LMS Imagine.Lab AMESim Powertrain Transmission

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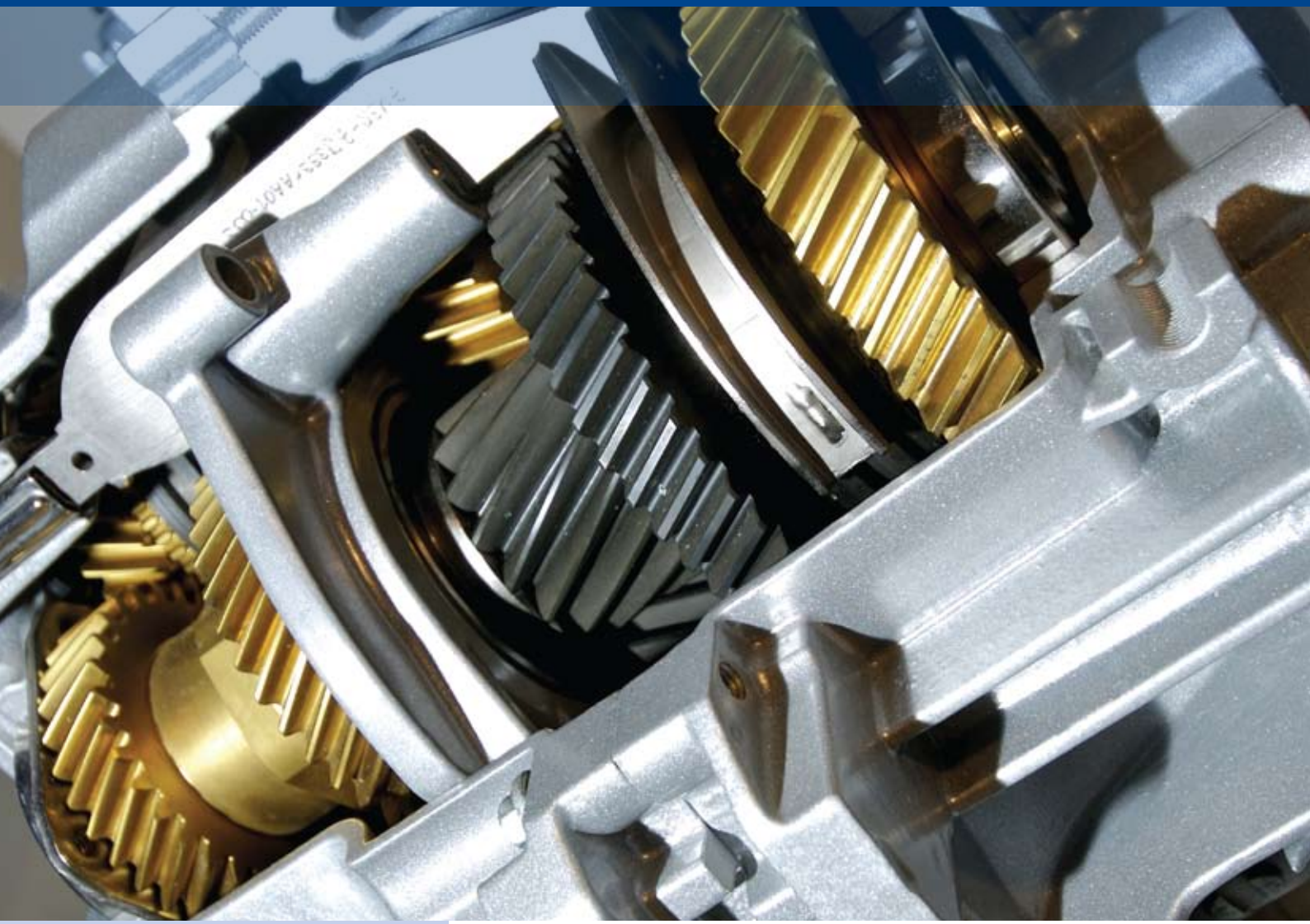
LMS Imagine.Lab Powertrain Transmission

