

LMS Imagine.Lab AMESim Vehicle System Dynamics



LMS Imagine.Lab Vehicle System Dynamics

LMS Imagine.Lab Vehicle System Dynamics offers dedicated capabilities to design individual chassis system components (brakes, suspension, steering, anti-roll system and the vehicle itself) and integrate them in a single system model to simulate and validate global chassis control strategies. Engineers can easily and efficiently connect all chassis components for detailed analysis. LMS Imagine.Lab Vehicle System Dynamics presents a unique platform to model and simulate actuators and vehicles, with different levels of model details and straightforward integration with software-in-the-loop or hardware-in-the-loop validation processes. It also includes an extensive vehicle dynamics library, and interfaces with simulation suites like LMS Virtual.Lab Motion, MSC.Adams and Simulink.



- **Vehicle Dynamics**
- **Vehicle Dynamics Control**
- **Braking System**
- **Power Steering**
- **Suspension and Anti-Roll**

References

PSA Peugeot Citroen - Vehicle dynamics engineering
Delphi - ABS pump simulation
IAV - Design of anti-roll system
ZF Lenksysteme - Simulation of power steering systems
Toro Rosso - Analysis of a F1 car braking system
Doosan Infracore - Steering system of a wheel loader
International Truck and Engine - Chassis applications
Continental - Modeling of a brake actuation system
Fiat - Electro-hydraulic braking

LMS Imagine.Lab Vehicle Dynamics

LMS Imagine.Lab Vehicle Dynamics offers a complete toolset to test and optimize vehicle comfort as well as ride and handling behavior from the early concept stage onwards. It is able to assess the interaction between the vehicle, its key subsystems (steering, brakes, suspension) and their controllers to ensure optimal driving pleasure, comfort and enhanced safety.

To meet the increasingly shorter full vehicle development process, LMS Imagine.Lab Vehicle Dynamics presents a modular approach and functional models for vehicle dynamics study. Users can create functional models for vehicle dynamics and carefully evaluate the full vehicle behavior. The AMESim modularity, excellent solver capabilities and specific physical libraries open up integration possibilities for OEMs and suppliers.

LMS Imagine.Lab Vehicle Dynamics delivers a modular and open architecture, which creates possibilities to share libraries and subsystem models not only between internal departments but also with external supplier companies. The open communication possibilities help to effortlessly link 1D AMESim simulation studies with in-depth 3D multi-body analysis tools. The solution comes with a large set of dedicated tools especially useful for vehicle dynamics purposes, including data management, parametric functions to modify the shape of kinematics tables, post-treatment and optimization tools. The strong integration capabilities of the vehicle dynamics engineering process provide a detailed insight into the numerous component and system interactions that determine a vehicle's ride and handling profile.

Features

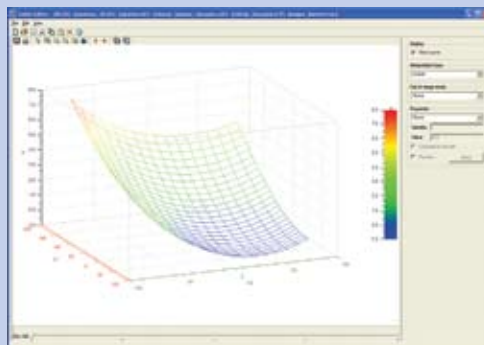
- Comprehensive vehicle dynamics library for real-time simulation or real-time hardware
- Open tool for vehicle data management of OEMs and suppliers process
- Parametric functions to modify the shape of kinematics tables in order to optimize the vehicle behavior

Benefits

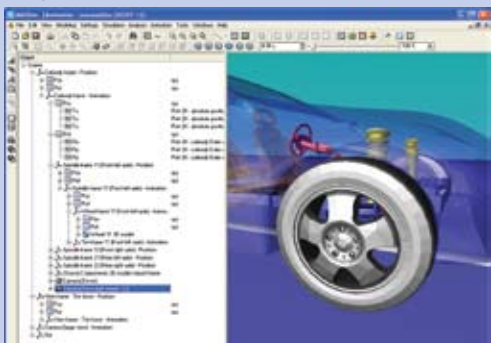
- Analyze global vehicle behavior without use of detailed models of suspension architecture
- Design vehicle architectures with an advanced real-time physical system approach
- Test, analyze and refine your technical choices thanks to a large range of post-processing tools (linear analyses, optimization, FFT)
- Choose the complexity degree of your subsystem thanks to connections to other AMESim libraries (mechanics, hydraulics, electro-mechanical)



LMS Imagine.Lab Vehicle Dynamics presents a modular approach and functional models for vehicle dynamics study.



