis of NVH and ride comfort in the concept stage would definitely improve this process. But this requires sufficiently accurate and detailed models, which are simply not yet available in the concept phase. To overcome this hurdle, LMS Engineering Services has developed an innovative approach that directly derives the required models from the available vehicle dynamics model. To improve its accuracy, the vehicle dynamics model is enriched with a limited set of additional information where needed. For example, component flexibility is added for ride comfort and a dedicated NVH tire model is included for road noise analysis up to 300Hz.

In the case of NVH, an advanced substructuring technology Frequency Based Substructuring (FBS) dramatically increases the calculation and thus optimization speed and enables the inclusion of test-based information in the vehicle dynamics model. Additionally, a process was developed which enables attribute optimization to be driven from a common set of parameters. This means, for example, that a change in hard point location will affect all attribute calculations.

Advanced load prediction for durability analysis in the concept phase

An approximate concept model of the vehicle body is not sufficient to accurately analyze the durability performance of a new vehicle design. One must be able to predict the loads and to analyze the propagation of these loads through the wheels and the suspension. But the actual loads can only be measured when the first physical prototype has been constructed and tested on an endurance test track.

LMS Engineering Services developed the Hybrid Road approach that bypasses the need for a fully conform prototype and enables the prediction of loads on new vehicles through measurements on a predecessor vehicle. The approach starts by back-calculating the road profile of the predecessor vehicle, based on measurements and CAE models of the predecessor. Once the road profile is obtained, the vehicle model is virtually driven over the road profile and component forces are calculated.

The Hybrid Road approach is unique in that it enables a full-blown durability analysis before a prototype is available. Even without measured loads, the body inputs can be calculated based on knuckle displacements from a predecessor vehicle to guarantee accuracy and consistency through the different models.

The Hybrid Road approach enables vehicle development teams to take the targeted durability performance into account during the concept phase. LMS offers dedicated services to deploy the approach and to guide engineering teams in achieving an overall improved durability performance. ■

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LMS is focused on the mission critical performance attributes in key manufacturing industries, including structural integrity, system dynamics, handling, safety, reliability, comfort and sound quality. Through our technology, people and over 25 years of experience, LMS has become the partner of choice for most of the leading discrete manufacturing companies worldwide.

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