

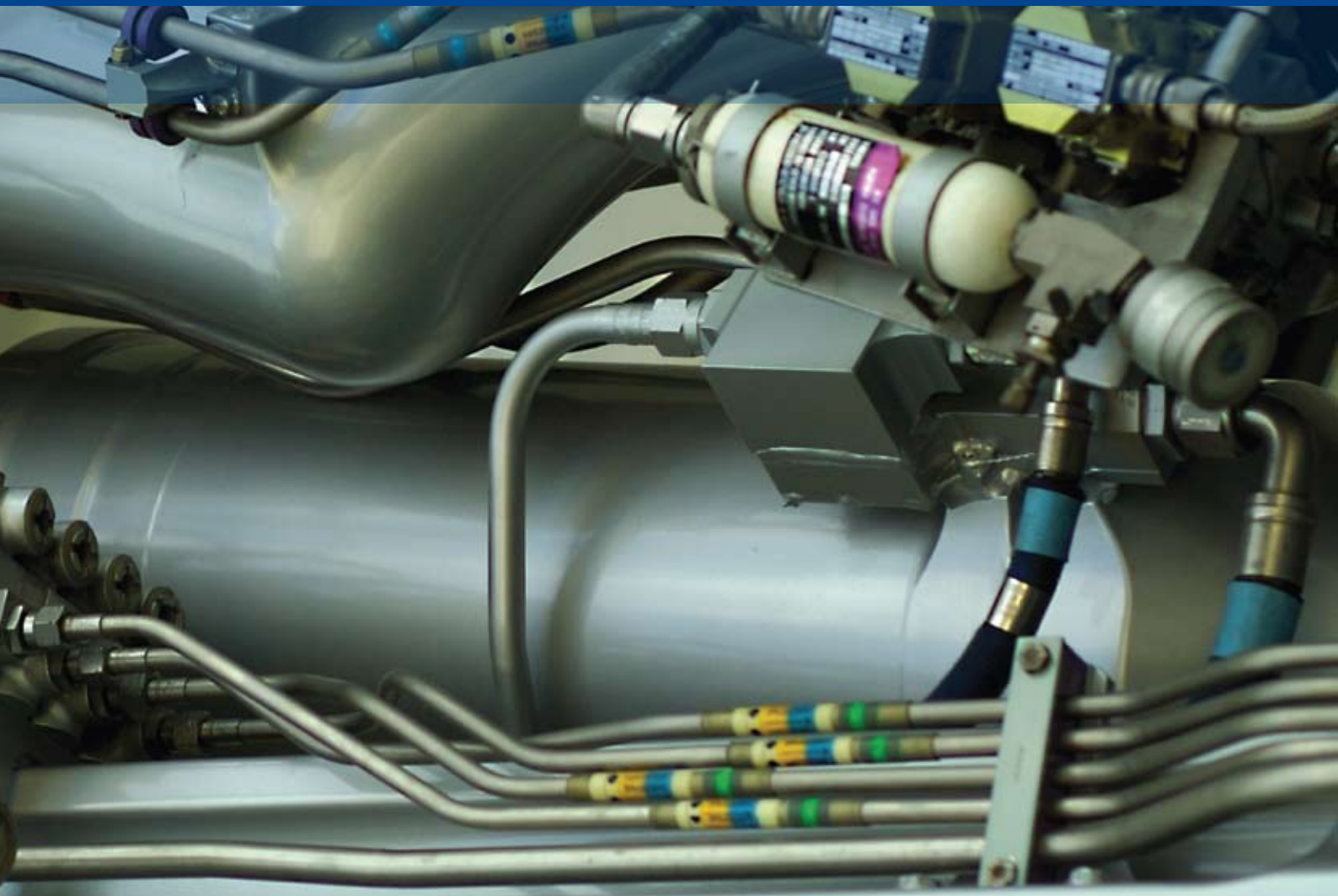
# LMS Imagine.Lab AMESim Fluids Systems



# LMS Imagine.Lab Fluids Systems

Using physics-based simulation, LMS Imagine.Lab Fluids Systems help engineers to design complete fluids hydraulic and pneumatic systems, from from the tank to the actuators up the fluid network. LMS Imagine.Lab Fluids Systems are supported by an extensive experience in fluids, which are capitalized in robust libraries. These assist both experienced and inexperienced users in modeling fluids systems from the functional to the detailed model level. The flawless communication between libraries and the accurate modeling of physical phenomena enables the design of any fluids system and the coupling with other related systems in a single platform, from the component to the global architecture.





