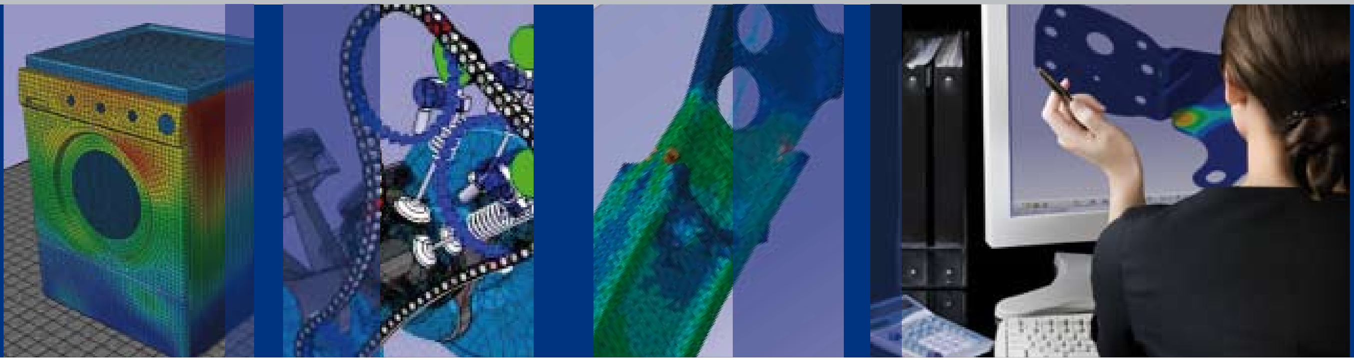
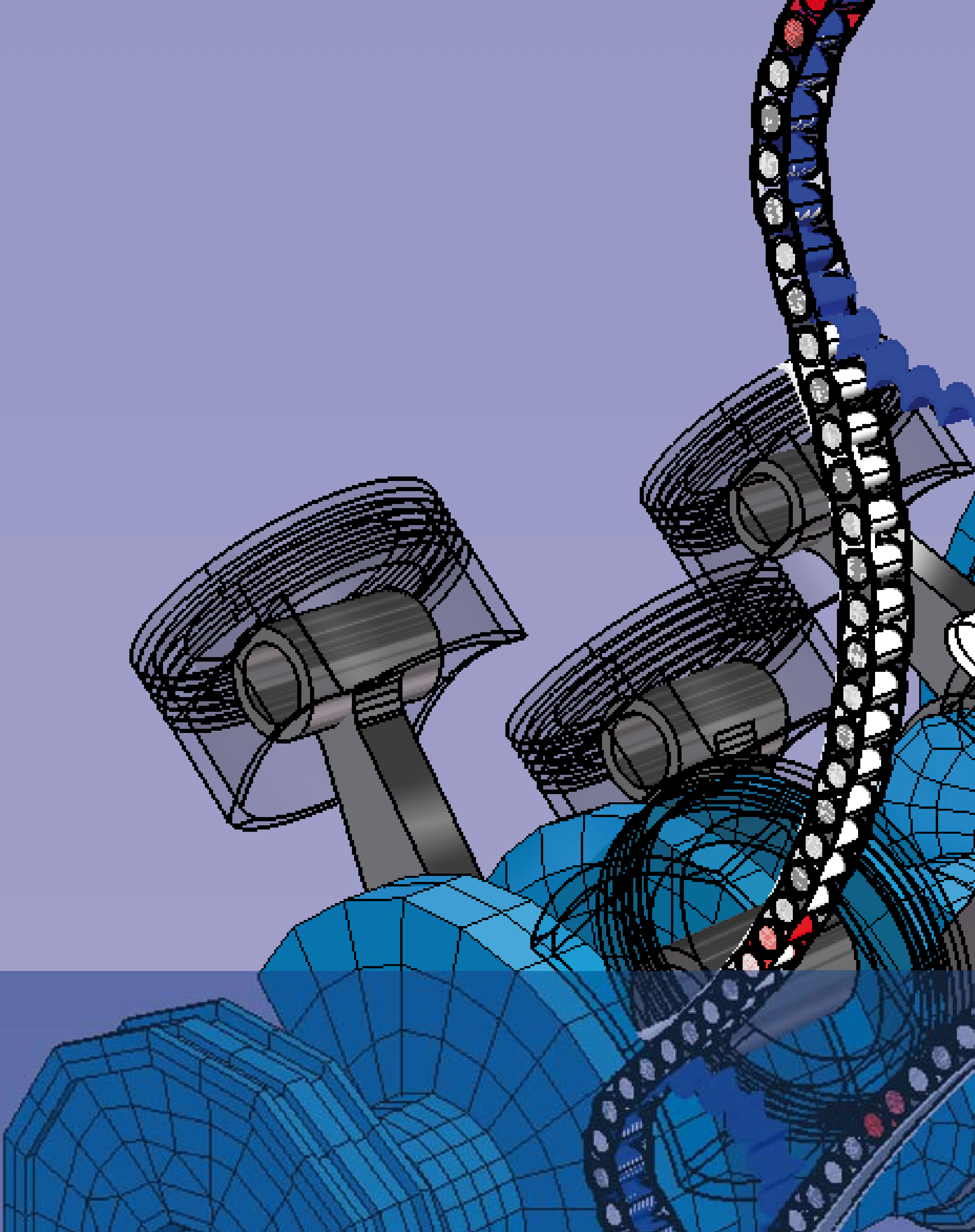
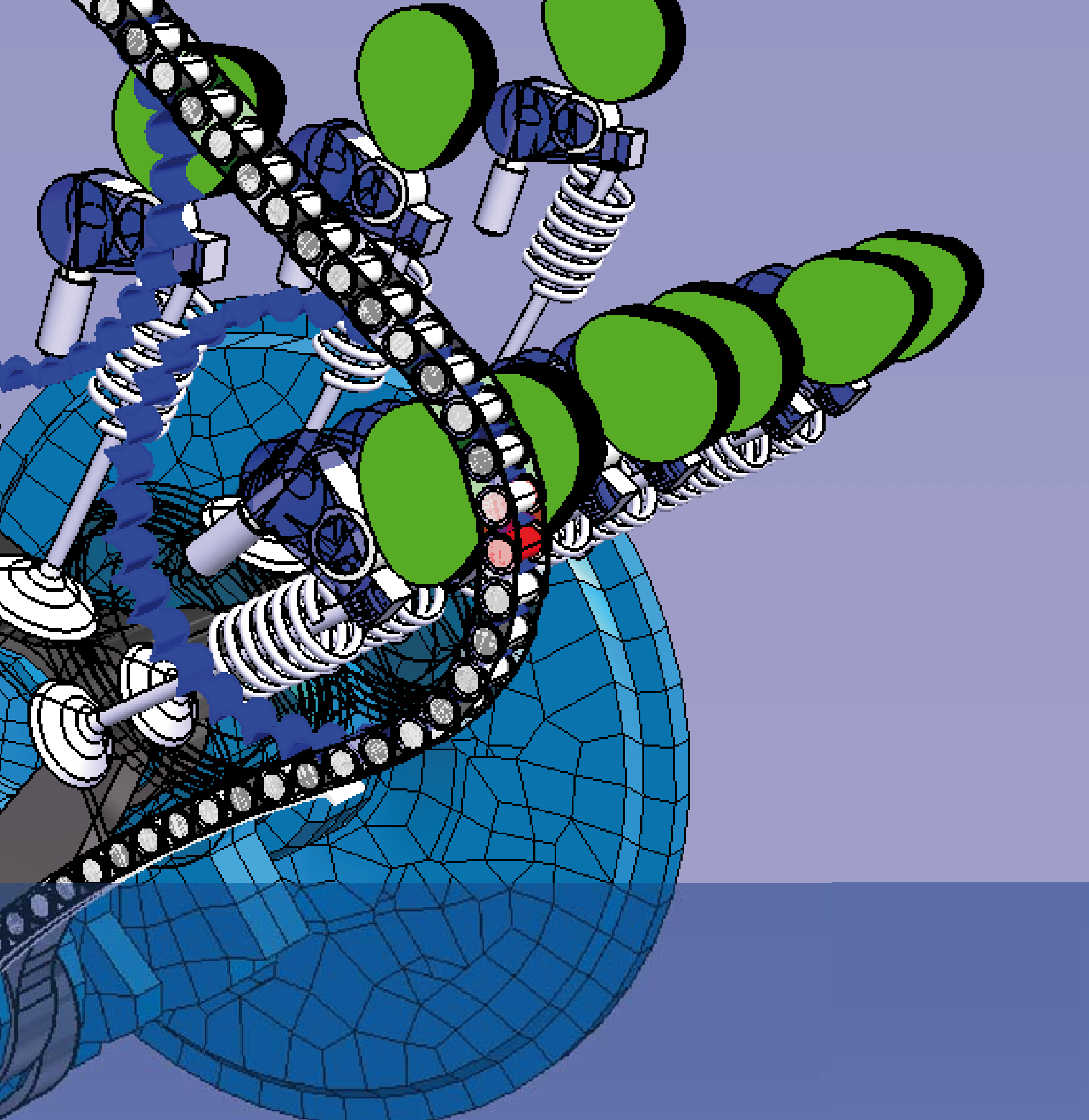
LMS Virtual.Lab Motion





LMS Virtual.Lab Motion

Optimizing real-life performance of mechanical systems



LMS Virtual.Lab Motion

Optimizing real-life performance of mechanical systems

Manufacturers are pressured to deliver more complex products with increased quality in shorter development cycles. Engineering the performance of mechanical designs with traditional test-based development processes is no longer an option. The only valid alternative is evaluating functional performance attributes on a virtual prototype. LMS Virtual.Lab Motion enables engineers to effectively analyze and optimize real-life performance of mechanical and mechatronic systems, long before physical testing.

