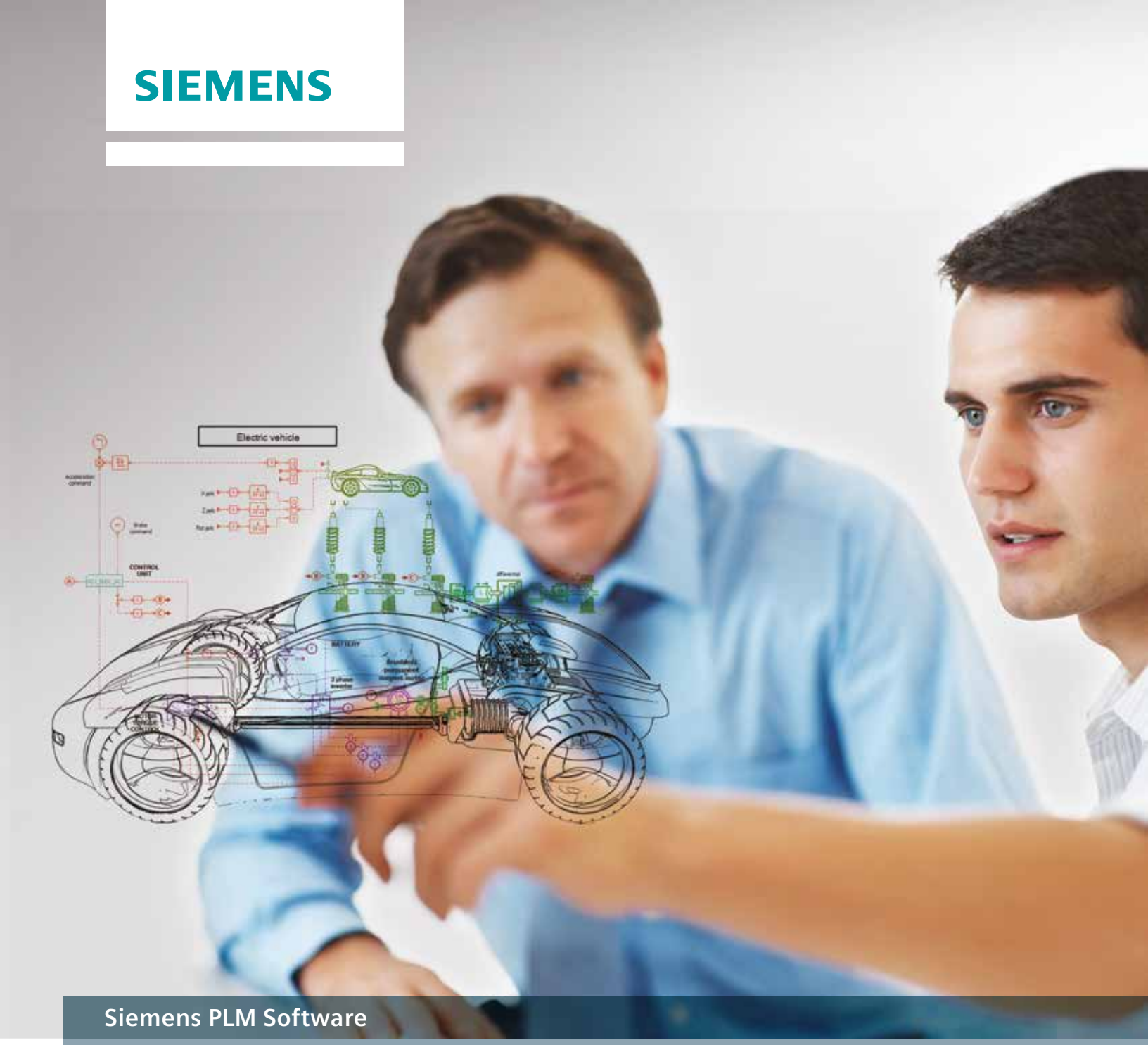
SIEMENS



Siemens PLM Software

LMS Imagine.Lab

Mastering engineering complexity

siemens.com/plm/lms

LMS Imagine.Lab

Mastering engineering complexity

Under pressure to reach ever-increasing performance levels, most industrial companies are integrating advanced controls into their products and, as a result, these products are becoming mechatronic systems. Managing the inherent complexity of these systems requires mastering their multi-domain dynamic behavior, making it a virtual requirement to use system simulation software. The mandatory association of mechanical and controls design cycles transforms these processes as well as provides the new challenge of managing engineering knowledge.

How can the engineer easily balance product performance in an intelligent system? And how can the engineer achieve an optimized design architecture well before committing to expensive and time-consuming prototype testing, and share his models with the global engineering team?

Mastering this complexity is exactly what LMS Imagine.Lab™ software for mechatronic system simulation is built for.

With the LMS mechatronic system simulation platform, engineers are able to create, manage and use models and data to answer various model-based systems engineering needs.

LMS Imagine.Lab transforms complexity into simplicity. It is developed with ease of use, time and cost savings in mind. The results can be drastically shortened cycle times and superior products that truly excite customers, as well as reduced development costs and risks.