- **Internal Combustion Engine Related Hydraulics**
- **Mobile Hydraulics Actuation Systems**
- **Aerospace Engine Equipment**
- **Environmental Control Systems**

### References

- Volvo Powertrain** - Diesel injection system
- Robert Bosch** - Simulation of electronic controlled diesel fuel injectors
- Delphi** - Development of a common rail diesel injection system
- Fiat** - Development of the Fiat Uniair VVA system
- Hilite International** - Simulation of a cam phaser and 4-way solenoid valve system
- Rexroth** - Simulation of mobile hydraulics systems
- Hispano Suiza** - Jet engine fuel flow metering unit simulation
- Zodiac** - Coupling between system and CFD model for aircraft oxygen mask design
- Embraer** - Aircraft bleed system

# LMS Imagine.Lab Internal Combustion Engine Related Hydraulics

LMS Imagine.Lab Internal Combustion Engine Related Hydraulics helps design and optimize fuel systems and components from tank to injector. It further assists in designing valve actuation systems in relation to the engine cylinder:

- Injection Systems
  - Gasoline, diesel and alternative fuels: DME, LPG, CNG
  - Low and high-pressure injection systems
  - Indirect/direct injection, common rail, unit injector, in-line pump
  - Solenoid, piezo, electro-hydraulic valve or mechanical actuation
- Valvetrain
  - Variable valve timing and cam phasing
  - Variable valve actuation with mechanical (MVT), electro-mechanical (EMVT) or electro-hydraulic (EHVT) systems
  - Engine compression brake
  - Camless systems

LMS Imagine.Lab Internal Combustion Engine Related Hydraulics is based on the LMS Imagine.Lab AMESim multi-domain system simulation approach and helps develop new concepts to confront challenges posed in systems such as high pressure multiple injections, gasoline direct injection, return-less low pressure gasoline systems, variable valvetrain and engine compression brake systems. The solution comes with a large and flexible set of models, addressing different complexity levels (leakage, compressibility, stiffness, inertias, friction...).

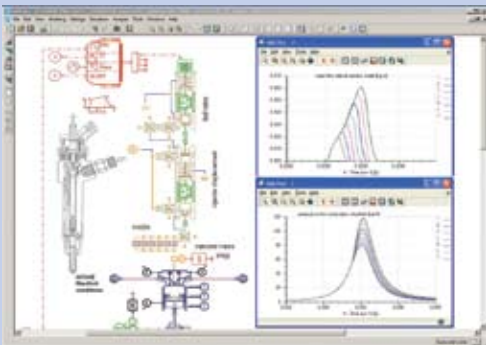
The accessibility, solver efficiency and accuracy of the models help both specialist and non-specialist engineers to design robust systems while keeping costs and delays under control.

## Features

- Hydraulic component design: Morphologic approach to model components based on geometrical data, focusing on physical effects, like energy exchange
- Advanced analysis tools: linear analysis, design exploration, activity index
- Connection of subsystems

## Benefits

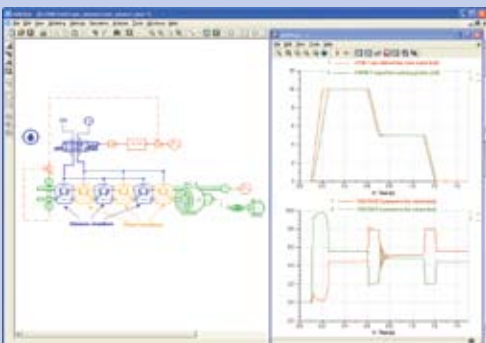
- Accurate description of fast fluid dynamics physics
- Study any kind of environment, from very low-pressure (cavitations) to very high pressure (>2000 bar)
- Easily couple subsystems components for global system analysis
- Accurately predict injection and valve lift flow rates for different operating conditions



Virtual test bench for analysis of the impact of injection strategies on combustion.