Improving product quality

For engineers, the challenge is to guarantee that the dynamic performance of their mechanical systems matches the specifications. They need to make sure that numerous components interact and move as planned under real-life conditions, such as gravity and frictional forces. Virtual prototyping has to deliver the right answers on time and with the required accuracy to positively impact the development process. The best solutions are those that can be easily re-scaled to support the various stages of the entire development process. Equally important is that these solutions assess the dynamic motion performance in light of all system requirements, including durability, noise and vibration.

Simulating real-life behavior

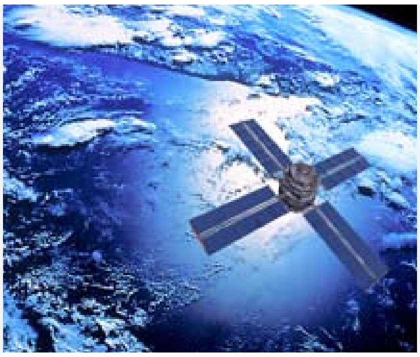
LMS Virtual.Lab Motion is specially designed to simulate realistic motion and mechanical system loads. It offers effective ways to quickly create and use multi-body models, efficiently re-use CAD and FE (Finite Element) models and perform fast iterative simulations to assess the performance of multiple design alternatives. Engineers can use its scalable models to execute conceptual kinematic studies during the earliest development stages, integrate test data, and run more detailed assessments at subsequent stages. Motion results can easily be used to drive subsequent analyses in LMS Virtual.Lab in order to perform concurrent cross-attribute optimization.

- **Assess the real-life behavior of complex mechanical systems**
- **Generate accurate loads for structural analysis, durability and noise and vibration studies**
- **Analyze and optimize real-life performance of mechanical systems before prototype testing**

LMS Virtual.Lab Motion Solutions for:

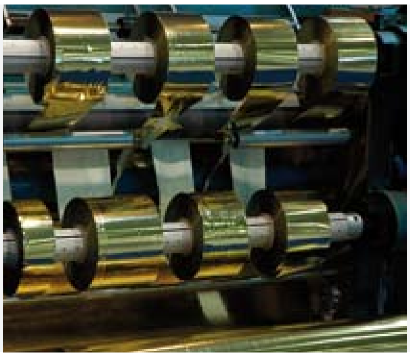
Automotive and Ground Transportation

LMS Virtual.Lab Motion offers vehicle engineering teams a dedicated environment to efficiently model, test and refine suspensions, powertrain systems, body parts, interior systems and other complex vehicle mechanisms. From the early concept stages onwards, engineers can tune and optimize suspensions to meet ride and handling targets, analyze the dynamic behavior of new engine designs, and predict component and system loads for fatigue or noise and vibration assessments. Control systems are used to model driver behavior and on-board ESP systems. LMS Virtual.Lab Motion also simulates the dynamic performance of agricultural, construction and all-terrain vehicles.



Aerospace

From initial sketches of control surfaces, complete modeling and simulation of wing flaps and slats, landing gear and door systems to advanced full-aircraft landing simulations, LMS Virtual.Lab Motion enables aviation engineers to meet strict functional specifications, ensuring safety, reliability and stability. Control systems are very important to make sure operation of the system is smooth and precise, not only for safety reasons but also for functional performance. LMS Virtual.Lab Motion also evaluates the dynamic behavior of space assemblies, such as launchers and satellites, under a wide range of extreme operating conditions.

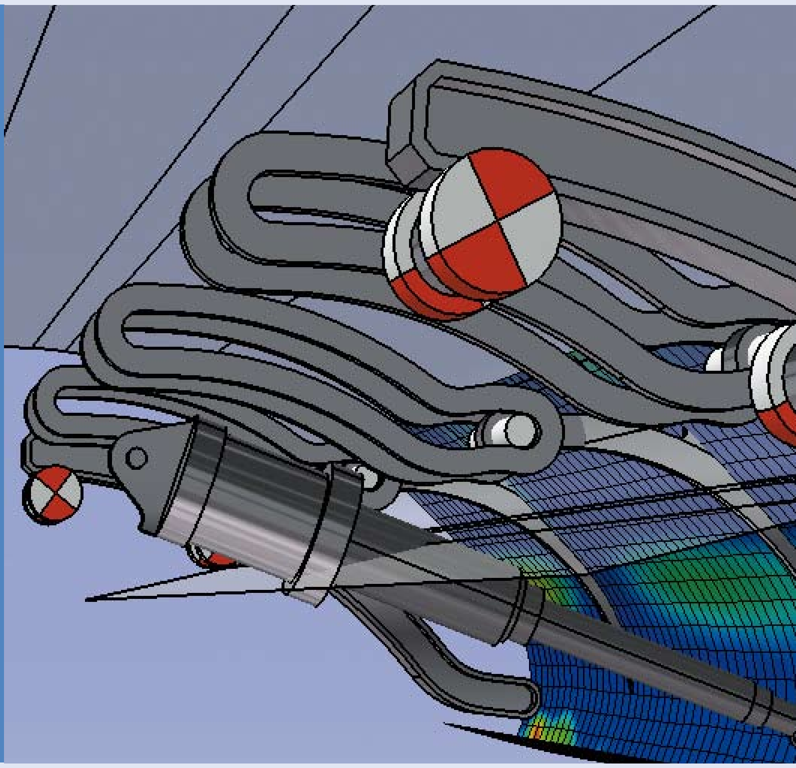


Industrial machinery

Offering the best return on investment is what matters for manufacturers of industrial equipment, being in the power generation, industrial or construction machinery industries. Higher speeds, more accurate movements and increased operational reliability can be realized through simulations in LMS Virtual.Lab Motion. The engineering challenges are very broad and include multi-physics and multi-attribute simulations, high rotation speeds and operation loads, vibrations, deformations and precision to name a few. For mechanical machinery, simulation delivers crucial engineering insight and automation to fit better into your process while delivering speed and ease-of-use.

Consumer and business electronics

Dynamic simulations of rotational mechanisms with high-precision mechanics enhance the operational reliability of faxes and printers, CD players, hard disk drives and high-speed DVD drives. LMS Virtual.Lab Motion also helps engineers to control the dynamics and further reduce operational noise and vibrations of white goods, despite ever-increasing rotating speeds.



An effective process to optimize designs prior to physical prototyping

Developing optimized mechanical systems before building and testing expensive physical prototypes requires accurate dynamic motion results. Kinematic modules in today's CAD packages are unable to fulfill these needs because they are limited to motion range prediction and collision detection without compliance effects. LMS Virtual.Lab Motion, on the contrary, simulates dynamic system behavior by including factors like inertia, gravity, stiffness, damping and friction. It can deliver much more valuable engineering insights throughout the entire product development process. Fast iterative simulations that accurately predict dynamic motion and internal loads and stresses empower engineers to assess the real-life performance of multiple design alternatives.

All-inclusive model set-up

When setting up the model, engineers start by importing or creating detailed CAD or wireframe geometry for the different components. They create constraints and connections between the components so that the complete system kinematics are described properly.

After this, engineers define the model and its environment further by including dynamics to accurately predict the loads in the system on a time-domain basis. This means that gravity, masses and inertias are defined as well as all forces between components, including stiffness, damping, contact, and friction. Implementation of those forces can be applied through a broad range of algorithms such as specific springs, dampers, bushings or contact elements that are very contextual. A force element could be as simple as a basic spring or as complex as a detailed tire.

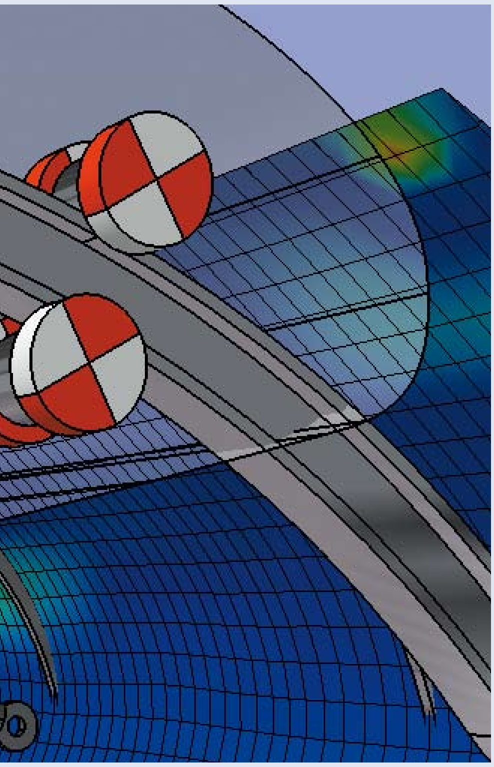
Additional refinement modeling

Basic modeling is enhanced with more detailed force representation. For example, when a body is not stiff enough to be considered rigid, engineers can represent the bodies as flexible. They can deform under high loads according to predefined mode shapes derived from the simulation itself or imported from test data. Intermediately, a long flexible body, such as a suspension stabilizer or a wind turbine blade could be automatically substructured as a multi-beam to account for overall non-linear deformation of the body under loads. LMS Virtual.Lab Motion also includes detailed descriptions of tire forces, bushings, contact between flexible bodies, gear contact, beams, engine, combustion loads, hydrodynamic bearings or aerodynamic forces to name a few.

Solving and post-processing

When the model is described accordingly, engineers can solve it and review the results simultaneously using both animation and graphing. To better understand the model's behavior, engineers can improve the design in order to make it reach its performance targets, including related to loads and stress analysis.

When the model includes very specific and detailed controls and forces such as hydraulic, pneumatic and electro-magnetic, engineers can make use of the full mechatronic capabilities included in both LMS Virtual.Lab Motion and LMS Imagine.Lab AMESim using co-simulation.



Ease-of-use

Dedicated tools have been further developed to facilitate analysts' work and improve process efficiency. Dedicated application interfaces have been developed to help designers and analysts create a specific model much faster than by doing the same job manually. Vertical interfaces are layered on top of LMS Virtual.Lab Motion to complete specific modeling and analysis set-up tasks.

