Under pressure of reaching ever-increasing performance levels, most industrial products make use of integrated controls and are becoming mechatronic systems. Managing the inherent complexity of these systems requires mastering their multi-domain dynamic behavior, making the use of system simulation software almost a requirement. The mandatory association of mechanical and controls design cycles leads to a deep transformation of the processes and, finally, the new challenge of engineering knowledge management.

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 the LMS Imagine.Lab™ mechatronic system simulation platform is built for.

With LMS Imagine.Lab, 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 – Aerospace and aviation

- Virtual integrated aircraft
- Virtual iron bird
- Energy and thermal management
- What-if analysis
- Failure impact analysis
- Cabin comfort
- Power management

- Engine integration
- Thermal analysis
- System design and performance
- Controls integration
- Subsystem integration optimization
- Dynamic testing

[1] Environmental control systems
- Bleed air
- Anti-icing
- Ventilation circuit
- Oxygen and life system

[2] Power and distribution networks
- Hydraulic systems
- Pneumatic systems
- Electrical systems
- Electrical wire harness

- Primary and secondary flight controls (EHA, EMA)
- High-lift devices, spoilers, air brakes

[4] Landing gear
- Actuation systems
- Braking systems
- Steering systems
- Shock absorber

[5] Engine equipment
- Fuel metering systems
- Lubrication
- Heat exchangers
- Thrust reversers
- Equipment box
The latest developments in LMS Imagine.Lab make LMS™ solutions more than ever 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, multi-level, mechatronic system modeling, simulation and analysis
• Create multi-domain simulation models by simply assembling pre-defined 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
• Truly 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

Mechatronic simulation

<table>
<thead>
<tr>
<th>Physical modeling</th>
<th>Controls modeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMS Imagine.Lab Amesim</td>
<td></td>
</tr>
<tr>
<td>LMS Imagine.Lab Sysdm</td>
<td></td>
</tr>
<tr>
<td>LMS Imagine.Lab System Synthesis</td>
<td></td>
</tr>
</tbody>
</table>
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 various validated components to simply and accurately predict dynamic system performance.

With extensive dedicated libraries, LMS Amesim actually saves enormous amounts 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 actually frontloads system simulation early in the development cycle, it truly 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. Focusing on the actual physics, LMS Amesim 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

**Unrivalled numerical core**
- Capability to robustly execute inhomogeneous dynamic systems
- Advanced numerical techniques (ODE, DAE)
- 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 APIs capabilities

**Open platform**
- Efficient integration with third-party software for SiL, MiL, HiL, real-time simulation, multi-body simulation, process integration and design optimization
- Generic co-simulation interface to couple to dynamic 3D models
- Compliant platform with Modelica
Physical libraries
4500 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 are directly executable within the 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

Aerospace
- Aircraft fuel systems
- NPSS interface
- Aeronautics and space

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

Electrics
- Electrical basics, electromechanical
- Electrical motors and drives
- Electrical static conversion
- Aircraft electrics, electric storage

Control
- Signal and control
- Engine signal generator

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

With LMS Amesim, analyzing the functional performance of a mechatronic system is at your fingertips.

Step 1: Build your multi-domain system – Select the components among the 4500+ available ones.

Step 2: Set system parameters – Change parameters default values to adapt to your specific system design.

Step 3: Launch the appropriate simulation – Define run parameters and analysis methods.

Step 4: Analyze results – Access 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 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 is a solution to manage system models, libraries and architectures originating from LMS Amesim and other tools for system simulation, to 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 capturing of the complete time evolution of the 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, function, 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 to configure and integrate 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 system architecture, configuring and simulating. This is done by using models and data originating from multiple authoring applications like 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

“LMS Amesim is a very powerful tool that lets us think about how to make the component in the best possible manner. It enables us to eliminate on average 2-3 test sessions per component.”

Jerome Fraval
Performance and Modeling Engineer
Messier-Bugatti

“What we appreciate in LMS Amesim are its multi-domain capabilities, the solver’s robustness, and the simple ‘block-by-block’ interface, that still remains open to customization with LMS Imagine.Lab Ameset.”

Rodolphe Denis
Head of Actuation System Mechanics and Simulation
Aircelle

“Due to LMS Amesim’s unique multi-physics approach and excellent local support, we choose LMS as our simulation partner.”

Vincent Pommé
Aircraft Systems Manager
Daher Socata
“LMS Amesim successfully integrated our Numerical Propulsion System Simulation (NPSS) model to understand the behavior of the environmental control system when connected to the engine.”
Jonathan Curry
Flight Sciences Engineering
Gulfstream

“The use of LMS Amesim enables to reduce development times by 25 percent, and the availability of the test benches increased by 60 percent.”
Achour Debiane
R&D Manager
Certia

“Simulation with LMS Amesim enabled us to anticipate and reduce the inherent risks of new technology development by validating our technical choices upstream.”
Michael Benmoussa
Senior Design Engineer
Messier-Bugatti
About Siemens PLM Software
Siemens PLM Software, a business unit of the Siemens Industry Automation 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 decision. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

Headquarters
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 972 987 3000

Americas
5755 New King Court
Troy, MI 48098
USA
+1 248 952 5664

Europe
Researchpark Haasrode 1237
Interleuvenlaan 68
3001 Leuven
Belgium
+32 16 384 200

Asia-Pacific
Suites 4301-4302, 43/F
AIA Kowloon Tower,
Landmark East
100 How Ming Street
Kwun Tong, Kowloon
Hong Kong
+852 2230 3308