Linear analysis highlights the intrinsic dynamic properties of a gasoline low-pressure injection circuit.



The solution helps design the whole cam phaser system: fluid components and control strategies.



The solution assists in the development of new concepts on variable valvetrains such as the FIAT Uniair system.

# LMS Imagine.Lab Mobile Hydraulics Actuation Systems

LMS Imagine.Lab Mobile Hydraulic Actuation Systems solution helps to design fluid power actuation systems for crane, crawler, earthmoving & mining equipments, machine tools and more. It delivers the required insights to improve product quality, robustness and reliability, reduce power generation (variable displacement pumps, load-sensing), and to develop new functions (self-leveling, control strategies). LMS Imagine.Lab Mobile Hydraulic Actuation Systems provides engineers with a set of cutting-edge features and advanced simulation tools for:

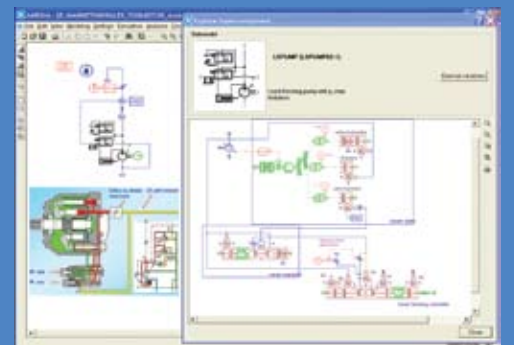
- Developing products with components actuated by hydraulic and pneumatic fluid power systems
- Improving product quality with robustness and reliability
- Reducing power generation (variable displacement pumps, load-sensing)
- Developing & optimizing new functions (self-leveling, control strategies) regardless of loads & machines kinematics

The dynamic behavior of such systems is hard to predict since every subsystem needs to be taken into account. For prototyping early in the development cycle, it is efficient to use a single simulation environment in which users can couple different modules. This results in enhanced compatibility, reduced implementation time, user-friendliness of the interface and no programming effort.

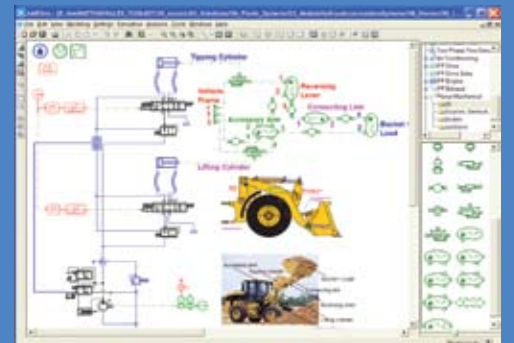
AMESim helps the visualization of mobile hydraulics systems with AMEAnimation, a 3D visualization tool which seamlessly imports your CAD data, automatically generates a CAD view from your AMESim model and animates simulation results.



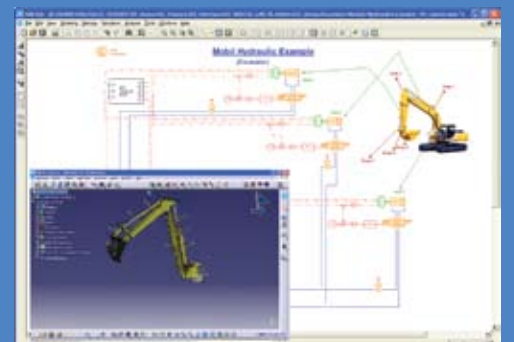
The mobile hydraulic actuation systems solution enables the design of fluid power actuation systems for crane, crawler, earthmoving & mining equipment.



The Hydraulic Component Library concept helps predefine and design complex components such as load-sensing pumps on virtual prototypes before any test.



Since most mechanical systems are planar mechanisms, the Planar Mechanical Library is fully dedicated to the study of mobile hydraulics actuation systems.



Interactions between the fluid actuation systems and complex multi-body systems can be easily managed thanks to the interface with specialized multi-body packages.