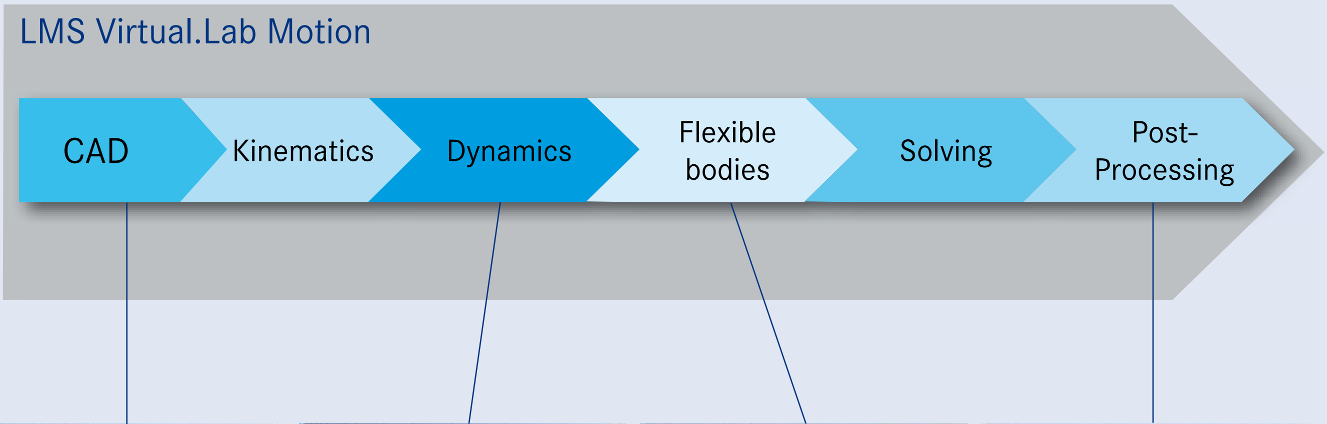
Besides dedicated verticals, LMS Virtual.Lab Motion lets users assemble a system modularly from existing subsystems. This way, subsystem departments at your company can work independently while remaining closely connected on the system level.

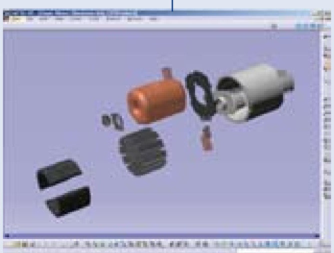
Integration

The LMS Virtual.Lab package provides an integrated environment for seamless multi-attribute simulations. Thanks to system parameterization and associativity, engineers can troubleshoot and optimize models in a very simple and efficient way. When any change is made to a model parameter, it is automatically cascaded to produce updated results in the dynamic motion simulation as well as in the durability and NVH results. Moreover, a complete set of parameters can be changed in one single click thanks to the use of design tables. This saves time and error-prone effort in file transfer an updating, letting engineers spend more time in the actual analysis phase rather than in the modeling one.

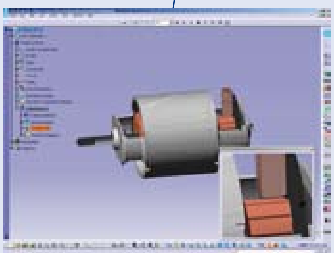
Automation

Another LMS Virtual.Lab Motion advantage is the ability to automate any repeated process thanks to VBA (Visual Basic for Applications) journaling and scripting. Engineers can automate a specific process by creating a dedicated GUI either within or on top of LMS Virtual.Lab Motion. This not only saves time by eliminating highly repetitive tasks, it puts the process emphasis on performance optimization of the design, rather than on performance analysis of the current design.

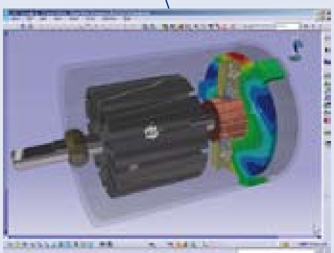




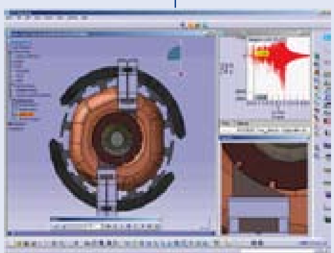
CAD geometry is imported and assembly joints and constraints are created.



Dynamic elements are added to represent contact and other forces.



Flexible modeling increases results accuracy by considering component deformation and modal excitation.



Combined graphing and animation post-processing helps understand root causes of a design weakness.

LMS Virtual.Lab Motion Pre/Post

VL-MOT.80.1

LMS Virtual.Lab Motion Pre/Post is the platform for multibody simulations and contains all required basic capabilities to execute the modeling and analysis part of the job. Solver capabilities are not included within this platform but solver input files and solver results files can be exported and imported to the solver. The LMS Virtual.Lab Motion Pre/Post offering is suited for departments that need more pre/post than solver resources.

LMS Virtual.Lab Motion Pre/Post allows the creation of complete models. System components are assembled with constraints and joints. Compliant interactions between components and their environment are modeled with suited and detailed force elements representing real dynamic physical behavior.

Animation features help visualize more complex movement, including deformation of components in flexible bodies and interference detection between components during the dynamic event case. In addition, special features allow users to examine animated swept volume, vector force visualization and more. Various graphing features allow users to view detailed results of the overall motion of each of the bodies in the system like translational and rotational displacement, velocity and acceleration. All possible loading results in the system like internal and external forces and torques and components' internal stresses are also available for graphing. Dedicated post-process for suspension and vehicle and other user-defined template plots capabilities are provided as well to facilitate analysts' work. The advanced user interface supports Visual Basic journaling and scripting to let engineers automate any complex and repetitive modeling process and reporting tasks allowing them to concentrate their efforts on the design analysis and optimization part of the work instead of spending non-value added time on design modeling and updating.

LMS Virtual.Lab Motion Pre/Post features includes:

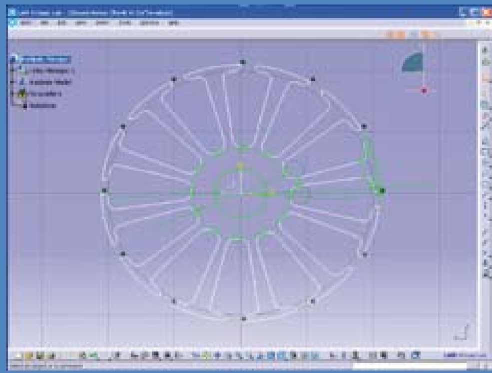
- CATIA V5 geometry creation
- Mechanism assembly using kinematic joints and constraints
- Modular assembly using sub-mechanisms
- Dynamic modeling based on stiffness, damping, friction, contact or user definitions
- Dynamic modeling based on higher level force elements
- Flexible bodies modeling based on existing FE data (simulation or test modes)
- 3D Animation
- Graphing of all results
- Collision detection, swept volume, vector force visualization, etc
- Automatic motion model conversion to FE-assembly model for NVH
- Automatic motion model conversion from ADAMS model and reversely
- Automation capabilities through journaling and scripting

Features

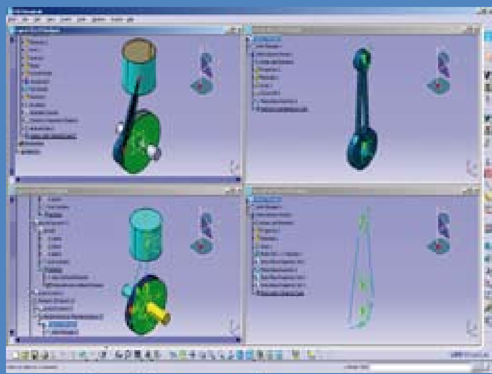
- Solid modeling based on CATIA V5
- Assembly and kinematic constraints to position solid bodies
- Advanced animation for rigid and flexible bodies
- Versatile result plotting
- Automation features and Visual Basic programming interface
- Direct seamless connection to LMS Virtual.Lab Durability, NVH, Structures and Optimization

Benefits

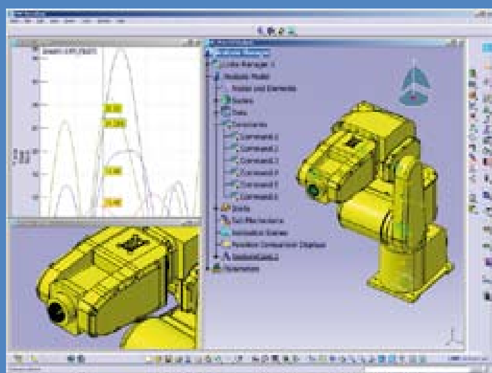
- Create more accurate and detailed dynamic system models
- Gain insight into complex behavior through animation and plotting
- Maximize CAE analysis with advanced cross-attribute simulation
- Predict loads, displacements, velocities, and accelerations for any type of mechanical system
- Make important design decisions without extensive physical prototypes



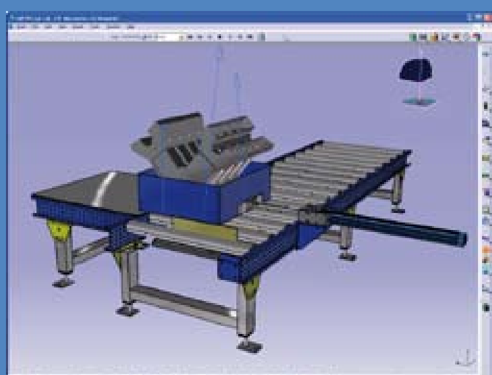
Each component is represented by using wireframe or solid geometry. Users can import or draw their own parametric geometry.



Components can be modeled as rigid body, fully flexible body, or substructured multi-beam body.



Post-process capabilities enable synchronized 3D animation and 2D graphing with following cursors.



LMS Virtual.Lab Motion is successfully used in a wide range of industries including industrial machinery.

