

Siemens PLM Software

# LMS Imagine.Lab Amesim for heavy equipment

Enhancing the multidisciplinary performance of intelligent systems

## Benefits

- Accurately predict the multidisciplinary performance of intelligent systems
- Make the right choices earlier in the design process
- Connect to controls design so you can assess and validate strategies
- Seamlessly integrate with your company's existing software environment
- Protect your IP and know-how while creating and sharing your components or libraries

## Summary

With a rapidly changing global economic climate, manufacturers face an immediate challenge that is compounded by increasing competition. These manufacturers are being called on to provide more capabilities while reducing costs. In addition, there is a global drive to facilitate a more sustainable society by reducing pollutant emissions and providing long-term energy efficiency and related cost savings.

Heavy equipment customers need to reduce their cost of work-site operations so they can achieve efficiency, reduce downtime, manage changeover time and increase speed-to-market. Their equipment must be reliable, comfortable, safe and flexible. When these needs are met, end users can focus on their specialties, whether it is in agriculture, engineering, construction or mining.

Suppliers must also adapt to these changes. They need to evolve from simple system suppliers to real integrators that are able to tailor products according to original equipment manufacturer (OEM) specifications.

Siemens PLM Software offers a comprehensive methodology that can be integrated into an existing development process and combines mechanical, hydraulic, thermal, electrical and control engineering in one software environment. LMS Imagine.Lab Amesim™ software offers a complete 1D simulation platform to model and analyze heavy equipment systems so you can predict their multidisciplinary performance. From concept development to detailed engineering on the component or vehicle level, this platform helps balance vehicle energy performance with operability and emission levels.

# LMS Imagine.Lab Amesim for heavy equipment

## Features

- Innovative and open platform for mechatronic system design and simulation
- Unique combination of ready-to-use validated physical libraries for a wide range of multi-domain applications
- Efficient transient and steady-state simulations of complete vehicle systems
- Built-in scalable and energy-conserving models that enable fine-tuning of the level of complexity
- Powerful and simple analysis tools for the time and frequency domains



Compatible with any vehicle architecture, including conventional, hydraulic-hybrid and electric-hybrid, LMS Amesim helps engineers manage the growing complexity of mechatronic systems. By frontloading design decisions, off-road OEMs and suppliers can significantly reduce time-to-market and optimize development costs.

Furthermore, thanks to the LMS Amesim platform, engineers can not only independently study each mechatronic system, but they can incorporate the subsystems into a unique environment to evaluate their interaction, enabling vehicle integration and multi-attribute balancing.

### Design optimal powertrain architectures

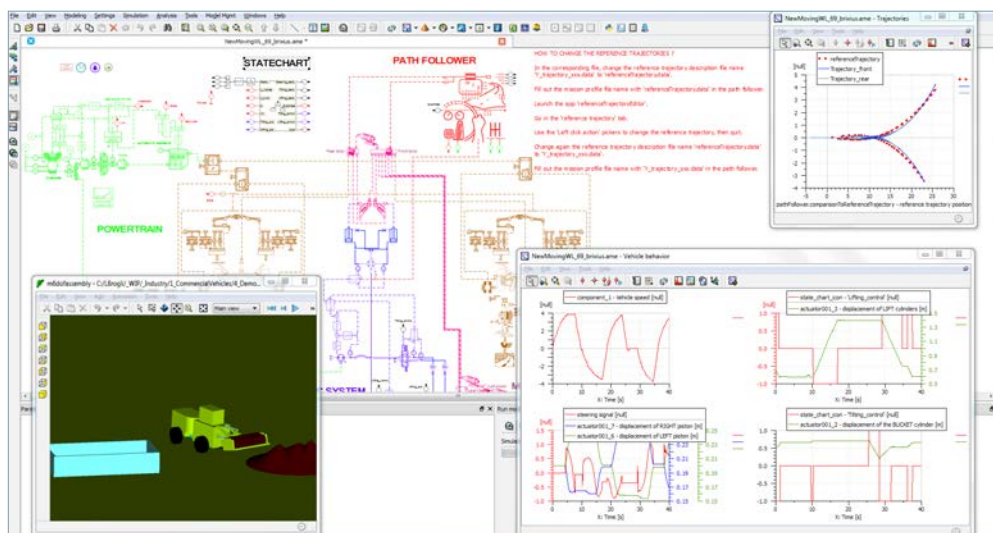
Using LMS Amesim helps you evaluate, design and optimize comprehensive engine systems – from air management and

combustion to fuel injection and engine control – by providing accurate physical engine and component models.

Our software solutions are developed in close collaboration with IFP Energies nouvelles (a public-sector research, innovation and training center active in the fields of energy, transport and the environment), and offer a cutting-edge, flexible environment for designing and optimizing virtual engine and automotive-subsystem concepts. They enable you to analyze the impact of advanced technology choices and give you a powerful toolset to investigate alternative engine architectures and concepts. Our plant modeling and multilevel approach enables you to optimize mechanics and software simultaneously as an integrated system, and helps to accelerate the validation of control strategies.