Engineer the right product

- Quickly analyze a multitude of design options
- Balance a product's performance and regulation constraints according to brand-critical attributes
- Achieve the optimal design while reducing physical prototyping to its strict necessity

Accelerate the development process

- Optimize complex mechatronic systems from the start
- Avoid the need for extensive in-house software programming and maintenance
- Drastically reduce time spent on physical testing

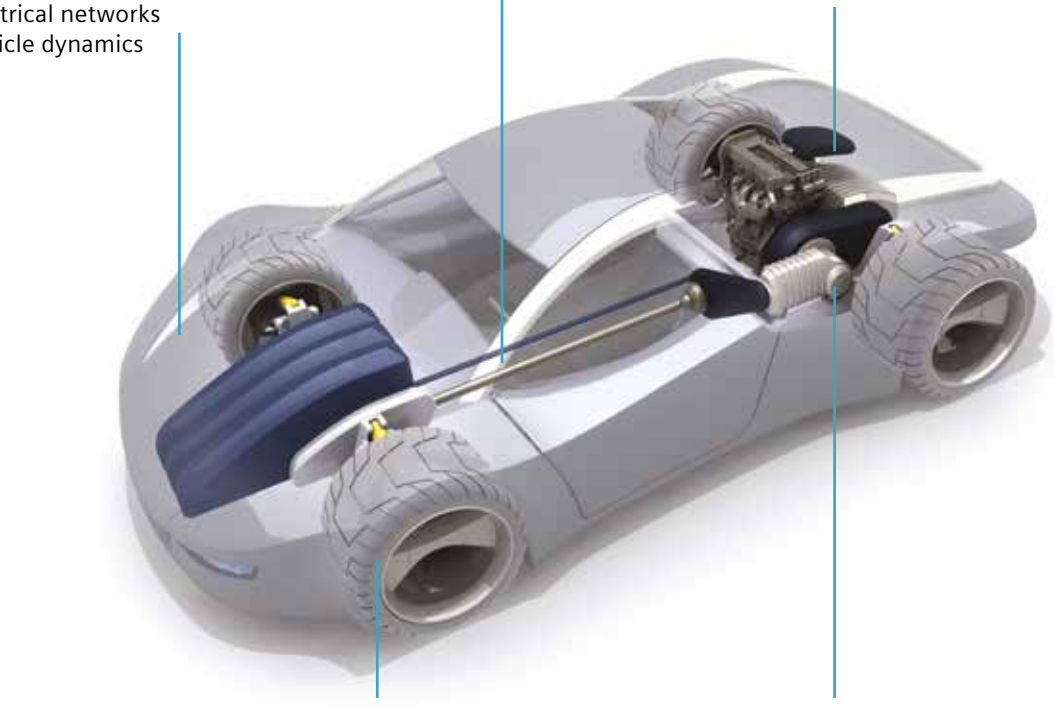
Industry applications – Passenger cars and commercial vehicles

- Fuel economy
- Pollutant emissions reduction
- Vehicle energy management
- Cabin comfort
- Safety
- Drivability
- Ride and handling
- Driveline vibration
- Transmission dynamics
- Performance and losses
- Controls integration
- Subsystems integration

[1] Vehicle
- Conventional, electric vehicle, hybrid electric vehicle
- Exhaust
- Under hood thermal systems
- Air conditioning
- Cabin
- Electrical networks
- Vehicle dynamics

[2] Driveline
- Dual-mass flywheel
- Torque vectoring
- Torsional dynamics

[3] Internal combustion engine
- Engine controls
- Air path
- Combustion
- Engine cooling, lubrication
- Fuel injection and valvetrain



[4] Chassis systems
- Braking
- Steering
- Suspension/anti-roll

[5] Transmission
- Manual
- Automatic
- Continuously variable
- Dual clutch
- Hybrid architectures

The innovative, open simulation platform for mechatronic system development

The latest developments in LMS Imagine.Lab more than ever make it a solid choice for model-based systems engineering. Geared toward mechatronic simulation, the LMS Imagine.Lab platform offers engineers an open development approach starting from functional requirements to physical modeling and simulation. The platform consists of three modules: LMS Imagine.Lab Amesim™ software, LMS Imagine.Lab Sysdm software and LMS Imagine.Lab System Synthesis software.

LMS Imagine.Lab Amesim

Software environment for multi-domain, multilevel, mechatronic system modeling, simulation and analysis

- Create multi-domain simulation models by simply assembling predefined and validated components from different domain libraries and avoid the need for time-consuming programming
- Analyze a multitude of design options by adjusting the components and balance the product's performance according to various brand attributes
- Frontload system simulation early in the development cycle

LMS Imagine.Lab Sysdm

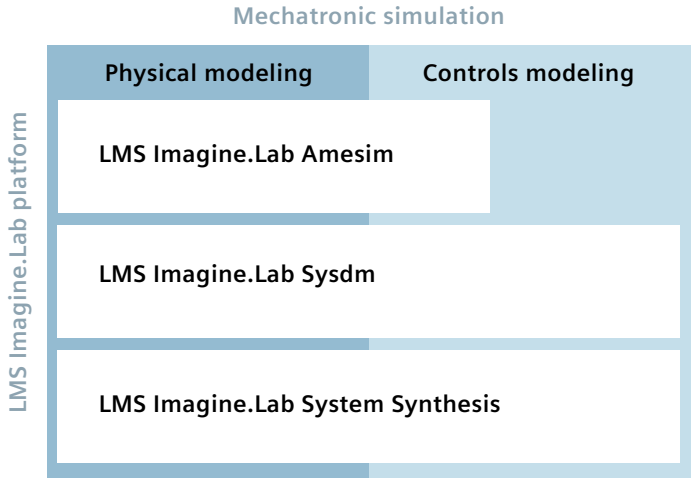
Solution for the organization and management of mechatronic data, from mechanical to controls engineering