LMS Virtual.Lab Motion

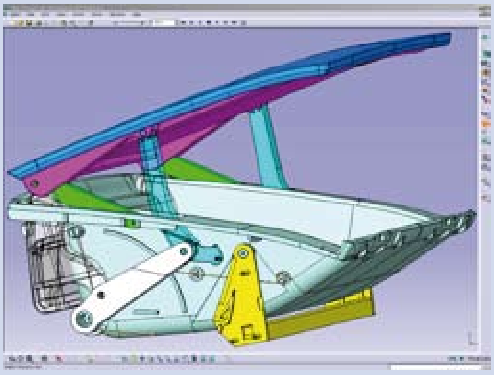
VL-MOT.33.2

LMS Virtual.Lab Motion contains all required basic capabilities for a realistic multibody simulation, including modeling, solving and analysis. LMS Virtual.Lab Motion offers capabilities extensions like parallel and batch solver for departments that need more solver resources than pre/post ones.

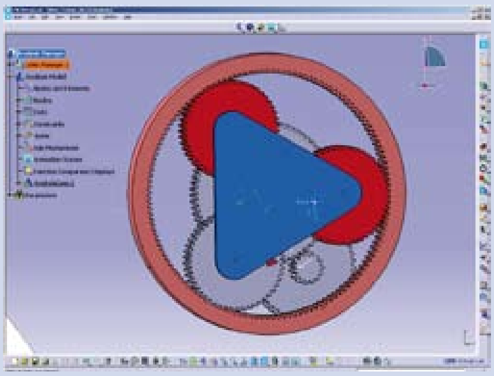
LMS Virtual.Lab Standard Motion is a complete and integrated solution to simulate realistic motion and mechanical system loads. It permits engineers to quickly analyze and optimize the real-world mechanical design behavior and guarantee that it performs as expected before committing to expensive physical prototype testing.
LMS Virtual.Lab Standard Motion allows users to model, simulate and analyze results of any rigid multibody mechanical system. Mechanical elements include an extensive list of joint and constraint features and an extensive library for force elements modeling including stiffness, damping, friction or contact forces (including CAD contact). The stable and high-performance solver guarantees accurate and efficient handling of even the most complex dynamic problems. The results include displacement, velocity, acceleration, and all reactive forces and torques for all bodies in the simulation. The solution also allows users to improve the dynamic behavior performance and to predict component and system loads for use in structural analysis, noise and vibration simulation, fatigue life prediction and other fields within a seamless environment.

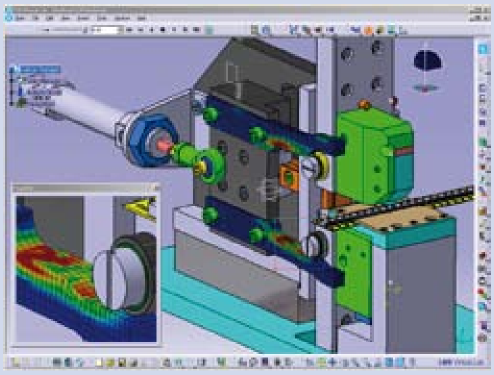
LMS Virtual.Lab Standard Motion provides leading-edge technology in solid modeling, parameterization, CAD geometry, flexible body features, control and hydraulic capabilities, solver performance, and post-processing capabilities like animation and graphing. It uniquely integrates all required functionalities into a single, user-friendly desktop environment, eliminating the need for multiple solutions and time-consuming data transfers. Users can quickly create and refine fully parameterized virtual prototype models of mechanical systems using a fully integrated CAD engine based on CATIA V5.

Dedicated post-processing help engineers easily identify and effectively solve the root causes of an engineering problem allowing team members to step into the design and make relevant critical decisions.


Simulation reproduces the dynamic behavior of a dashboard compartment when driving a car.


Complete wind turbine with all its control systems simulated for safety and optimization.


Gear contact simulation with variable meshing stiffness predicts dynamics, gear rattle and gear whine.


Flexible contact predicts accurate stresses and fatigue life in components undergoing high contact loads.

Features

- Create individual part geometry based on the CATIA V5 solid modeler
- Assemble bodies using a complete library of kinematic joints and drivers
- Add forces between bodies using springs, dampers, tires, friction, and contact forces (including CAD contact)
- Include accurate body mass and inertia based on solid modeling and density
- Based on the accurate and stable LMS DADS solver
- Perform kinematic, dynamic, inverse dynamic, quasi-static and pre-load analyses
- Calculate forces, displacements, velocities, and accelerations
- Collision detection based on detailed solid modeling

Benefits

- Gain full insight to internal loads acting on mechanism components to assess strength and fatigue life
- Animate complex dynamic motion and detect potential collision between parts
- Identify and optimize parameters that impact real-life design performance
- Define motor and actuator dimensions by computing the required force and torque for a desired mechanism motion
- Analyze problems identified during prototype testing and quickly explore possible solutions
- Explore safety limits without putting people or expensive equipment at risk

LMS Virtual.Lab Vehicle Motion

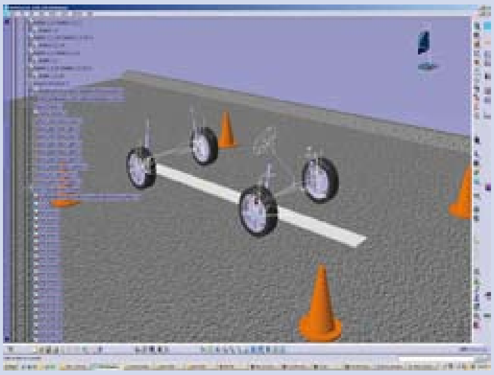
VL-MOT.34.2

LMS Virtual.Lab Vehicle Motion simulates all types of vehicle ride and handling behavior from passenger cars and motor sport vehicles to multi-axle vehicles like trucks and buses.

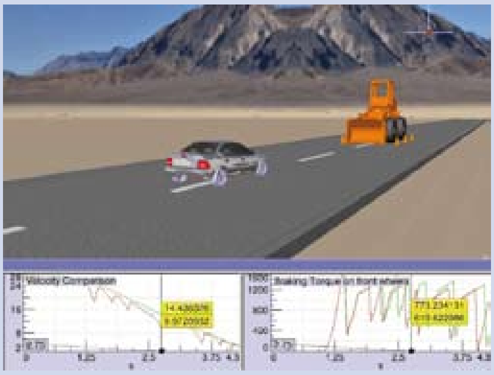
Front and rear-axle suspension models created with the LMS Virtual.Lab Suspension Interface can easily be integrated modularly into a full-vehicle model including a steering system, brakes, powertrain and driveline, electronic control systems and tires. Dedicated subsystem templates for suspensions, steering, braking systems and driveline are also provided.

Vehicle simulations include multiple runs with standardized events. The available library of pre-defined vehicle events, including ISO maneuvers can be extended by any user-defined event. The car can be driven through a kinematic driver (open-loop control) or through a path following control algorithm implemented in LMS Virtual. Lab Motion (closed-loop). Additionally, the IPG Driver model includes complex driver-vehicle interaction to include human reactions in the dynamic vehicle model.

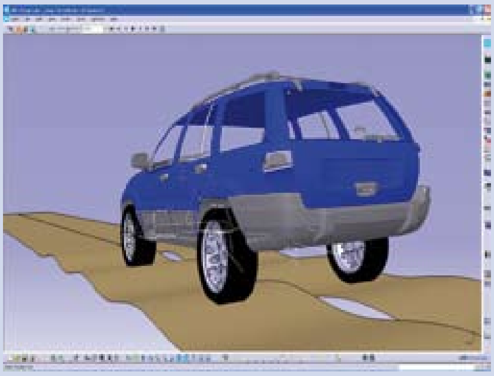
To use motion simulations as input for downstream durability and comfort analysis with LMS Virtual.Lab Durability and LMS Virtual.Lab Noise and Vibration, accurate tire and road modeling are vital. LMS Virtual.Lab Motion offers a set of specific tire models dedicated to specific applications going from basic ride and handling analysis at low frequencies (<10Hz) up to more complex comfort and durability analysis at higher frequencies(<100Hz). TNO MF Tire for LMS Virtual.Lab is based on the well-known Magic Formula empirical model. TNO MF Swift for LMS Virtual.Lab and LMS CDTire are both based on physical models. TNO MF Tire for LMS Virtual.Lab offers accurate and scalable tire models for concept studies and handling simulations. TNO MF Swift is best suited to ride performance. LMS CD Tire provides a scalable 2D, 2.5D and 3D approach that accurately tracks tire vibrations up to 80 hertz for comfort and durability studies. Besides these specialized tire models, a simple version is included for vehicles where tire performance is not crucial to the overall design. LMS Virtual.Lab Motion also provides scalable road surface modeling from the 2D even road up to the digitized test track solution allowing the digital reproduction of any proving ground for both calculation and model visualization.



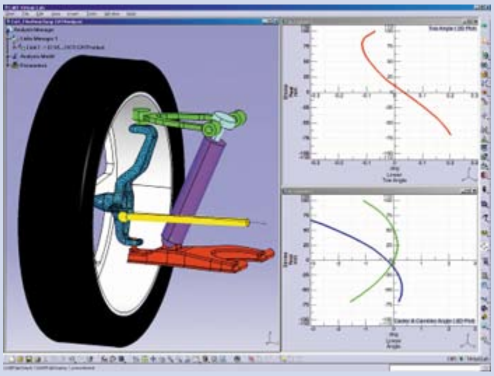
Optimizing a quarter suspension using Design Sensitivity Analysis during any kind of test rig event.



Ride & handling simulations of human driving interaction by embedded controls or IPG-driver co-simulation.



Vehicle simulated driving on a flat, or uneven 2 or 3D road including a digitized proving ground.



Virtual test rigs are used to reproduce suspension loads when a digitized road isn't available.

