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Automobili Lamborghini

Simcenter Amesim helps Automobili Lamborghini create the Aventador LP700-4 driveline concept design

Product

Simcenter

Business challenges

Implement a simulation process to detect the possible root cause of noise

Avoid booming noise from powertrain and clunking noise from the gearbox

Optimize design for NVH performance

Keys to success

Easily model complex dynamic systems using prepackaged components

Generate models with the complexity in function of the phenomena the user intends to investigate

Benefit from efficient execution of what-if analysis

Results

Designed the torsional vibration characteristic of the Aventador LP700-4 driveline (using Simcenter Amesim)

Supported torsional vibro-acoustic driveline optimization

Siemens PLM Software solution enables automaker to support torsional vibro-acoustic driveline optimization

Noise is not the same as sound

Dealing with extremely demanding quality and performance targets is daily business at Automobili Lamborghini, one of Italy's most prestigious sports car brands. These supercars are built to impress. Besides a breathtaking design, sporty driving experience and powerful explosion when pushing the throttle, customers expect to hear the brand's characteristic sound when "all the horses" are released. Combining those prerequisites can be challenging. Although high-power generation leads to high internal torsional forces, and stable ride and handling calls for a stiff chassis, engineers have to make sure that sound does not become noise, and that the produced sound level complies with legislative requirements.

Giacomo Papotti and Claudio Manzali, research engineers in the Lamborghini transmission department, witnessed the complexity of conflicting targets while designing the Lamborghini Aventador LB700-4 driveline.

"Even the smallest noise that can disturb the driver needs to be avoided," says Papotti. "Our test drivers experienced booming noise from the powertrain and a clunking noise from the gearbox while testing prototypes

during the development phase. The traditional way to solve such problems was by adding mass elements to change the eigenfrequencies, or by modifying support stiffness.

"But increasing weight obviously has to be avoided at all times, and there is a risk of introducing new resonances. This manual process requires a lot of iterations and is very lengthy. Our mission was to find an effective simulation process to detect the root cause of noise issues and perform optimization."

Insight through fast and correct modeling
Being a satisfied LMS Test.Lab™ software customer for many years, Lamborghini decided to use Simcenter Amesim™ software, also part of the Simcenter™ portfolio from product lifecycle management (PLM) specialist Siemens PLM Software.

Simcenter Amesim was employed to evaluate the torsional vibration response of the driveline to the cylinder pressures. The Lamborghini engineers are especially pleased with the efficiency, scalability and reliability of Simcenter Amesim.

"The prepackaging of components helps a lot when modeling complex dynamic systems," says Papotti, "and the modularity of the software allows generating models with a complexity in function of the phenomena the user intends to investigate. Thanks to the availability of detailed dedicated libraries, users can efficiently create models that simulate real-life behavior.

"During the simulation, a few secondary variables, like the rotational speed of the gearbox shaft, were successfully correlated to measurements, giving us full confidence in the correctness of the model."

"We can give more precise directions to our suppliers and save a lot of hardware loops. We have really succeeded evaluating many more possibilities in shorter time thanks to using Simcenter Amesim."

Ing. Giacomo Papotti
R&D
Transmission Department
Automobili Lamborghini

Generating a correct model in a fast and easy way is an important strength of Simcenter Amesim. The entire simulation model for torsional behavior of the driveline can be created by ready-to-use components from the powertrain library, in addition to a few components from the mechanical design and signal control libraries.

"The construction of the model was very easy because all building blocks were already there," says Manzali. "Only about 25 percent of our time went into the modeling. The remaining 75 percent was calibration work that includes defining all the parameters. Most of those were acquired by testing. We only sometimes needed data from suppliers. The data could easily be plugged into our Simcenter Amesim models."

Despite the rather simple model setup, the Simcenter Amesim simulation models were able to be used to provide Lamborghini with the necessary insight to solve the noise issues much more effectively than in the traditional way.

"All parameters can be analyzed during simulation," says Papotti. "Batch simulation allows producing graphs for calculated values in function of the different parameters. This ensures fast, easy and detailed insight in the system's dynamic behavior. This efficient workflow is a real added value to our process and saves us a lot of time. We can give more precise directions to our suppliers and save a lot of hardware loops. We have really succeeded at evaluating many more possibilities in a shorter time by using Simcenter Amesim."

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The tool of the future

With a successful introduction, Lamborghini engineers plan to continue using Simcenter Amesim. Both the model and results have been adopted by the entire Lamborghini research and development (R&D) department.

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