Parametric functions help to modify the shape of kinematics tables to optimize the axle system geometry and the vehicle behavior.



AMEAnimation is useful for visualizing the results of the Vehicle Dynamic solution as a 3D animation scene.



LMS Imagine.Lab Vehicle Dynamics can make a coupling between the vehicle model and the detailed model of key subsystems such as the steering system.

LMS Imagine.Lab Vehicle Dynamics Control

With LMS Imagine.Lab Vehicle Dynamics Control, chassis designers and engineers can simulate vehicles, sensors, actuators and the control strategy in a single comprehensive platform, which can be extended to Simulink/RTW for real-time simulation purposes. Via the Simulink interface, the solution can handle high-quality control strategies on detailed models, as well as tests on safety-related electronic systems (ECU design, testing, robustness and fault diagnosis).

Users can explore functional architectures for vehicle dynamics control to enhance vehicle ride comfort, handle the best compromises and integrate new concepts, all in one single platform. It offers the possibility to explore overlapping functions (interactions of tire, driveline, brake, suspension and steering) and analyses couplings in critical situations in which actuator dynamics are relevant. The platform's open-ended architecture makes it possible to include customer models/libraries and seamlessly run complex analyses, model reduction and real-time tests.

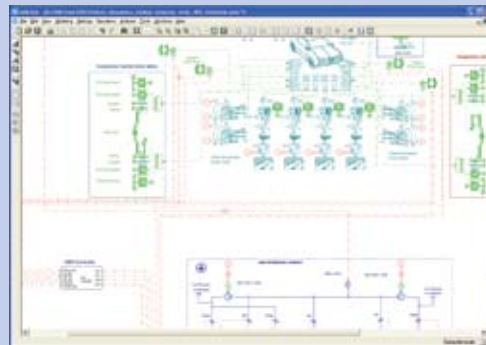
LMS Imagine.Lab Vehicle Dynamics Control ensures significant productivity gains, maximizes knowledge and minimizes time by using reliable libraries and advanced interfaces with most commonly used third party technologies for controls. Engineers can identify the optimal configuration between vehicle, actuators and controllers, and predict vehicle system response to driver steering, braking, throttling and shifting, road inputs and wind perturbations.

Features

- AMESim/Simulink interface (import, export and co-simulation) to couple the ECU model with the plant model
- Powerful analysis tools for adapting models to specific purposes:
 - Activity Index
 - Eigenvalues
 - Modal Shapes
 - State Count

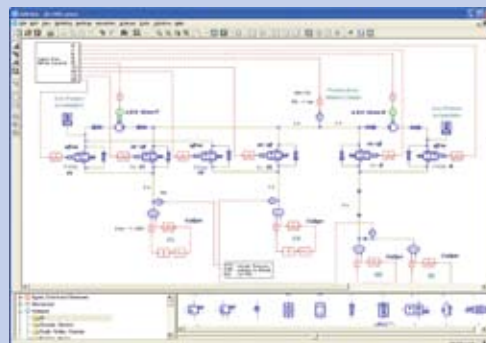
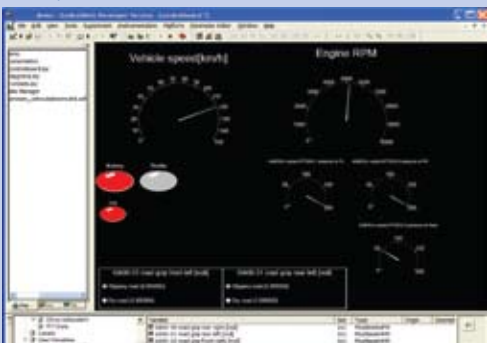
Benefits

- Easy integration of various sub-systems (braking system, power steering, suspension to deliver performance improvements as well as driver support and comfort)
- Detailed analysis on real-time models
- Test and validate control strategies on detailed models early in the process of ECU testing



LMS Imagine.Lab Vehicle Dynamics Control helps test and validate control strategies on detailed models early in the process.