Features

- Full vehicle modeling template with front and rear suspension models for quick body assembly
- Standard Tire Interface (STI) with basic 2D tire models and interface links to TNO Tire Human driver model for open-loop and closed-loop maneuvers
- Dedicated vehicle dynamics post-processing functionalities include body roll, pitch, yaw angles and rates, and suspension-related characteristics, such as toe, camber angle, and caster.
- Seamless integration for the optional LMS CD Tire and Monroe Shock Absorber model

Benefits

- Ensure efficient modeling and analysis with full vehicle simulation templates
- Save costly test track time by simulating ride and handling behavior on virtual prototypes
- Provide accurate durability input loads for suspension optimization very early in the design process by driving full-vehicle motion models with corresponding tire models on a digital test track
- Verify control strategies, like power-assisted steering, power-assisted braking and ESP, in the concept stage on 3D virtual vehicle models

LMS Virtual.Lab Powertrain Motion

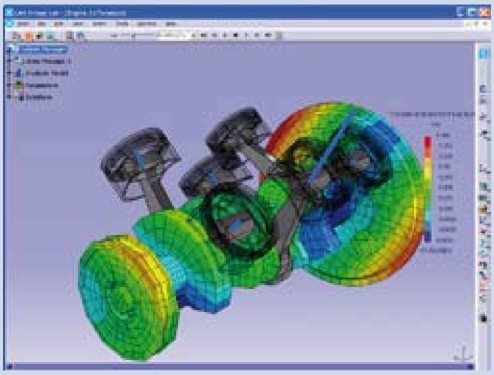
VL-MOT.35.2

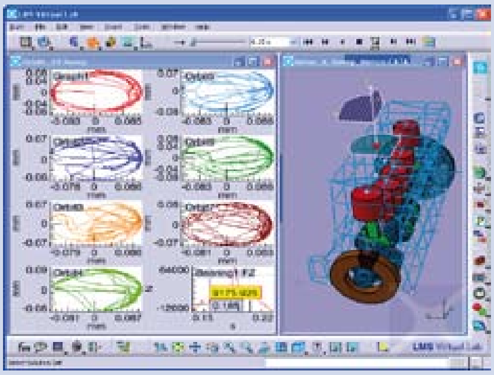
When developing new and improved engines, engineers often face conflicting design goals. Modern design requires the best of both worlds: reduced engine emissions and fuel consumption with more power, reduced weight and vibrations, optimal sound and maintenance-free operation. LMS Virtual.Lab Powertrain Motion is a complete, integrated solution to simulate complex dynamic engine performance and accurately predict internal loads. Loads are required to determine fatigue life, vibrations and engine radiated noise. Using virtual simulation, engineers can quickly identify the most promising new engine concepts and ideas, such as cam phasers, variable valve-lift devices and variable compression-ratio engines. LMS Virtual.Lab Powertrain Motion also supports engineers investigating shaft whirl, torsion vibrations, chain noise, gear rattle and whine to optimize driveline system dynamics.

LMS Virtual.Lab Powertrain Motion provides dedicated powertrain modeling templates that help users to quickly build detailed models of full powertrain assemblies or specific sub-assemblies like valve train, crank train, driveline, timing chain and belt, geartrain and other accessory drives. Separately created sub-mechanisms can easily be joined together to study coupled behavior. The powertrain template generates fully parameterized models enabling fast modifications and accelerated alternative design analysis.

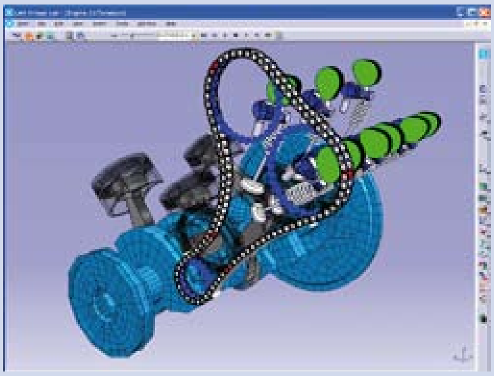
The LMS Virtual.Lab Motion solver handles a broad range of powertrain applications directly on the virtual model:

- Valve train: simulate high-order/high-speed effects including spring surge, cam-contact design, or valve-seating performance
- Crank train: analyze crankshaft and engine block interactions, bearing loads, crankshaft vibrations and dynamic stress
- Driveline: analyze prop shaft bending and whirl, garage clunk and shift clunk, or driveline booming
- Timing chain: quick lay-out and fast recursive solver for dynamic simulation of complicated sprocket, guide, tensioner and chain configurations


Flexibility of the cranktrain simulates accurate loads at the journal bearings.


Combustion loads, hydrodynamic bearings and flexible engine block are modeled for accurate and fast results.


Surge effect of the helical spring is captured through 3D flexible representation.


Coupled cranktrain, valvetrain, timing and accessory drive simulation gives insight into subsystems interaction.

Features

- Modeling elements for hydrodynamic bearings, flexible valve springs, cam contact forces, hydraulic lash adjuster
- Combustion tacho elements apply measured gas forces to pistons and cylinder head
- Cam profile synthesis tool
- Automatic set-up of valve train parts, gas forces and firing order adapted to engine configuration
- Integrated engine-speed controls for simulation of stationary speeds, speed sweeps and transient run-ups
- Flexible bodies support dynamic stress computation
- Dynamic stress animations indicate failure
- Topological hot spot detection ranks the most stressed regions on the FE mesh

Benefits

- Templates accelerate crank train, valve train and timing drive systems modeling
- Predict loads throughout the powertrain system
- Evaluate dynamic stress on different engine regimes to efficiently determine engine vibrations and analyze crankshaft and engine block reliability
- Study new engine concepts, such as cam phasers, variable valve-lift devices and variable compression-ratio engines
- Design powertrain components while respecting dynamic performance targets
- Study belt and chain dynamics and coupled powertrain subsystem behavior

LMS Virtual.Lab Landing Gear

This dedicated simulation solution for landing gear systems allows development teams to build detailed aircraft landing gear models that reliably simulate real-life performance. Team members can quickly assess multiple design alternatives and optimize aircraft designs before constructing the prototype. Developed in close cooperation with several aircraft and landing gear manufacturers, LMS Virtual.Lab Landing Gear addresses specific landing gear engineering challenges and predicts total system loads for typical aircraft movements, such as landing, taxiing, and take-off.

LMS Virtual.Lab Landing Gear provides team members with detailed insight into landing gear dynamic behavior and overall performance in terms of reliability, stability and safety. During landing, take-off and taxiing maneuvers, the landing gear assembly must absorb huge amounts of energy without generating reaction forces that exceed the dynamic loads envelope. Dynamic motion simulation – using rigid as well as flexible bodies – help engineers to tune the landing gear design and reach the targeted dynamic characteristics. LMS Virtual.Lab Landing Gear also assesses new system design responses to extreme and failure load cases, an aspect where physical tests are either too dangerous or too costly.

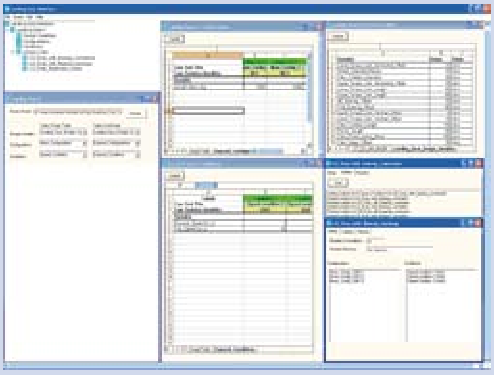
This application interface was developed on top of Virtual.Lab Motion by using Visual Basic for Application (VBA) scripting capabilities and can be customized and reproduced for any other similar user needs.

Features

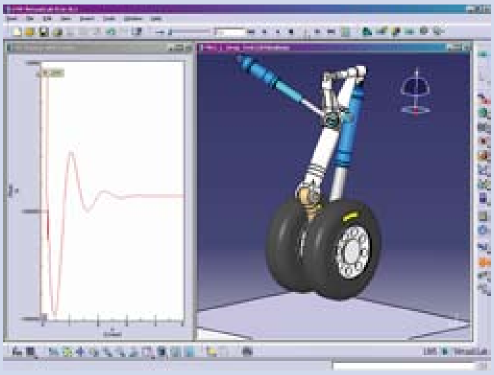
- Modeling of landing gear through parametric templates or existing models
- Connection of the landing gear to any kind of aircraft
- Set up of any maneuver including landing, taxiing, etc defined within the templates or by the user
- Automatic ground loads calculation and reporting for the different combinations of landing gear, aircraft and maneuver.

Benefits

- Templates accelerate modeling and updating of a landing gear after analysis
- Predict ground loads with high level of accuracy
- Remains totally open and suitable for classic analysis within LMS Virtual.Lab
- Design Tables, Design Sensitivity Analysis and Optimization to optimize and update your model with any possible multi-attribute target

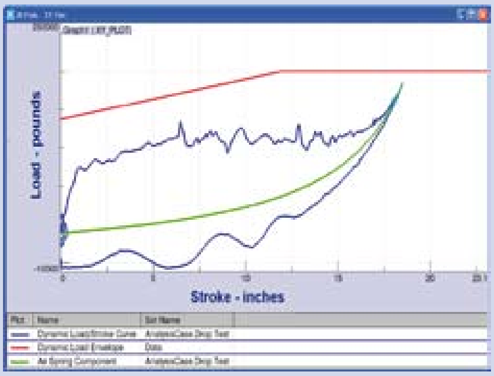


Simulate landing gears, aircraft topologies and various events like taxiing, take-off, retraction and landing.



An oleo-pneumatic damper and tires are accurately modeled with LMS Virtual.Lab and LMS Imagine.Lab.

Various components can be modeled flexible increasing simulation accuracy.



Simulate absorption of energy during landing, while ground loads remain within a prescribed envelope.