LMS Imagine.Lab Powertrain Transmission provides a generic platform for analyzing and designing optimal transmission systems. LMS Imagine.Lab Powertrain Transmission gives access to driveline, engine and transmission models and components, and focuses on comfort, performance, losses and NVH (Noise-Vibration-Harshness) issues. These solutions help users to study the global behavior of the entire powertrain architecture, from low to high frequencies (> 40 Hz).
LMS Imagine.Lab Powertrain Transmission facilitates the development of new concepts and solves powertrain transmission challenges such as high shift quality and low noise level of drivelines. It gives access to robust and effective modeling of non-linear phenomena as one may find in dry or wet clutches and also in dampers, dual mass flywheel, mass balancer, universal joints and gears backlash. The development time of powertrain systems can be significantly reduced from months to weeks, and the maintainability of models is greatly facilitated, thus increasing life-length while reducing costs of systems development. The constant evolution of application libraries ensures applicable models in an ever-changing industrial world.



- → Transmission Comfort
- → Noise, Vibration and Harshness
- → Performances and Losses

References

General Motors - Automatic transmission development and hardware-in-the-loop testing
Ford Motor Company - Modeling for electro-hydraulic subsystems in automatic transmissions
Renault - Manual and automatic gearbox study
Valeo - Transmission modeling for dynamic behavior, axial and torsional vibrations and stability study
ZF Getriebe - Simulation of the hydraulic control unit of the automatic transmission 6HP26
Volvo (Renault Trucks) - Powertrain vibrations and crankshaft deflexion/torsion study
Borg Warner - Hydraulic control unit skills for full service application
Elasis - Development and validation of a Selespeed gear-box model

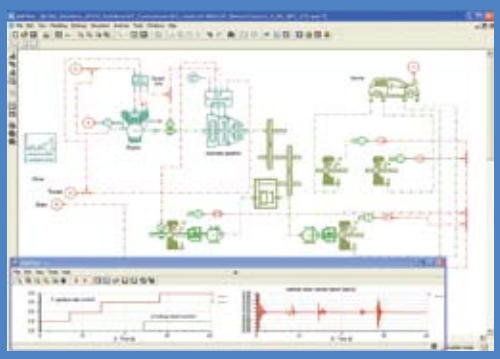
LMS International | info@lmsintl.com | www.lmsintl.com

LMS Imagine.Lab Transmission Comfort

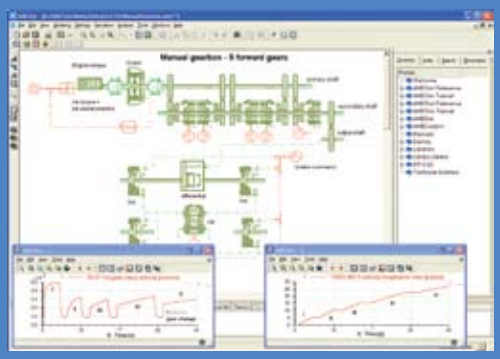
The main challenge for today's car and truck manufacturers is to increase their vehicles' performance, while reducing fuel consumption pollutants emissions. At the same time, the vehicle's comfort needs to be increased. LMS Imagine.Lab Transmission Comfort helps to accelerate the complete powertrain design. It guarantees maximum driver comfort through optimal shift transmission quality and provides a good torque applied to vehicles from engine through driveline. With LMS Imagine.Lab Transmission Comfort, users can comprehensively study the entire physics and control strategies of gear shifting for every kind of vehicle architecture (gearbox, driveline and engines) to improve comfort and avoid bad oscillations (0-40Hz). Every classical or "exotic" vehicle architecture can be computed with a flexible toolset that is included in the various structured libraries of physical models and consists of different complexity levels (from complex models validated at 40Hz to real time models).