A complete dynamic vehicle model with integrated ABS system, coupled with the ABS controller developed in Simulink.



dSPACE ControlDesk has the ability to create a complete experimental environment with virtual instrument panels, piloting or showing defined parameters and variables of the AMESim model.

A functional model of an ABS system helps to validate the real controller unit on a real-time target.

LMS Imagine.Lab Braking System

With LMS Imagine.Lab Braking System, users can design and optimize braking systems and components (booster, master cylinder and valves) early in the process as well as test control strategies using hardware-in-the-loop. It facilitates the development of ABS and ESP systems, as well as other active control systems. It further gives an understanding of the noise and vibration behavior and control of the braking system.

LMS Imagine.Lab Braking System gives access to braking circuit dynamics and helps to analyze and compare different hydraulic architectures (X, H, I) to evaluate braking distance or vehicle stability if connected to a vehicle model. Moreover, the solution seamlessly handles both hydraulic and/or pneumatic systems.

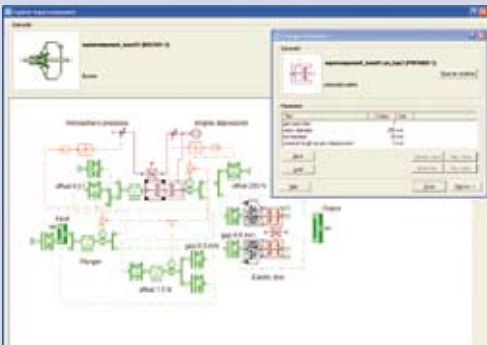
In more detailed studies, LMS Imagine.Lab Braking System has the capability to perform global system sizing and handle behavior analyses of typical braking circuit components (both for low and high frequency). It has the ability to study pressure valves stability of ABS and ESP systems, run analyses of the ABS and ESP complete hydraulic circuit and cavitation (noise) in the master cylinder when releasing pressure. The complete braking circuit including booster, master cylinder and valves can be assessed in a detailed or in a more basic way that is able to run in real-time.

Features

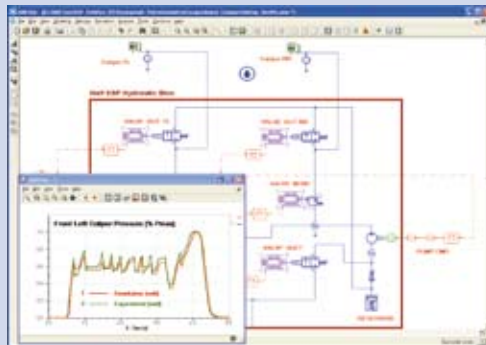
- State-of-the-art hydraulic & pneumatic component design of ABS, ESP and standard braking systems
- Real-time possibilities with semi-automatic model reduction features
- Seamless integration with the chassis through through the Vehicle Dynamics library models

Benefits

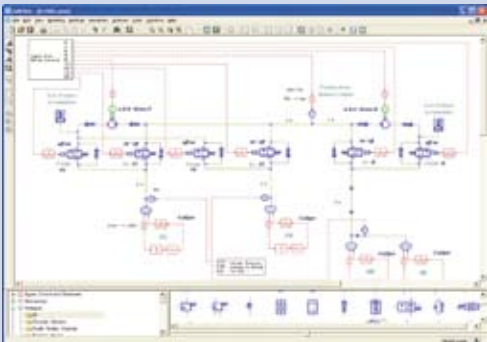
- Accurately analyze specific issues posed by braking systems such as noise, vibrations and architecture impacts
- Benefit of a comprehensive platform for studying multiple technologies:
 - ABS, ESP, TCS, Antiskid circuit analysis
 - Booster, master cylinder, caliper and circuits
 - Electro-hydraulic braking systems
 - Pneumatic systems for trucks and buses
- Evaluation of the braking system performances on the entire virtual vehicle model



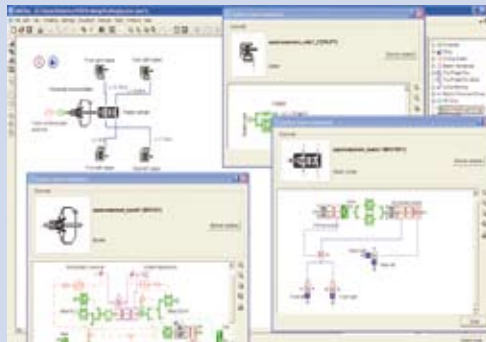
A detailed technological model of the booster, which helps to evaluate its performance in function of the geometry and material characteristics.