LMS Virtual.Lab Race Car

Developed in cooperation with leading racing teams, LMS Virtual.Lab Race Car is a dedicated simulation solution for professional racing teams. With immediate access to sophisticated race car simulation capabilities, design teams can avoid modeling errors and save valuable time. All the user needs to do is simply enter relevant vehicle parameters to access information regarding the vehicle assembly, view a dynamic simulation and obtain documented results. LMS Virtual.Lab Motion runs various automated analyses in the background, including steady-state cornering, dynamic maneuvers, 7-poster rig tests or kinematics and compliance rig tests. The various runs allow for Design of Experiment and Optimization of the racing vehicle topology. Racing team professionals appreciate simple user interface and efficient simulation solution. Full-vehicle studies can take place right at the track during test laps and even the race itself.

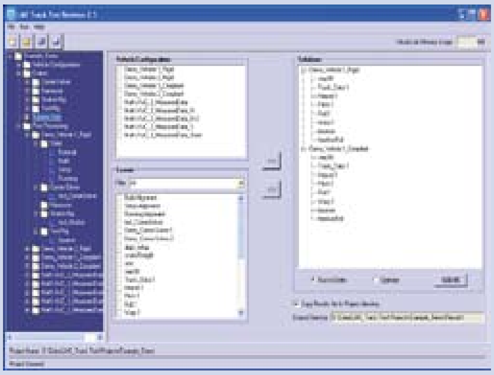
This application interface was developed on top of LMS Virtual.Lab Motion by using Visual Basic for Application (VBA) scripting capabilities and can be customized and reproduced for any other similar user needs.

Features

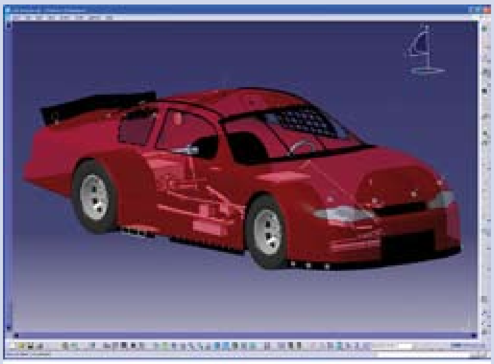
- The interface is a VBA application built on top of Virtual.Lab Motion and LMS Noesis Optimus
- Suspension and vehicles can be designed in a classic way or using templates
- Various maneuvers with close-loop control can be performed, including static alignments, static corner state analysis, dynamic test-rig, dynamic shaker-rig and other dynamic maneuvers
- Design of experiment and efficient car topology optimization

Benefits

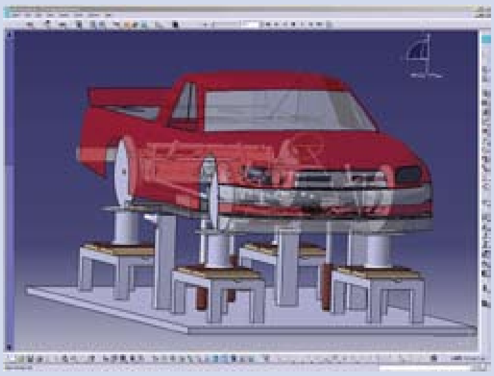
- The dedicated interface allows automated and intuitive modeling, simulation and analysis processing, including optimization.
- The multi-body model interaction is streamlined, allowing the user to interact with 1 to 1 suspension and chassis adjustments of the real car
- Manufacturers can customize their racing car to fit the need of their customers and racers can adapt their car right at the track during test laps and even the race itself
- Racing cars and teams are better performing on any kind of track thanks to appropriate vehicle topology and characteristics.



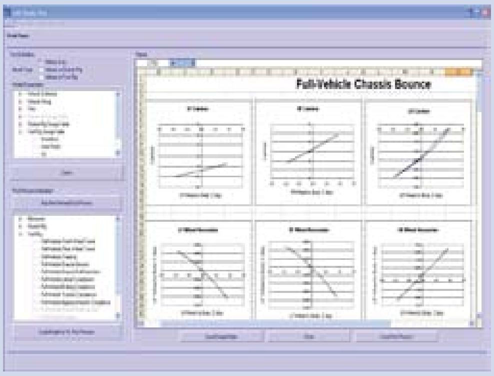
The interface allows to select a set of vehicle topologies and dynamic events used for simulation.



Simulate and optimize race track suspension topology for a specific race track using optimization technologies.



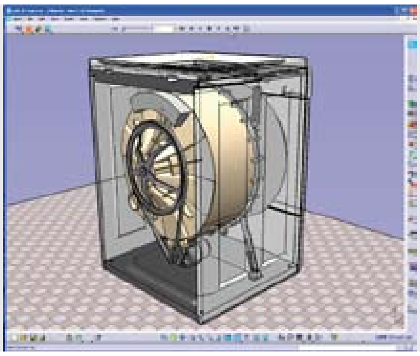
Virtual shaker and test-rig simulations replicate the corresponding lab tests.



Get immediate insight into the specific race car set-up via an automatic report.

LMS Virtual.Lab Motion - Options

VL-GEO.xx.2



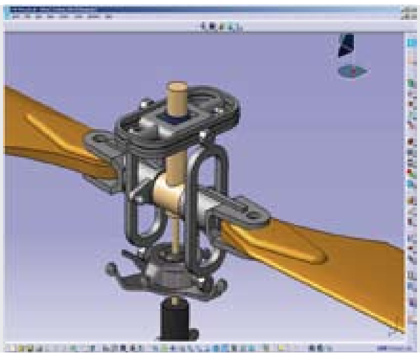
CAD Interfaces

All CAD interfaces import part and assembly data.

- STEP Interface
- IGES Interface
- ProE Interface
- CATIA V4 Interface
- Native Unigraphics and generic ParaSolids (SolidWorks, SolidEdge)
- Autodesk Inventor Interface*

* imports only part data

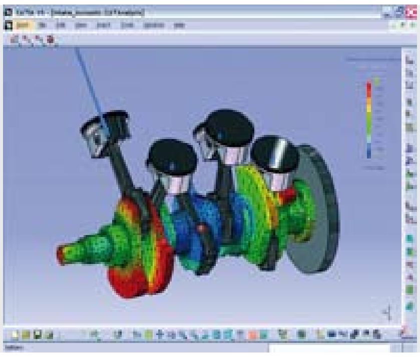
VL-MOT.20.2



CATIA V5 Kinematics Transfer

An easy and efficient manner to integrate CATIA V5 Kinematics mechanisms in LMS Virtual.Lab Motion, users can transfer parts, joints and kinematic constraints with a single click of a button. After the transfer, dynamic force-producing items like tires, springs, and bushings can be added in LMS Virtual.Lab Motion. Users can easily enhance CATIA V5 Kinematics with the dynamic, inverse dynamic, preload and static analysis possibilities found in LMS Virtual.Lab Motion.

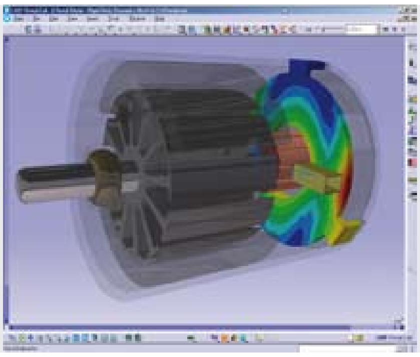
VL-MOT.72.2



Flexible Bodies

Flexible Bodies increases multi-body model accuracy by considering component deformation and modal excitation during motion. The method combines multi-body simulation technology with Finite Element results, based on a set of modes from either Finite Element analysis (Craig-Bampton modes) or modal test measurements. A number of FEA interfaces for common FE solvers, such as Nastran, Ansys, Abaqus, Permas and I-DEAS, are provided within this product so that users can import modes calculated by the FE solver. The final results, including stress results, can be visualized as an animated total system.

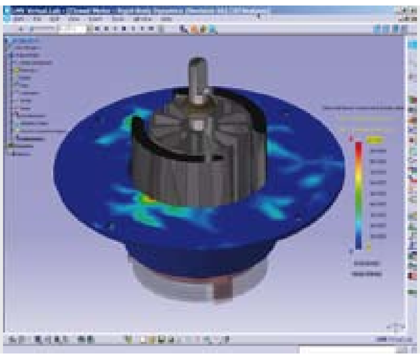
VL-MOT.73.3



Flexible Bodies Advanced

Optional with LMS Virtual.Lab Motion Flexible Bodies, this module provides more complex flexible body modeling capabilities. It drives the Nastran and Ansys FE solvers as well as provides various pre-processing and post-processing structural analysis capabilities. If the LMS Virtual.Lab Component Structural Analysis option or CATIA V5 GPS is available, users can automatically create a flexible body that uses Craig-Bampton modes, automatically substructure large complex flexible meshes such as stabilizer bars and model contact force associated with flexible bodies (also known as flexible contact).

VL-FEA.02.4

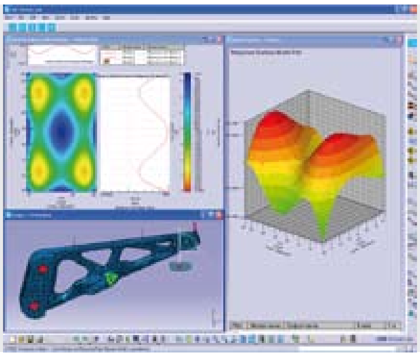


Component Structural Analysis

Component Structural Analysis is the finite element mesher and solver embedded in the LMS Virtual.Lab framework. The solver supports frequency and/or static linear elastic finite-element (FE) parts analysis to provide modal data for motion, durability, noise, vibration and handling modeling. It includes a rich set of boundary conditions, automatic meshing, and a fast FE solution to produce deformation, stress and strain data.

For long deformable parts like a car stabilizer bar, a new multi-beam representation has been developed that accounts for large non-linear deformations while solving faster than classical flexible bodies.