LMS Imagine.Lab Transmission Comfort provides a comprehensive, flexible development framework ranging from design to validation and control. Thanks to off-the-shelf component libraries, users have access to graphical multi-physics system design, simulation and analysis in a single environment. The solution handles various levels of engine behavior (cold start, starter, etc.) and any kind of transmission (hybrid, DCT, IVT, AT, MT, CVT...). Users can combine all possible components in a gearbox, driveline or engine and subsequently analyze the total system design, thereby focusing on the comfort impact of defined strategies. The solution further offers to connect engine acyclism and vehicle driveline databases. Frequency analysis tools (modal shapes, eigenvalues, FFT, etc.) as well as the AMESet provide an accurate environment to represent physical details of a specific component design.

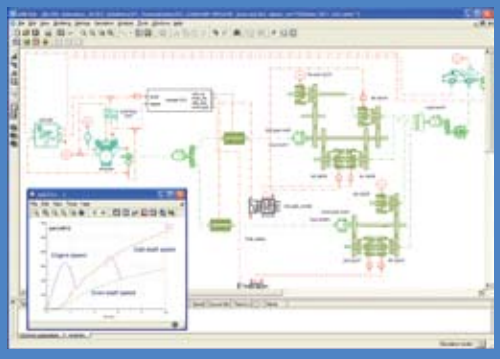
LMS Imagine.Lab Transmission Comfort provides an optimal shift quality for every transmission technology.



Automatic transmission: gear shift impact on passenger comfort.



Manual transmission: Powertrain Library icons facilitate the recognition of different elements - the resulting sketch is very close to a technical plan of a gearbox.



Dual Clutch Transmission: validation of gear shifting control strategies.

Features

- Multi-domain system simulation platform
- Multi-level engine representations (2D, 3D, with different acyclism representations)
- Multi-level transmission representations (complex 40Hz to real time models)
- Modeling of all transmission types (hybrid, DCT, IVT, AT, MT, CVT)
- Wide range of driveline components (clutches with flexible models of dampers, U-joint, piloted differential, tires, 2D or 3D vehicle models)
- Design exploration matrix
- Coupling tools with Simulink and real-time platforms

Benefits

- Modeling of all possible gearbox designs and powertrain architectures in a single integrated platform
- Modeling of every type of actuator
- Better physical insight into driveline vibration due to gear shift actuation
- Significant reduction of chassis dyno tests using off-line test procedure validation (HIL or/and SIL)
- Increased quality of final products
- Reduced time-to-market and lower costs

LMS Imagine.Lab Noise, Vibration and Harshness

LMS Imagine.Lab Noise, Vibration and Harshness (NVH) gives users an in-depth understanding of the NVH powertrain system performance. The solution provides all the required information on the root causes of noise and vibration problems related to hydraulic dynamics, mechanical contacts or slip control. These can potentially generate a negative quality perception or key component durability problems. Moreover, with LMS Imagine.Lab Noise, Vibration and Harshness, mechanical parts and overall system architecture can be optimized. Uses can focus on NVH sources and related corrective component efficiency: engine torsional harmonics, driveline vibration analysis, dual mass flywheel, clutch dampers, idle noise (>300Hz) and whining noise (>1 kHz).

The solution provides a better physical understanding of driveline vibrations due to a combination of linear and nonlinear systems (dry frictions, variable stiffness, endstops, bearings, joints, gear backlash). The Finite Element (FE) import interface is able to include any FE mesh (modal base or condensed) in an AMESim sketch to study the coupling between mechanical 3D structures or 3D shafts with actuators (electrics or hydraulics).