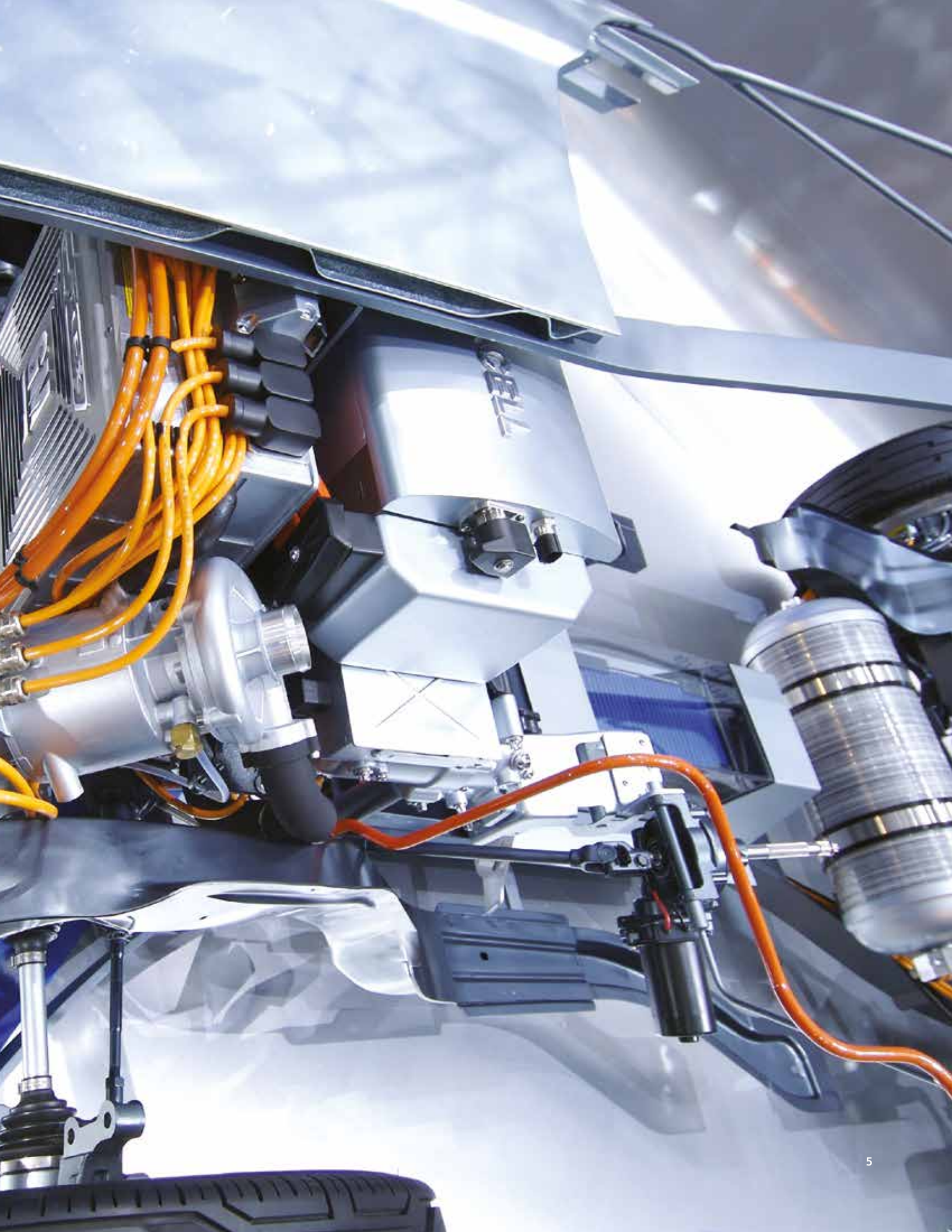
- Share and leverage knowledge
- Increase efficiency
- Store and organize mechanical and controls models and data across the organization

LMS Imagine.Lab System Synthesis

Software tool to support configuration management, systems integration and architecture validation

- Synthesize complex system configurations
- Create product architectures based on performance requirements