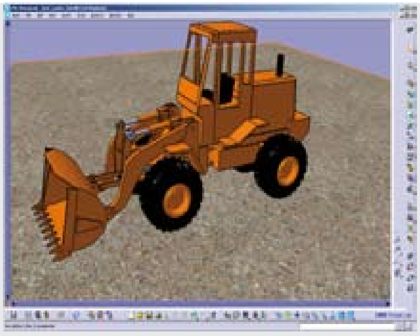
VL-OPT.41.2



Motion Design Space Exploration

LMS Virtual.Lab Design Space Exploration employs a Design of Experiment (DOE) methodology to define an optimal experiment set in the design space. This lets users obtain as much information as possible with the highest accuracy for the least cost. DOE is commonly combined with Response Surface Modeling (RSM), which runs a continuous surface through the discrete data obtained from the DOE experiments. This way users can obtain more insight into how the design variables influence the specified result quantities.

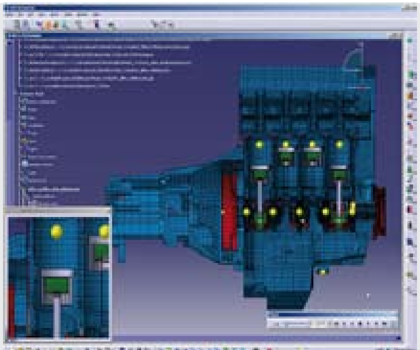
VL-MBT.07.2



Multi-Processing Batch Solver (stackable per 4 nodes)

The LMS Virtual.Lab Motion Multi-Processing Batch Solver lets users remotely manage different LMS Virtual.Lab Motion solver jobs. This way, the system can be designed to maximize CPU capacity and licenses running multiple analyses on different machines, or queuing multiple analyses for a single machine. In addition, users can monitor the progress of all submitted batch jobs.

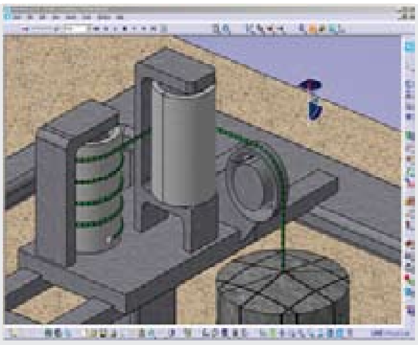
VL-MBT.08.2



Motion Parallel Solving

LMS Virtual.Lab Motion Parallel Solving provides overall productivity and solving time gains by using different parallel processors. It distributes the various solver tasks over different processors to reduce the calculation time. This is especially useful when processing relatively large simulation models built in a modular fashion, such as tracked vehicles or chains and belts.

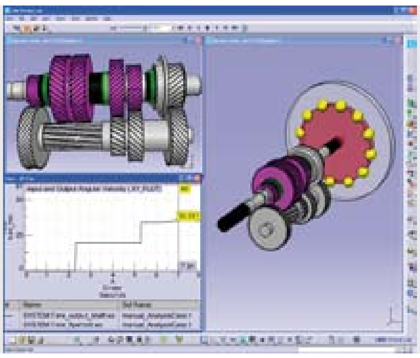
VL-MOT.21.2



Cable Modeling

This dedicated cable modeling solution lets users quickly define pulleys, guides, cable paths and cable properties. It automatically creates a discrete cable model including elements, such as stiffness, friction, and contact. The Cable Modeling Tool provides modeling scalability: cable properties can cover axial tension as well as bending and twist properties. Engineers can efficiently explore the effects of design changes on the parameterized LMS Virtual.Lab Motion model by understanding and improving their cable system in light of dynamic transient behavior and loads prediction on the pulleys and guides.

VL-MEP.25.2

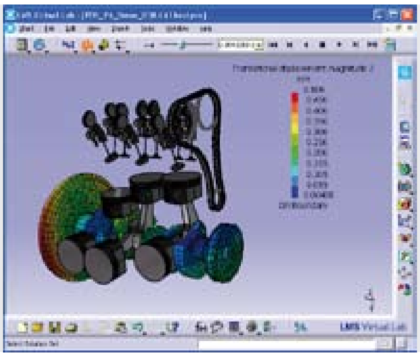


Gears

The Gears modeling interface automates system definition and simulation involving helical and spur gears as well as internal and external gear sets for automotive, ground vehicle or general machinery applications. The solution predicts a gear system's dynamic behavior and component loads by modeling the variable contact stiffness of the gear meshing. With this information, engineers can see how gear system backlash and contact ratio spreads throughout a mechanical system. This is especially helpful when looking for the root cause of noise issues, such as gear rattle or gear whine.

Gear systems can be incorporated into larger system models to study system-level responses and to generate accurate load predictions.

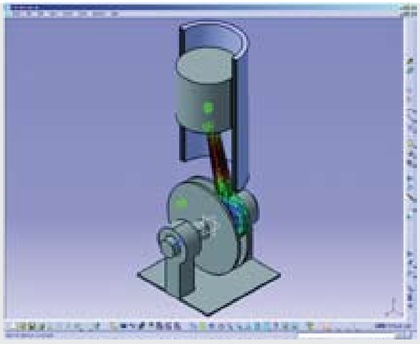
VL-MEP.27.2



Standard Engine

The LMS Virtual.Lab Motion Standard Engine groups numerous tools and features to create detailed engine simulation models in one user-friendly interface: The Powertrain Dynamic Simulator (PDS) Interface. This specialized yet easy-to-use tool provides users with a feature-rich, general-purpose environment to edit and create models. The tool includes all necessary modules like Crank Train, Valve Train, Helical Spring, Cam Generator, Cam Contact, Tachometer, Combustion, Hydraulic Lash Adjusters and much more.

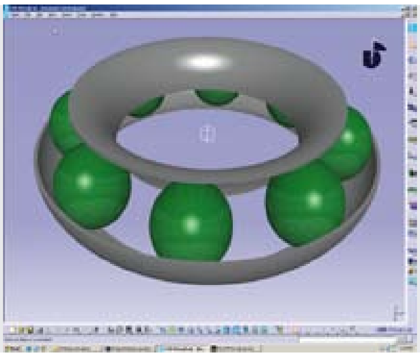
VL-MEP.26.2



Piston Lubrication

Piston Lubrication lets users analyze aligned and misaligned piston performance in a fluid film. Forces between the piston and cylinder wall are predicted and applied to each moving body. Oil film equations are used to predict non-linear pressure distribution and the forces acting on both bodies. Pressure distribution is determined in function of the clearance and its time derivative along with oil viscosity. Using this more detailed modeling method improves engine simulation and system-level load accuracy.

VL-MEP.01.2



Hydrodynamic Bearing

Hydrodynamic Bearing permits users to analyze aligned and misaligned hydrodynamic fluid-film journal bearing performance. Common applications include journal bearings in an engine crank train, like the main journals, crank pin or wrist-pin journals. This module predicts highly non-linear oil film pressure distribution within the bearings. Forces and moments are determined to properly couple structural vibrations to the surrounding structures. Two algorithms are provided: an analytic-based impedance algorithm and a Finite Element-based algorithm.

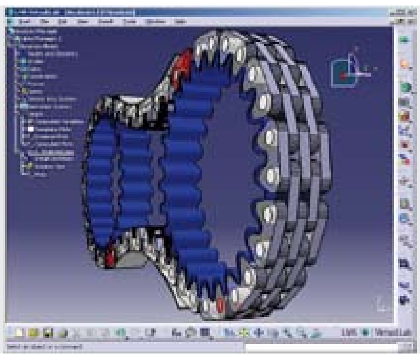
VL-MEP.40.3

Elasto-hydrodynamic Bearing

Like Hydrodynamic Bearing, Elasto-hydrodynamic Bearing lets users analyze aligned and misaligned hydrodynamic fluid-film journal bearing performance. Common applications include journal bearings in an engine crank train, such as the main journals, crank pin, or wrist-pin journals.

Elasto-Hydrodynamic Bearing solves highly non-linear oil film pressure distribution within the bearing. Forces and moments are determined to properly couple structural vibrations to the surrounding structures.

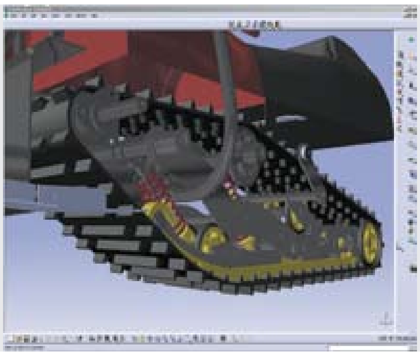
VL-MEP.28.2



Chain and Belt Application

The LMS Virtual.Lab Motion Chain and Belt Application is used to quickly create detailed chain and belt simulation models. The Powertrain Dynamic Simulator (PDS) Interface can be used to create models of discrete belt-pulley or chain-sprocket systems for further analysis within LMS Virtual.Lab Motion. The Timing Belt module creates singular or multi-stage belt-drive system simulations. The Accessory Drive module creates models of discrete belt-pulley systems, including Goodyear Poly-V® automotive accessory belts. The Chain module creates discrete chain and sprocket simulations with roller chain links or inverted tooth links. The PDS chain and belts generated models are combined with valvetrain, cranktrain, and other powertrain subsystem models.

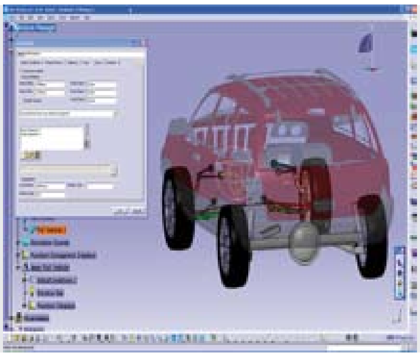
VL-MSV.23.2



Tracked Vehicle Modeling

LMS Virtual.Lab Motion Tracked Vehicle provides a convenient interface to simplify complex multi-part track modeling. The track material can be either a rubber or elastomer belt, or discrete metal link. The interface collects concise information to define track geometry, mass properties, stiffness and damping. Multiple bodies are created with appropriate stiffness, damping, and initial conditions. All required contact force features are also automatically created. Customers who need to study how a complex dynamic track system interacts with both the ground and the vehicle will find this an extremely powerful and useful tool.

