SIEMENS

Automotive and transportation

Automobili Lamborghini

LMS Imagine.Lab Amesim helps Automobili Lamborghini create the Aventador LP700-4 driveline concept design

Product

LMS

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 LMS 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.

Results *(continued)*

Detailed physical insight into the system's dynamic behavior

Drastically reduced number of hardware loops

Provided available model and results for further projects

"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 LMS Imagine.Lab Amesim™ software, also from product lifecycle management (PLM) specialist Siemens PLM Software. LMS 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 LMS 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

"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 LMS Amesim."

Ing. Giacomo Papotti
R&D
Transmission Department
Automobili Lamborghini

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."

Generating a correct model in a fast and easy way is an important strength of LMS 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 LMS Amesim models."

Despite the rather simple model setup, the LMS 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

"Owning a complete simulation model of the driveline is a huge added value to our development work. It will allow us to easily evaluate changes on the base model and it can be used any time the market or legislation pushes us into a new challenge."

Ing. Claudio Manzali
R&D
Transmission Department
Automobili Lamborghini

Solutions/Services

LMS Imagine.Lab Amesim
www.siemens.com/plm/lms-amesim

Customer's primary business

Automobili Lamborghini S.p.A. designs and develops luxury sports cars and supercars for worldwide markets: Europe, Middle East, Africa, America, and Asia and Pacific countries. The company was founded in 1963. Automobili Lamborghini operates as a subsidiary of Audi AG.
www.lamborghini.com

Customer location

Sant'Agata Bolognese
Italy

"The prepackaging of components helps a lot when modeling complex dynamic systems, and the modularity of the software allows generating models with a complexity in function of the phenomena the user intends to investigate."

Ing. Giacomo Papotti
R&D
Transmission Department
Automobili Lamborghini

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 LMS Amesim."

The tool of the future

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

"Owning a complete simulation model of the driveline is a huge added value to our development work," says Manzali. "It will allow us to easily evaluate changes to the base model and can be used any time the market or legislation pushes us into a new challenge.

"The true power of LMS Amesim is demonstrated by how easy it is to evaluate different driving conditions, software or hardware changes and even different configurations; and the speed at which those modified models give us correct results and trends."

"The true power of LMS Amesim is demonstrated by how easy it is to evaluate different driving conditions, software or hardware changes and even different configurations; and the speed at which those modified models give us correct results and trends."

D Ing. Claudio Manzali
R&D
Transmission Department
Automobili Lamborghini

Siemens PLM Software

Americas +1 248 952 5664
Europe +32 16 384 200
Asia-Pacific +852 2230 3308

www.siemens.com/plm

Z3 43541 11/14 H