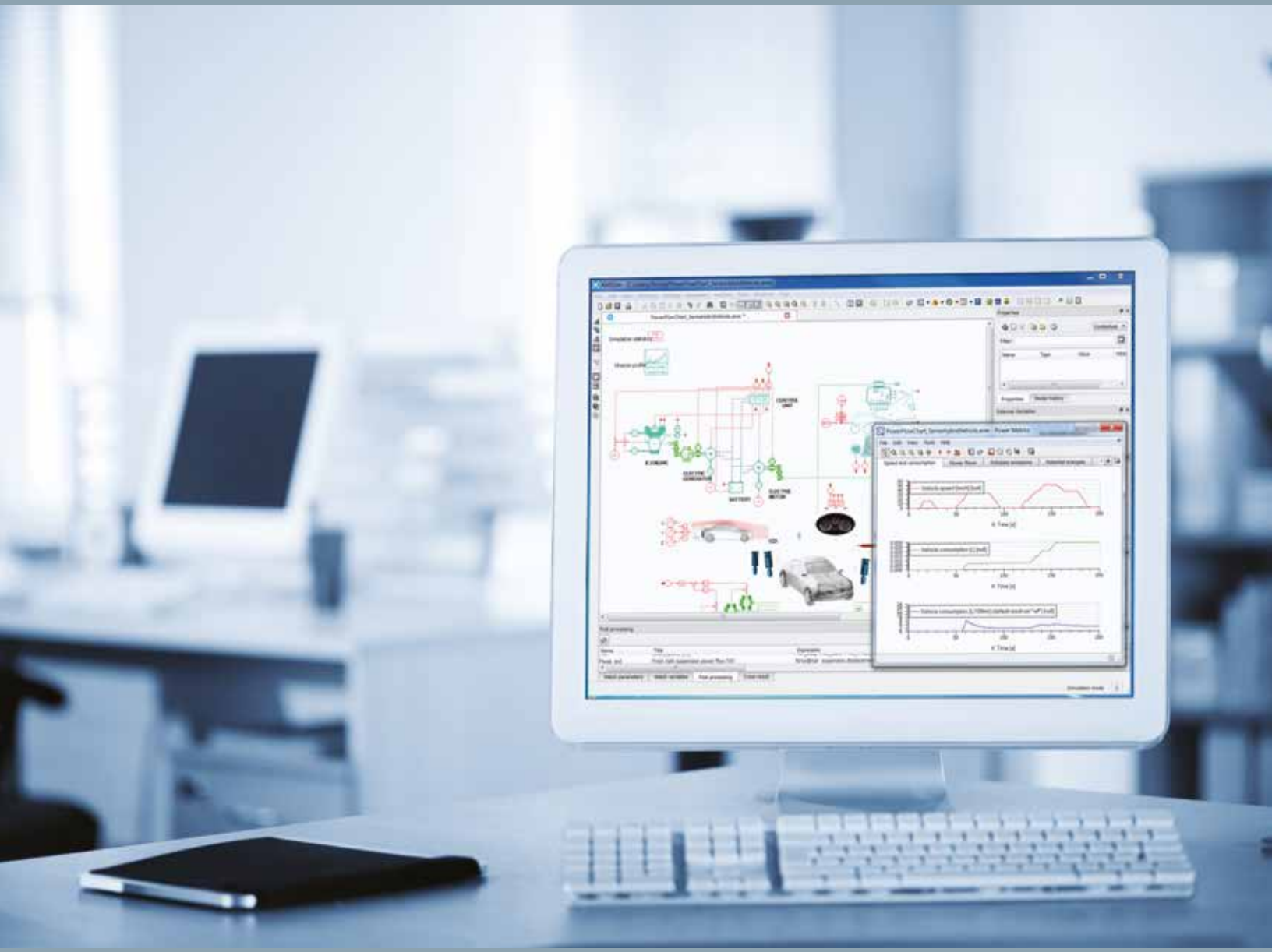


LMS Imagine.Lab Amesim

The de facto tool for physical simulation of mechatronic systems

LMS Imagine.Lab Amesim simplifies multi-domain integration thanks to its easy-to-use simulation platform. The engineer connects validated components to simply and accurately predict dynamic system performance.

With extensive dedicated libraries, LMS Amesim enables you to save an enormous amount of time by eliminating the need for extensive modeling. Thanks to application-specific simulation, engineers can assess a variety of subsystems in multiple physical domains. This way, design and engineering teams can carefully balance product performance according to various brand-critical attributes to achieve an optimized design before committing to expensive and time-consuming prototype testing. Since LMS Amesim enables you to front-load system simulation early in the development cycle, it allows mission-critical design functionality to drive new product development.



Open and productive development environment

Simulate and analyze multi-domain controlled systems

LMS Amesim lets users analyze the functional performance of mechatronic systems from the early development stages onward. LMS Amesim was built to focus on physics so it frees engineers from numerical aspects and time-consuming programming. Each model provides basic engineering elements that can be combined to describe any function of the component or system.

Intuitive graphical interface

- User-friendly modeling environment
- Seamless connection between various validated and predefined components
- Display of the system throughout the simulation process
- Several customization and scripting tools

Unrivaled numerical core

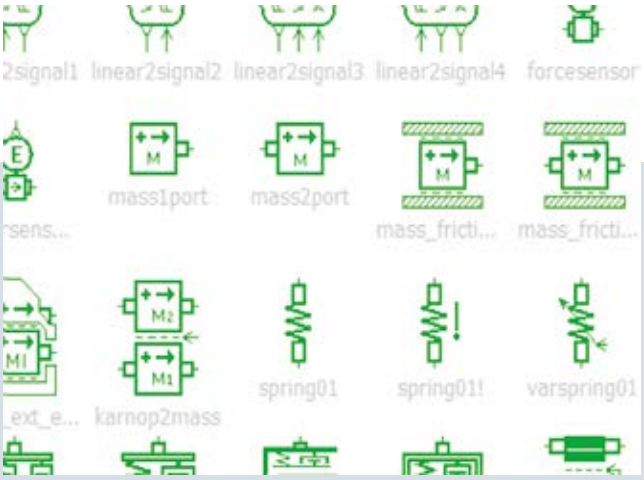
- Capability to robustly execute inhomogeneous dynamic systems
- Advanced numerical techniques (ordinary differential equations and differential algebraic equations)
- Dynamic selection of calculation methods
- Discrete partitioning, parallel processing and co-simulation

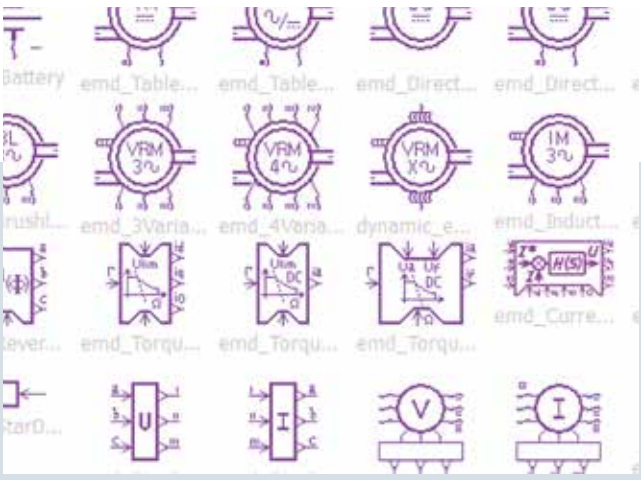
Advanced analysis tools

- Fast fourier transform (FFT)
- Plotting facilities, 2D and 3D postprocessing tools
- Spectral map and order tracking
- Linear analysis: eigenvalues, modal shapes, root locus and transfer function representation
- Scripting and application programming interface (API) capabilities

Open platform

- Efficient integration with third-party software for software-in-the-loop (SiL), model-in-the-loop (HiL), hardware-in-the-loop (HiL), real-time simulation, multi-body simulation, process integration and design optimization
- Generic co-simulation interface with couple to dynamic 3D models
- Compliant platform with Modelica





Physical libraries

4,500 multi-domain components

LMS Amesim comes with a set of standard and optional libraries of predefined and validated components from different physical domains. Components in the libraries are based on the analytical representation of physical phenomena. They can be executed using LMS Amesim solvers. Interlock compatibility avoids the need for extensive programming.