Engineers can considerably reduce the number of vehicle dynamics test benches, using AMESim's off-line test procedure validation on any vehicle powertrain architecture:

- Transmission part: mechanical, automated, dual clutch, infinitely variable, continuously variable
- Driveline part: universal joints, clutch dampers, dual mass flywheel, chassis
- Engine part: crankshaft, camshaft, valves, rocker arms

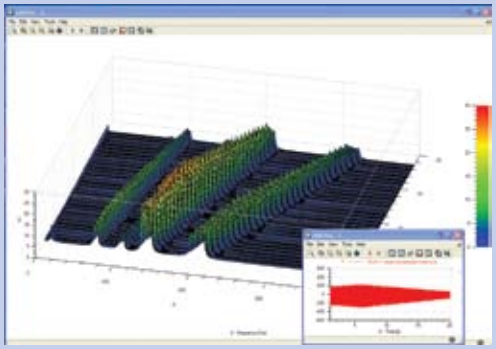
Features

- All frequency tools to accurately analyze oscillations (eigenvalues, modal shapes, order tracking frequency response analyzer)
- Coupling of linear and non-linear models
- Capability to connect Finite Element models (optimized for reduced CPU time) and non-linear actuators excitations

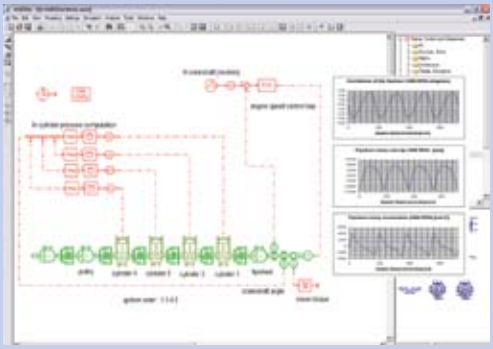
Benefits

- Ease of representing fluid and mechanical dynamics
- Detection and modification of natural modes contributors to reduce vibrations
- Reduction of contact force variations with backlash through teeth and planets optimization

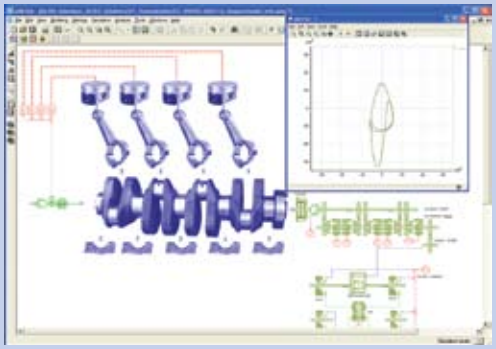
Vibration analysis of a truck driveline: eigenvalues and modal shapes.



Vibration analysis of a truck driveline: spectral map.



Engine torsional harmonics with variable number of cylinders.



Specific Finite Element submodels for advanced applications (here a 3D engine) based on modal analysis.

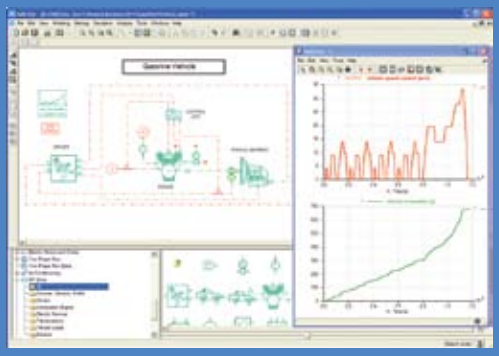
LMS Imagine.Lab Performance and Losses

With LMS Imagine.Lab Performance and Losses, users can define vehicle powertrain architectures for dedicated studies on performance and consumption. This helps engineers to design optimal strategies to reduce fuel consumption while providing a consistent output power curve within the engine's best operating range, which reduces mechanical losses and optimizes controls. LMS Imagine.Lab Performance and Losses gives engineers the required insight to take key design decisions for optimal customer satisfaction and comfort.