LMS Imagine.Lab Braking System facilitates the development of ESP systems, from valve design to control strategies validation.



A functional model of an ABS system helps to validate the real controller unit on a real-time target.



AMESim sketches can be simplified using supercomponents of detailed models of the systems.

LMS Imagine.Lab Power Steering

LMS Imagine.Lab Power Steering provides reliable and accurate models to design robust power steering systems (stability, vibration, couplings analysis) while reducing time-to-market. The solution involves different AMESim tools and libraries focusing on the reality of the multi-domain approach which is required when dealing with hydraulic, electro-hydraulic and electric power steering systems.

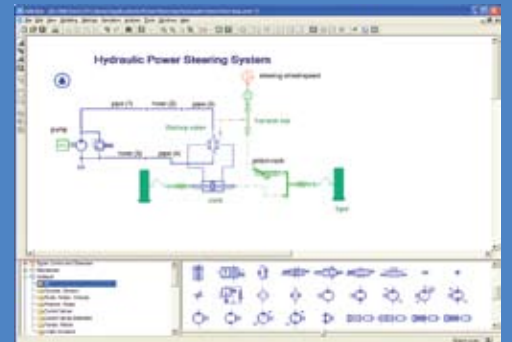
LMS Imagine.Lab Power Steering focuses on functional design (mainly stability or vibration issues) and enables engineers to examine functionalities and performances of any power steering system to assess technology risks and examine related electronic control units.

Detailed views of the rotary valve, pump, and hydraulic circuit can be generated for more in-depth studies as well as for analysis of vibrations and stability in parking maneuvers or driving conditions. It is even possible to analyze the shimmy phenomenon and display its contributions on the steering system through interfaces with multi-body software like LMS Virtual.Lab Motion or MSC.ADAMS.

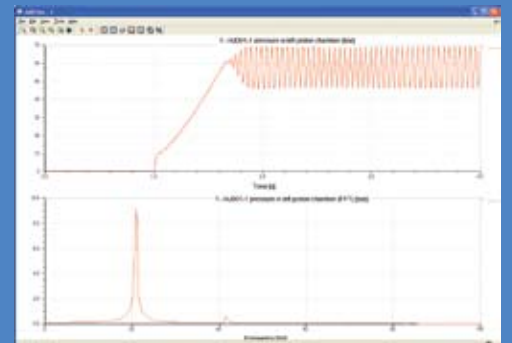
LMS Imagine.Lab Power Steering will significantly help to define optimal steering performance, present trade-offs between technologies, identify the optimal steering feel and assess the impact of driver assistance on the driver's perception.



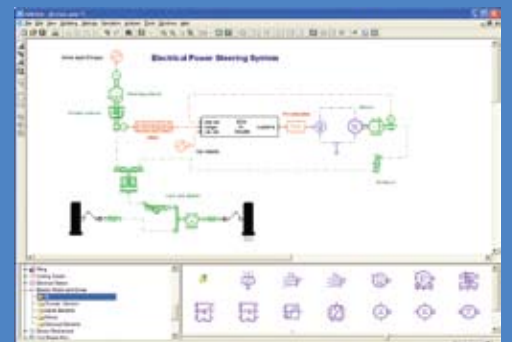
LMS Imagine.Lab Power Steering helps to evaluate steering system performances on the entire virtual vehicle model.



Example of a hydraulic power steering system, including a steering wheel, a rotary valve, a rack, a hydraulic jack and lines.



The plot facilities help to perform FFT analysis on any result.



Fully electric (EPS) power steering can be studied through a comprehensive Electric Motors and Drives library.