Fluids
- Hydraulic, hydraulic component design
- Hydraulic resistance, filling
- Pneumatic, pneumatic component design
- Gas mixture, moist air

Internal combustion engine
- IFP drive, IFP engine
- IFP exhaust
- IFP C3D, CFD-1D

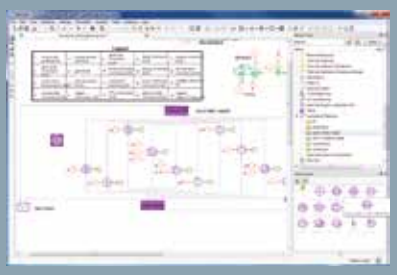
Thermodynamics
- Thermal, thermal hydraulics
- Thermal-hydraulic component design
- Cooling, air conditioning
- Two-phase flow

Electrical
- Electrical basics, electromechanical
- Electrical motors and drives
- Electrical static conversion
- Automotive electrics, electrochemistry
- Electric storage

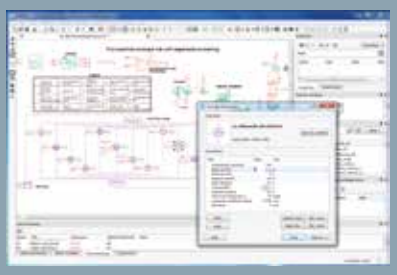
Control
- Signal and control
- Engine signal generator

Mechanics
- 1D mechanical, planar mechanical
- Transmission, cam and followers
- Vehicle dynamics
- 3D mechanical

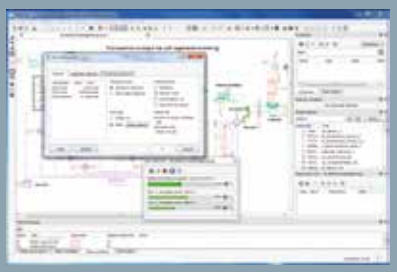
With LMS Amesim, you have the ability to analyze the functional performance of a mechatronic system at your fingertips



Step 1: Build your multi-domain system by selecting components from the more than 4,500 available.



Step 2: Set system parameters by changing parameter default values to adapt to your specific system design.



Step 3: Launch the appropriate simulation by defining run parameters and analysis methods.

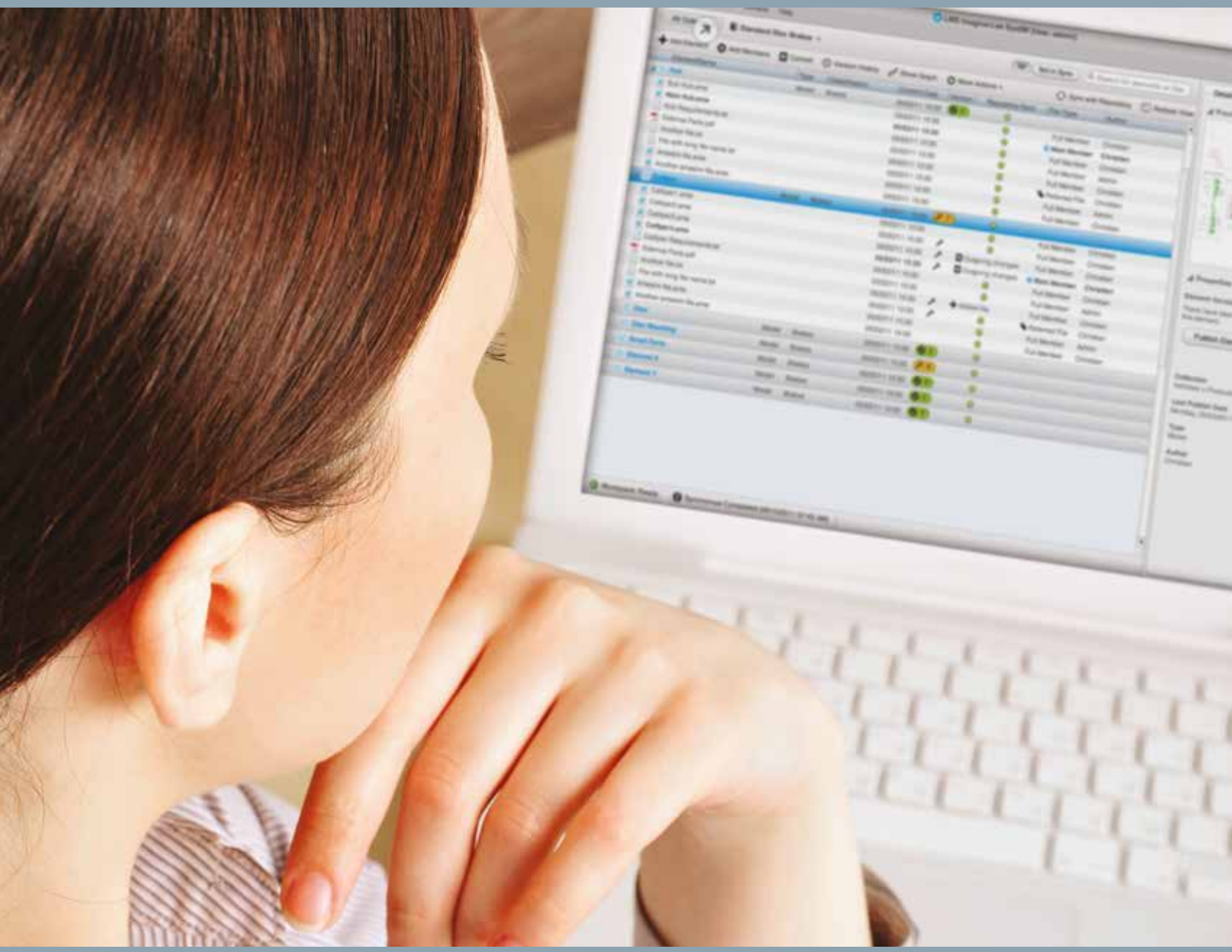
Step 4: Analyze results by accessing various dedicated analysis tools to assess system behavior and performance.