## Features

- A unique concept for Hydraulic component design (HCD) modeling
- Integrated 2D mechanism modeling facilities
- Interfaces with all major multi-body software and provides 3D animation capabilities
- Import/export capabilities to Matlab/Simulink for control integration from SiL to HiL
- Total vehicle modeling capability by linking dedicated application libraries (Engine, Drive, Cooling)

## Benefits

- Predefine valve design on virtual prototypes before any test
- Integrate control strategies from the beginning of the design process
- Define actuator impact on mechanical structures
- Analyze full vehicle system on a single platform

# LMS Imagine.Lab Aerospace Engine Equipment

LMS Imagine.Lab Aerospace Engine Equipment supports the design and industrialization of fuel systems (metering units, pumps, nozzle, starters, heat exchangers) and their controls, as well as engine control actuators. It helps engineers in designing market-specific gravity and pressure-feed fluid systems in aircraft engines and in building reliable thermal-hydraulic systems.

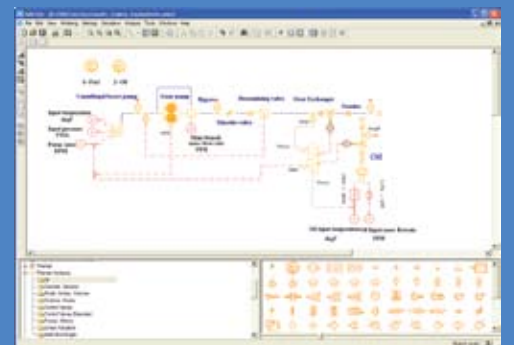
LMS Imagine.Lab Aerospace Engine Equipment is based on the LMS Imagine.Lab AMESim multi-domain system simulation approach and comes with dedicated thermal and hydraulics libraries including configurable components (metering valves, regulating valves) which are, once connected together, representative for the equipment hydraulic behavior. It provides equipment designers with the ability to specify and control the external design of aerospace engine-related components and systems.

The detailed models are based on experimental results of well-known geometries and are suitable to any new geometry or functional requirement. Straightforward coupling between libraries and components make it possible to easily run behavior analysis and testing on simple components as well as on wholly integrated fuel systems at any project level.

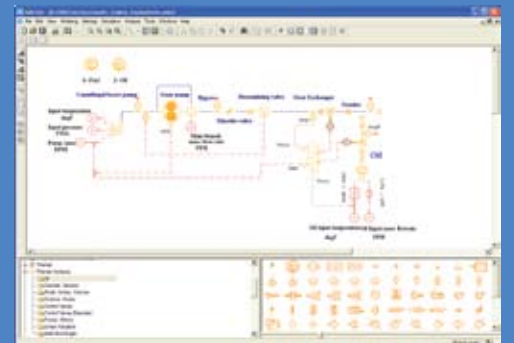
The aerospace fluids database of standard and customizable components is based on experimental results and ensures the necessary accuracy and validity of models required in aerospace engine design. LMS Imagine.Lab Aerospace Engine Equipment finally helps improve design quality, while reducing design time as well as the number of experimental tests and associated risks.



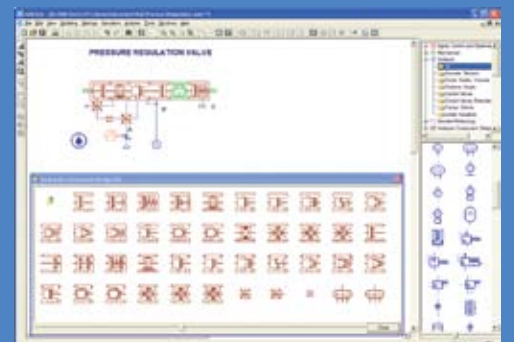
The Aerospace Engine Equipment solution helps the design of fuel systems and their controls, as well as engine control actuators.



The solution makes it possible to analyze complete aerospace fuel systems including all thermal aspects.



Advanced thermal-hydraulics components accurately predict dynamic behavior of systems under transient pressure and temperature conditions.



The Hydraulic Component Library helps model a huge variety of aerospace engine fluid equipment such as fuel metering units, pumps, actuators, nozzle and starters.