Features

- State-of-the-art models for fluids, mechanical and electrical modeling
- Pump models for flow ripple analysis and contribution in the supply line
- Wide friction models for detailed or real time aspects
- Interface with LMS Virtual.Lab Motion and MSC.ADAMS
- Electronic Control Unit integration with Simulink interface
- Seamless integration within the chassis through Vehicle Dynamics library models

Benefits

- Open architecture capable of studying different technologies: fully hydraulic (HPS), electro-hydraulic (EHPS), fully electric (EPS) power steering, steer-by-wire (SBW) systems
- Evaluation of steering system performances on the entire virtual vehicle model
- Rapidly analyze shimmy and shimmy phenomena as well as pure hydraulic vibrations
- Easily study various scenarios: parking or driving maneuvers
- Ensure better maintainability and reusability

LMS Imagine.Lab Suspension and Anti-Roll

LMS Imagine.Lab Suspension and Anti-Roll helps users to size and analyze circuits and components involved in suspension and anti-roll systems. It can optimize the dynamic contribution of these systems to passenger comfort and vehicle handling, improve damper design versus cavitation, understand causes of vibration and analyze suspension control issues.

LMS Imagine.Lab Suspension and Anti-Roll helps to model and analyze passive and active suspensions for both hydraulic and pneumatic technologies. Magneto-rheological actuators can be modeled on demand. Users can equally model air suspension or air cushion together with self-leveling systems for cars as well as trucks and buses.

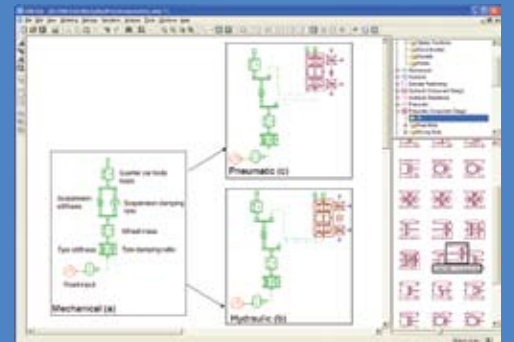
The different levels of modeling involved in the AMESim Hydraulic and Pneumatic libraries allow functional design and detailed analyses of such components in order to assess performance advantages (dynamics) and design/test those components according to control strategies. Finally, it is possible to accurately design control strategies regarding the technology and the dynamics involved.

Moreover, active roll systems can be modeled focusing on component and/or circuit design e.g. pressure valves stability and priority valve testing, couplings between the steering and roll bar circuits, cavitation in cylinders.

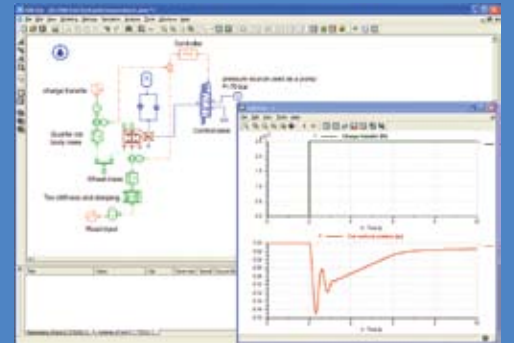
LMS Imagine.Lab Suspension and Anti-Roll is mainly used by the car industry but is also valid for buses, trucks and tilting systems for trains or special vehicles.



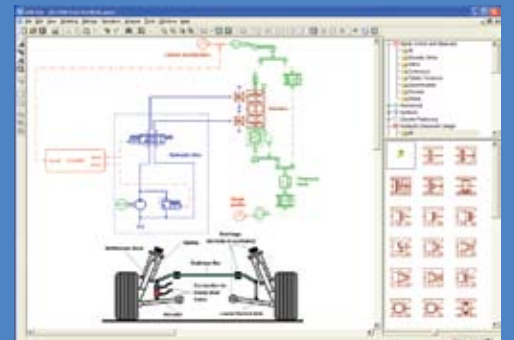
LMS Imagine.Lab Suspension and Anti-Roll helps to evaluate suspension system performances on the entire virtual vehicle model.



The flexibility of LMS Imagine.Lab Suspension and Anti-Roll helps to model hydraulic or pneumatic dampers.



Hydraulic suspension integrating a static height correction.



Active roll systems including different levels of modeling: component level (here the actuator) and circuit level (pump, pressure and flow valves).

Features

- Global view of valve characteristics
- Damper models or complete circuits
- Gas and liquid capabilities
- Simulink interface
- Seamless integration with vehicle dynamics models

Benefits

- Seamlessly define components
- Use functional models from conception to validation
- Validate usability of various suspension systems:
 - Passive, semi-active and active suspensions
 - Hydraulic and/or pneumatic suspensions
 - Global system or detailed component analysis
- Evaluation of suspension system performances on the entire virtual vehicle model



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