LMS Imagine.Lab Sysdm

The collaborative solution for model and data management

Model-based systems engineering relies on system-level models to simulate the overall performance and behavior of new, intelligent products made of complex interactions between mechanical, hydraulic, pneumatic, thermal and electric/electronic phenomena. This requires collaboration across multiple engineering departments that develop models for components and subsystems, and system-level engineering. Additionally, these system-level models need to be shared as plant models to accelerate model-based controls engineering for embedded software. Such collaboration needs to extend to suppliers who take an increasing responsibility in overall product innovation and development. The increase of smartness in mechatronic systems is driving the fastest adoption of model-based systems engineering.

The resulting complexity combined with the globalization of business is a compelling reason to have a collaborative solution to enable global distributed development of mechatronic systems.

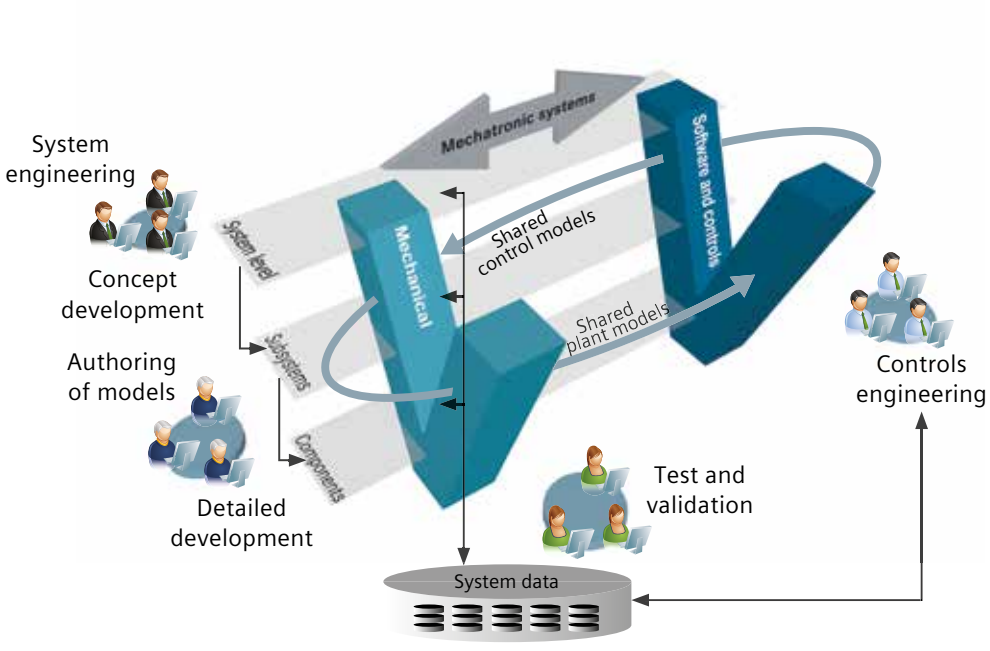


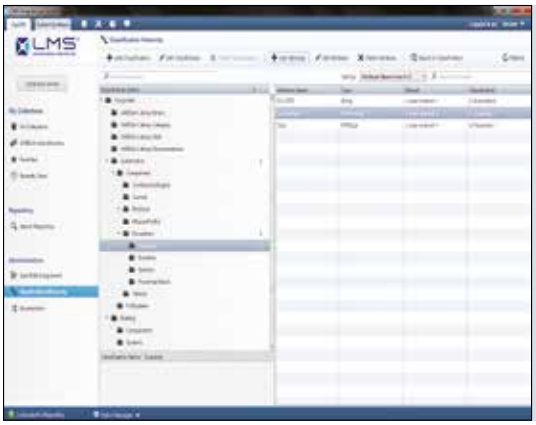
LMS Imagine.Lab Sysdm

Mechatronic data management, from mechanical to controls engineering

LMS Imagine.Lab Sysdm enables the management of system models, libraries and architectures originating from LMS Amesim and other tools for system simulation so you can support collaborative model-based systems engineering. System simulation models and data can be organized in a customer-defined structure, facilitating search and retrieval using engineering attributes. Version management enables you to capture the complete time evolution of system models at various stages of the V cycle.