## Features

- Advanced thermal-hydraulics components
- Heat exchangers with different modeling levels
- Pressure/flow/temperature distribution for various operating points
- Direct coupling of pressure and temperature for global system analysis
- Advanced analysis tools (linear analysis, design exploration)
- Large fluids database of standard and customizable components

## Benefits

- Accurately predict dynamic behavior of fuel systems under transient pressure and/or temperature conditions
- Access multi-scale levels from components to complete system with control strategies
- Gain significant development time through fast CPU, even for large systems

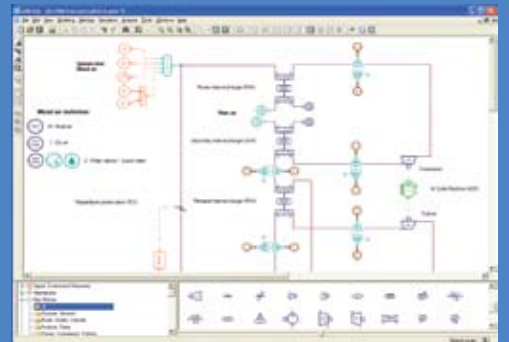
# LMS Imagine.Lab Environmental Control Systems

LMS Imagine.Lab Environmental Control Systems helps engineers design the optimal environmental control system that makes air breathable and comfortable - in terms of pressure, temperature, flow and humidity. Application areas include comfort optimization of passengers and crew in vehicles such as aircrafts, ships, submarines, trains and battle tanks. LMS Imagine.Lab Environmental Control Systems is based on the LMS Imagine.Lab AMESim multi-domain system simulation approach and handles multi-disciplinary systems for advanced design: gas dynamic, thermal pneumatics, vapor cycle (two-phase flow), air conditioning, controls and life and environmental sciences.

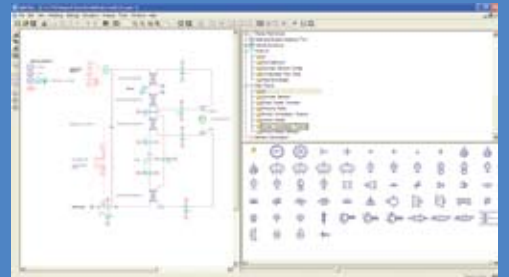
LMS Imagine.Lab Environmental Control Systems helps design various systems involved in environmental control systems: bleed system control, global energy management, air-conditioning, ventilation circuit, CO<sub>2</sub> bottle discharge, O<sub>2</sub> circuit, and cabin. The solution easily handles high system complexity, and takes into account multiple parameters (temperature, humidity, pressure and change of pressure rate) in dynamics conditions (temperature and pressure variations). It helps aircraft engineers to design systems with higher efficiency, lower weight and lower volume, and significantly optimizes energy consumption.



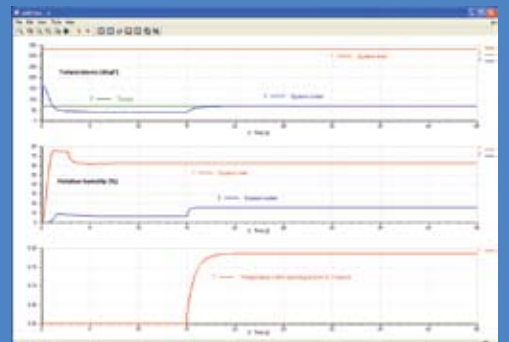
LMS Imagine.Lab Environmental Control Systems helps engineers design the optimal environmental control system that makes air breathable and comfortable.



An aircraft air conditioning system: part of the environment control system of an aircraft.



LMS Imagine.Lab Environmental Control Systems provides technical components such as turbines, compressors, gate, butterfly and globe valves.



Simulation results shows the Control Valve, which make it possible to manage the overboard air temperature by mixing air from the cooling system outlet and bleed air from the engine.

## Features

- Gas mixture library with up to 20 species
- Moist air library
- Pressure drops data base
- Turbines/compressors, gate/butterfly/globe valves
- Heat exchangers with different modeling levels
- State variables for dynamic species ratios and diffusion process
- Human body/ECS system interactions
- Accurate modeling of condensation/evaporation

## Benefits

- Accurately predict humidity and outlet temperature for optimized cabin air flow
- Significantly optimize overall energy consumption
- Seamlessly study transient flight conditions
- Suitable for various vehicle architecture and technologies



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