LMS Amesim also provides a generic platform for analyzing and designing optimal transmission systems. The software gives you access to driveline, engine and transmission models and components. It provides the capability to evaluate and define the appropriate powertrain architecture function of the targeted application. You can model the entire system, including all components, actuators and control systems. You can optimize the efficiency of hydraulic and mechanical systems and components (such as pumps, motors, gear trains, etc.), and take into account all interactions between subsystems.





The scalability of models (from functional to high-fidelity physical models) to accurately reproduce high-frequency and nonlinear phenomena enables you to conduct early design analysis, estimate energy losses and transients, and study the integration of the transmission with the engine, machine and control using model-in-the-loop (MiL), software-in-the-loop (SiL) and hardware-in-the-loop (HiL) techniques.

In addition, a combination of generic and application-oriented models make it possible to easily address innovative transmissions, including multiple speed, power split and continuously variable transmissions (CVT), etc. The software also allows you to develop energy recovery functions, estimate losses and compare several design alternatives to improve efficiency and assess mechanical comfort.

#### Analyze vehicle thermal systems

LMS Amesim provides dedicated tools to model, size and analyze thermal components, subsystems and the subsystem interactions, and run steady-state and real transient multi-domain simulations.

LMS Amesim gives you the opportunity to work on detailed models of vehicle thermal management subsystems, such as engine cooling and lubrication systems, engine thermal

models, air conditioning (AC) and in-cabin systems. The platform enables you to check the vehicle thermal behavior in different operating conditions and work cycles, and estimate the energy consumption of the fan and AC compressor.

You will be able to solve more design and integration problems earlier in the development cycle, and optimize energy management for the entire vehicle.

#### Enhance vehicle system dynamics

LMS Amesim offers application-oriented environments and dedicated capabilities to specify, design and validate vehicle dynamics as well as chassis subsystems and components. The software allows easy and seamless integration in a single modeling environment. It includes an extensive vehicle dynamics application, physical modeling libraries, a dedicated toolset, ready-to-use templates, application demonstrators and interfaces with simulation suites such as LMS Virtual.Lab™ Motion software and Simulink.

It enables you to design and evaluate the static and dynamic performance of any chassis system, and consider modifications of existing or new architectures at the predesign stage so you can anticipate potential gains. It also allows you to study the interaction of actuators (hydraulics or pneumatics) and mechanics, and integrate control strategies from the beginning of the design process. As a result, you can optimize the chassis system in order to shorten braking distance and reduce vibration with an optimized mounting system and advanced suspension while improving ride comfort and productivity.

#### Optimize electrical systems

LMS Amesim helps you define straightforward strategies for electrical or electromechanical systems throughout the design process. Mechatronic system engineering is a key development concern due to the increased use of electrical and electronic systems in heavy equipment systems.



LMS Amesim helps you simulate electrical and electromechanical systems and components, including batteries, drives and electric motors from specification to design and control strategy validation. Furthermore, the solution suite supports different analysis levels of electrical and electromechanical systems, such as power consumption estimation, accurate transient response evaluation and thermal effects.

#### **Boost mobile hydraulic actuation systems**

LMS Amesim allows you to design robust, reliable fluid power actuation systems for crane, crawler, earthmoving and mining equipment, machine tools and more. The hydraulics solution delivers the required insights to reduce power generation (such as variable displacement pumps and load sensing), develop new functions (such as self-leveling and control strategies) and improve product quality, robustness and reliability. The software enables you to consider every subsystem, and predict the dynamic behavior of the global fluid power system.

#### **Achieve vehicle integration and multi-attribute balancing**

LMS Amesim not only enables you to easily model and optimize components and subsystems, but it also provides you with a way to integrate all these systems and analyze the dynamic performance of the global system. You can anticipate and optimize technological choices by virtually integrating innovative eco-friendly concepts while improving efficiency, comfort, safety and performance. This approach supports conceptual architectural design iterations for any conventional, hydraulic-hybrid and electric-hybrid machines.

Thanks to unique scalability that offers models with various levels of detail, you can easily enrich the physical content of your simulation model while keeping the level of fidelity in line with the design stage and data availability. You can simulate trade-off analysis between fuel economy, performance, thermal comfort, drivability and noise, vibration and harshness (NVH)



in different maneuvers and operating conditions. Using LMS Amesim facilitates the frontloading and synchronization of the design of control strategies, and helps define and evaluate energy management strategies.

#### **Supporting control design**

LMS Amesim is also critical for control engineers because it provides robust plant models throughout the design cycle to enable efficient and concurrent mechanical and control design.

The multi-domain, scalable approach offers an efficient interface with Simulink, built-in links to market reference hardware-in-the-loop vendors, including DSpace, Opal-RT, ETAS and LabVIEW Real-Time (NI), as well as analysis tools and methodologies for model reduction.

This makes our simulation solutions ideal for supporting MiL, SiL and HiL testing activities so you can efficiently address the challenge of multi-attribute balancing.

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