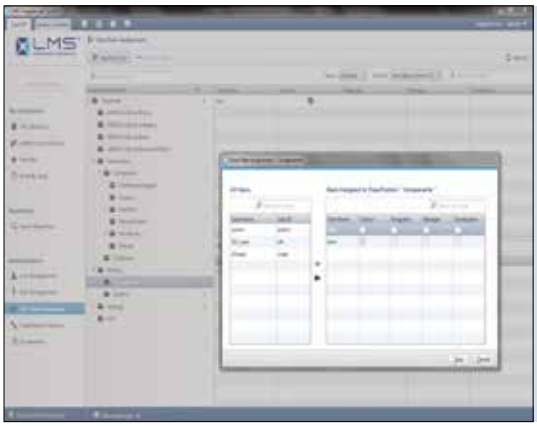
The management of multiple representations of components and subsystems in a system is enabled with variant management, allowing the instantiation of a system model at various stages of development. Role-based access control supports the implementation of various collaborative workflows. Overall, LMS Sysdm enables knowledge capitalization to improve productivity in the system simulation process.





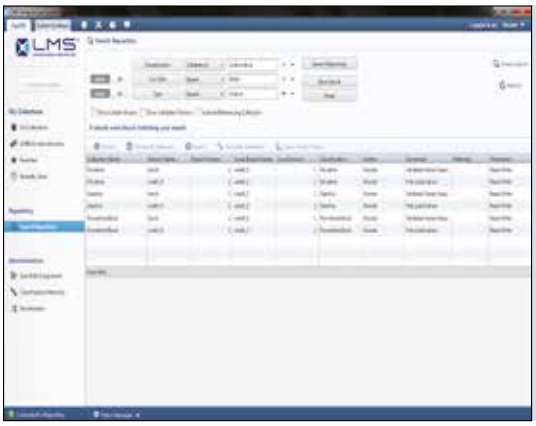
Organize system models in a user-defined structure

- Collection approach for hierarchical handling of system models and related data, such as parameter sets, scripts, experiments, as virtual elements and collections in support of model-based engineering
- Domain or organization-relevant classification and visualization of system models and data
- Intuitive search and retrieval of system models and data



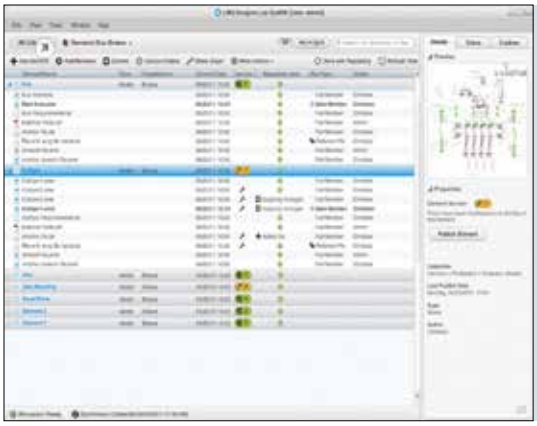
Enable multi-user collaborative model development through role-based access control

- Define user access rights to system models and data based on roles, functions and responsibilities
- Role-based view and access control to the model (according to specific user's profile)
- Implement collaboration workflows, including check-in and check-out of models, validation and upload of new versions, syndication to updates of models and data, etc.



Enable model sharing among controls, plant and system engineering communities

- Version control features for model lifecycle management
- Variant management to manage multiple instances of component, subsystem and system models, function of the product development stage and purpose of simulation



Put your resources and know-how to work for more effective and efficient system development

- Open environment to manage models using LMS Amesim, Simulink® and other system simulation tools
- Standalone configuration for individual desktop system model management
- Integrated client configuration in LMS Amesim

LMS Imagine.Lab System Synthesis

The tool for configuration management, system integration and architecture management

LMS Imagine.Lab System Synthesis is a platform for configuring and integrating physical and controls models into a logical view of the entire system for simulation. This lets system architects author the most logical view, configure it and integrate the various models as required for the system simulation.

Today, system engineering is based on a top-down approach: product requirements define functions, which are translated into mechanical and controls subsystems that can be simulated.

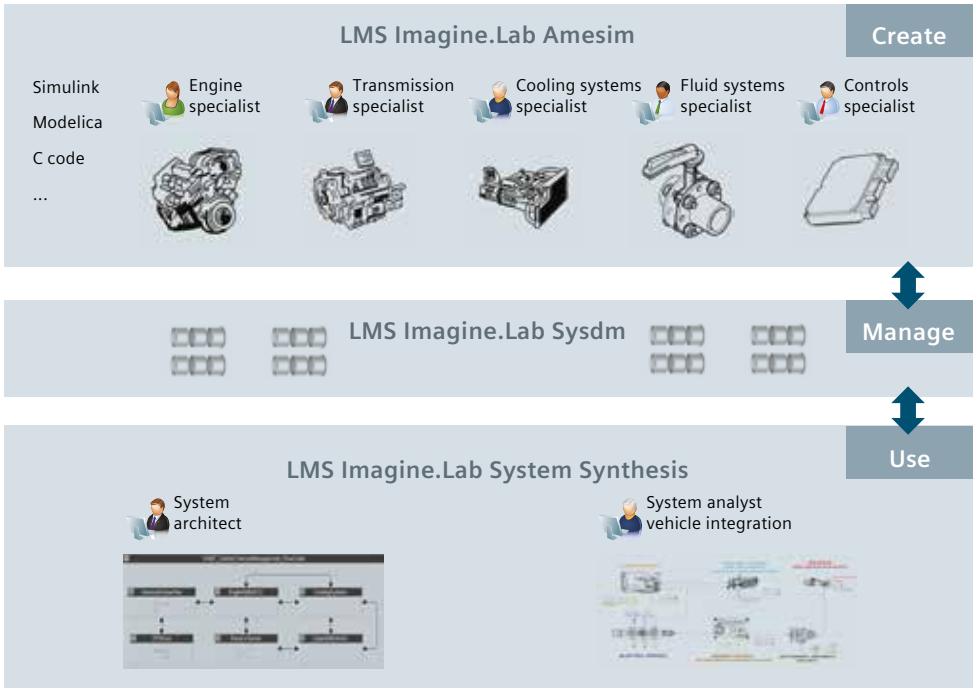
LMS System Synthesis supports the creation of model configurations making use of these subsystem models.