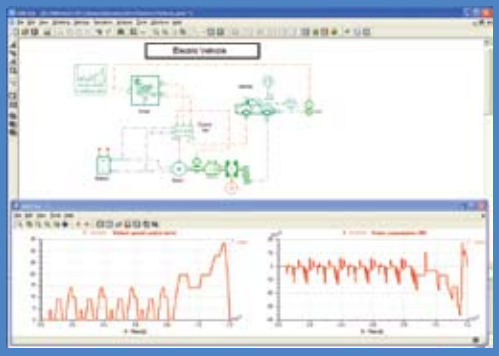
LMS Imagine.Lab Performance and Losses helps to accelerate the design of any kind of powertrain, drivelines and gearboxes: gasoline/diesel vehicles (sedan cars, utilities and trucks), hybrids (series, parallel and others), automatic gearboxes, CVT, IVT, DCT transmissions, accessories (air conditioning, power steering). Users can perform a detailed study of the various power consumptions in a chosen car architecture and are able to meet specific requirements with a system level analysis. LMS Imagine. Lab Performance and Losses comes with a set a state-of-the-art physical models and libraries to study the couplings between thermal, hydraulics, electrical and mechanicals domains. It also provides efficient simulations and quality results for optimized engine (ECU) and gearbox (TCU) control design and validation.

LMS Imagine.Lab Performances and Losses makes it possible to run off-line test procedure validation (HIL or/and SIL) and fully interface with Matlab Simulink and common real-time platforms (dSPACE, Opal RT, xPC Target); in this way integrating the design process from simulation to test bench. Finally, the solution can run performance testing and comparisons with customer's requirements, and evaluate fuel consumption/emission according to ISO requirements (cumulated raw emission calculation).

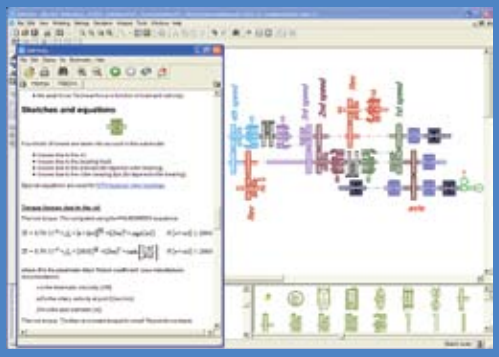
The flexibility of LMS Imagine.Lab Performances and Losses helps test innovative architectures like hybrid vehicles.



Fuel consumption on a conventional vehicle with gasoline engine and mechanical gearbox.



Model of an electrical vehicle including a strategy of battery regeneration during the braking phase.



Highly detailed modeling for gear losses: losses computation for each group of gears, bearings and joints.

Features

- Quasi-steady state and low frequencies simulation capabilities
- Models for global vehicle architecture definition
- Models for specific and detailed gearboxes
- Off-line test procedure validation (HIL or/and SIL)
- Fully interfaced with Matlab/Simulink and common real-time platforms (dSPACE, Opal RT, xPC Target)
- Flexible post-processing results (AMESim, Excel)

Benefits

- Optimization of ratios and control strategies over performance cycles
- Prediction of heat release leading to heat exchanger sizing
- Prediction of losses to improve consumption
- Analyze any kind of vehicle architecture

LMS INTERNATIONAL
Researchpark Z1, Interleuvenlaan 68
B-3001 Leuven [Belgium]
T +32 16 384 200 | F +32 16 384 350
info@lmsintl.com | www.lmsintl.com

Worldwide

For the address of your local representative, please visit www.lmsintl.com/lmsworldwide

LMS is an engineering innovation partner for companies in the automotive, aerospace and other advanced manufacturing industries. With approximately 30 years of experience, LMS helps customers get better products to market faster and turn superior process efficiency into key competitive advantages.

With a unique combination of 1D and 3D simulation software, testing systems and engineering services, LMS tunes into mission critical engineering attributes, ranging from system dynamics, structural integrity and sound quality to durability, safety and power consumption. With multi-domain solutions for thermal, fluid dynamics, electrical and mechanical system behavior, LMS can address the complex engineering challenges associated with intelligent system design.

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