LMS Imagine.Lab System Synthesis

Configuration management, systems integration and architecture validation

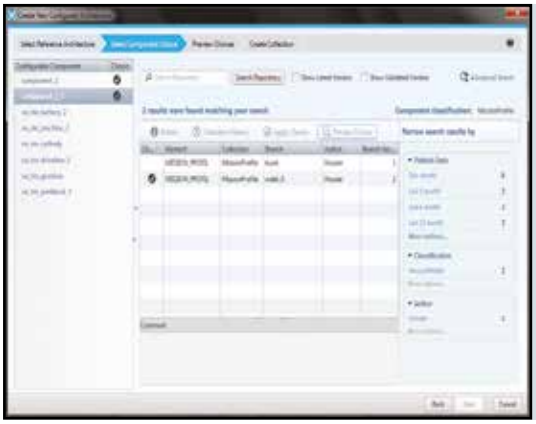
With LMS Imagine.Lab System Synthesis, system engineers and architects can seamlessly work on conceptual design by creating a system architecture, and then configuring it with the appropriate models and running the simulations to assess system behavior. This is done by using models and data originating from multiple authoring applications such as LMS Amesim, the Simulink environment and others. It supports the job of system integration in an architecture-driven development approach.

LMS Systems Synthesis is an open tool-neutral environment enabling architecture-driven development of mechatronic systems. This architecture-driven development approach is a top-down methodology starting from creating or importing tool-neutral architecture models, configuring them with physical or control models and libraries (from LMS Amesim, the Simulink environment, C-Code and others) and co-simulating in target solving platforms. It frontloads the system modeling activity by focusing on architecture construction with the right set of interface definitions to support various types of simulation downstream.



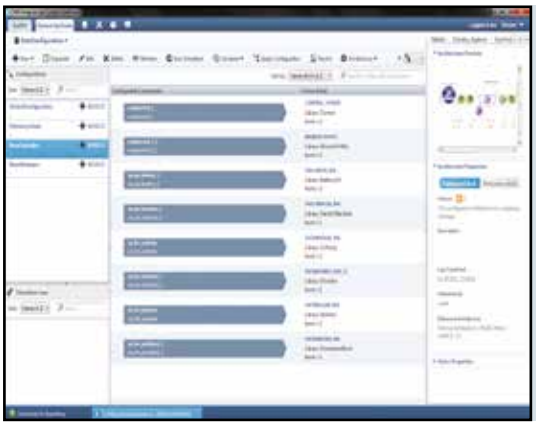
Import system architecture

- Import reference architecture models built in LMS Amesim and Simulink, or defined in SysML format
- Store the reference architecture in a tool-neutral format
- Add meta-information on the architecture corresponding to requirements, test cases and usage cases



Configure system architecture

- Configure the system architecture by re-using libraries and models stored in the central LMS Sysdm server
- During configuration the user can pick LMS Amesim libraries submodels, Simulink libraries and models for co-simulation
- Any change in reference architecture can be propagated to all the configurations



Create executable systems

- Apply configuration to create an executable system and open in the native simulation tool
- Create simulation run set by selecting various configurations
- Attach postprocessing script to process the results of all batch runs
- Compare configurations to confront architecture choices
- Create configuration HTML reports

Run system simulations

- Select simulation run set and execute simulation run for batch mode execution
- Simulation status is described at the end of simulation for each configuration

A proven track record

"The LMS Vehicle Thermal Management solution enables us to quickly and accurately predict how the complete AC system will operate, taking into account a wide range of conditions that otherwise would not be included."

Junichiro Hara
Senior Engineer and
Project Manager
Calsonic Kansei

"By using LMS Amesim, we were able to model three approaches for the battery heating strategy and get the first results in a matter of hours instead of days."

Sebastian Brixner
System Engineer
Continental Engineering Services

"Model-based systems engineering is truly our future. Simulation is the way forward. It enables us to study as many injector architecture choices as possible, with different parameters and test conditions. LMS Amesim is an ideal tool for this. Allowing for model exchange internally as well as with Delphi's customers, LMS Amesim meets our needs well."

Vincent Pichon
Solenoid Injector Simulation Manager
Delphi Technical R&D Center

"We have reduced the number of physical prototypes by a factor of 10 using LMS Amesim, which has resulted in huge cost savings and significantly shortened development time."

Urban Forssell
Vice President
Öhlins Racing

"Engineering with LMS Amesim lets the Renault team members concentrate on their core activity, which is innovation. The standardized use of LMS Amesim radically improves our level of efficiency. This project with Siemens PLM Software has enabled us to reduce the time required for complete model identification by a factor of five, from 50 days to only 10."

Vincent Talon
Team Leader, System Model 0D for Powertrain Engineering
Renault

"Without LMS Amesim, it would have been much more difficult to tackle our current design challenges. With a trial-and-error approach, the time required for physical testing would have been too long."

Eric Le Dantec
Powertrain Modeling and Simulation Expert
PSA Peugeot Citroën

About Siemens PLM Software
Siemens PLM Software, a business unit of the Siemens Digital Factory Division, is a world-leading provider of product lifecycle management (PLM) software, systems and services with nine million licensed seats and 77,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software helps thousands of companies make great products by optimizing their lifecycle processes, from planning and development through manufacturing and support. Our HD-PLM vision is to give everyone involved in making a product the information they need, when they need it, to make the smartest decisions. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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