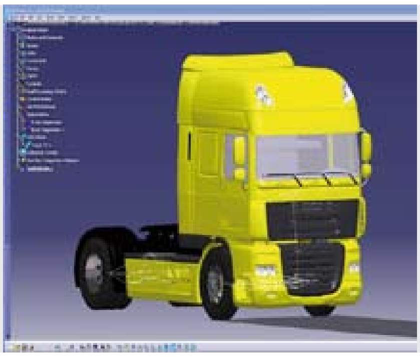
VL-MSV.05.2



Suspension Modeling

LMS Virtual.Lab Motion Suspension provides a dedicated, easy-to-use interface to model vehicle suspension. The interface guides the user through the suspension modeling and analysis process, starting from hard-point location importation and component and connection definition to dedicated post-processing capabilities from virtual test rig simulations. The user can start from a pre-defined suspension template as the initial model to significantly increase productivity.

VL-MSV.14.2



Vehicle Modeling

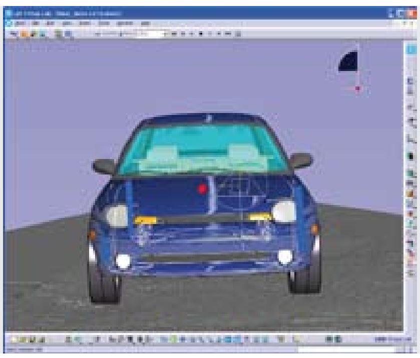
LMS Virtual.Lab Motion Vehicle Modeling gives chassis and suspension analysts a dedicated and easy-to-use interface to model vehicles for any kind of performance study: handling and steering, ride comfort, road noise and durability. It allows modular vehicle assembly using separate subsystems, such as suspensions, steering, braking, and driveline. Users can easily set up and post-process several standard vehicle maneuvers. Dedicated braking, steering and driveline modules are incorporated. The available library of pre-defined vehicle events, including ISO maneuvers, can be extended by any user-defined event. The car can driven through a kinematic driver (open-loop) or through a path following a control algorithm implemented in LMS Virtual.Lab Motion, known as a closed-loop.

VL-MSV.11.2

IPG-DRIVER for LMS Virtual.Lab

The IPG-DRIVER for LMS Virtual.Lab Motion adds the human factor to multi-body vehicle simulation. It simulates closed-loop maneuvers for vehicle dynamics performance tests under extremely realistic circumstances. Seamlessly integrated in LMS Virtual.Lab Motion, it is the industry-standard driver model, representing more than 15 years of development by IPG Automotive in Karlsruhe, Germany. Users can select a desired path, desired speed, and driving style. The IPG-DRIVER calculates gas, brake and clutch pedal positions, gearbox position and steering wheel input.

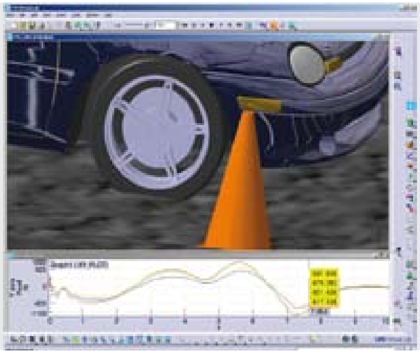
VL-MSV.12.2



Road Profile Interface

Road Profile Interface is a convenient way to build a complex 3D road profile or surface that can be uneven. This new feature generates road surface geometry from 3 different file sources: spline curves, spline surfaces and the CDTire ROAD 2000 format. This last format supports actual digitized road from any possible proving ground. Streamlining the overall process, it connects the analytical road surface used by the solver with the visualized geometry.

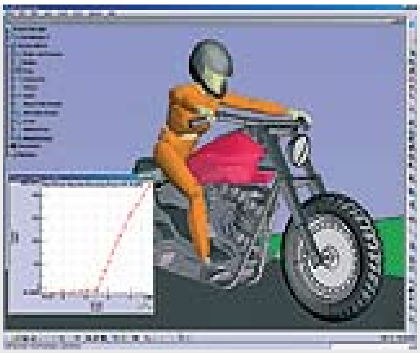
VL-MSV.02.2



Standard Tire

Standard Tire models tire forces between rotating wheels and the road. Three forces (lateral, longitudinal, and vertical) and three resulting moments are calculated based on the selected force relationship and then applied to the model wheels. Several tire forces can be incorporated in a single model, which can also include non-linear stiffness and damping, distributed contact, and advanced traction effects. Users can also edit the tire-force source code and add special force features. Standard Tire is compatible with the international standard, STI (Standard Tire Interface).

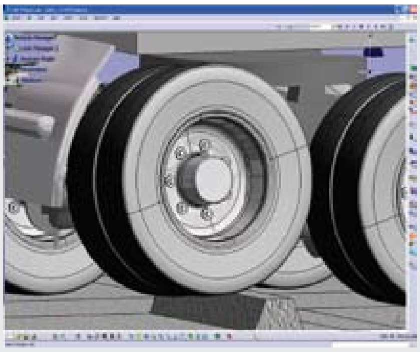
VL-TNO.20.2



TNO MF-Tire for LMS Virtual.Lab

TNO MF-Tire provides accurate full-vehicle ride and handling, comfort, and durability analysis for passenger cars, motorcycles, trucks and aircraft landing gear dynamic simulation. Extensively validated, TNO MF-Tire is Delft-Tyre's 6.0 implementation of the world-standard Pacejka Magic Formula tire model. Based on a semi-empirical approach using laboratory and road measurements, it provides fast and robust tire-road contact force and moment simulation for steady-state and transient tire behavior.

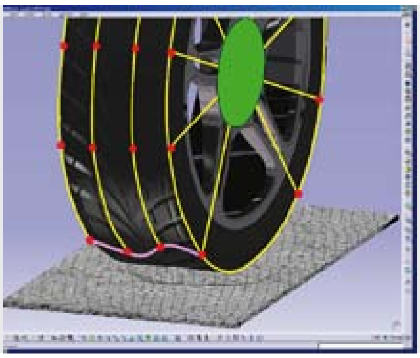
VL-TNO.21.2



TNO MF-Swift for LMS Virtual.Lab

A high frequency extension of the TNO-MF-Tire, TNO MF-Swift tire models enable accurate full-vehicle ride and handling, comfort, and durability analysis for passenger cars, motorcycles, trucks and aircraft landing gear dynamic simulation. It adds generic 3D obstacle enveloping and tire belt dynamics to MF-Tire's tire-road contact force and moment simulation. Extensively validated using numerous measurements, MF-Swift is an excellent 3D tire simulation model for frequencies up to 100 Hz.

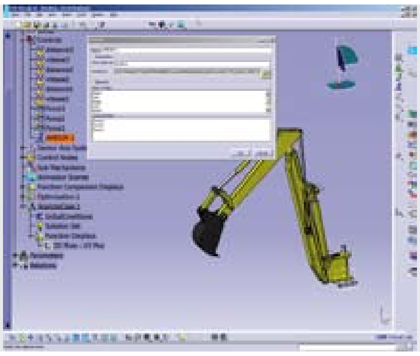
VL-MSV.13.2



CDTire

Ideal for car and truck simulation, LMS CDTire allows engineers to do full-vehicle ride and handling, and comfort and durability analyses with tire belt dynamics. The LMS CDTire computes the spindle forces and moments acting on each wheel while driving on a 3D road surface. LMS CDTire accurately captures vibrations in the supported frequency range for durability and comfort studies. Belt vibrations are simulated up to 80 Hz. Unlike empirical tire models, LMS CDTire is an actual physical tire model. The tire belt is modeled as a distributed mass-spring-damper model with the deformable tire contact patch taking tire-road friction into account. Users can change the tire inflation pressure to create quick what-if studies. LMS CDTire contains 3 tire models which suitability depends on road surface and desired accuracy.

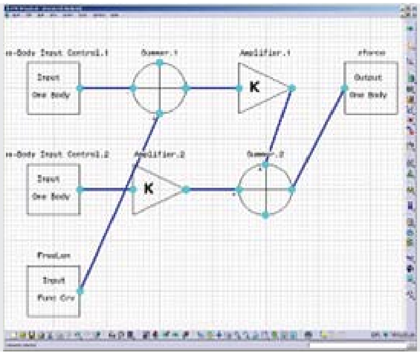
VL-MOT.63.2



Systems and Controls

To dynamically simulate mechatronic systems quickly and efficiently, LMS Virtual.Lab Motion Systems and Controls comes complete with an embedded library of control and hydraulics modeling elements. Directly accessible from the LMS Virtual.Lab interface, these control and hydraulics elements can be connected to the mechanical system to simulate a complete closed-loop mechatronic system. Users can also linearize a non-linear mechanical system by selecting an operational working point and providing a simple path follower for vehicle analysis studies.

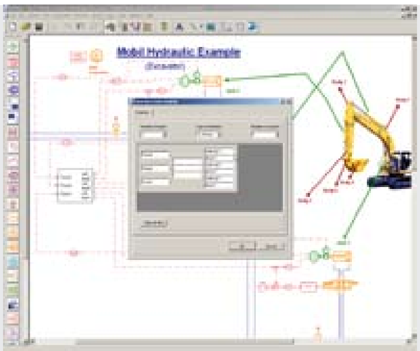
VL-MOT.65.3



Controls and Hydraulics Block Diagram Viewer

This product makes it easier to understand and debug mechatronic controls and hydraulic elements embedded in LMS Virtual.Lab Motion. Users can review a 2D block diagram of the controls and hydraulics system that clearly illustrates connections and feedback loops between the different elements.

VL-ITF.20.2



Mechatronics Interface

LMS Virtual.Lab Motion Mechatronics Interface supports mechatronic system design through coupled simulation with LMS Imagine.Lab and third party packages such as Matlab/Simulink, DSH Plus and MSC.Easy 5. LMS Virtual.Lab Motion uses a coupled equation method to solve mechanical system equations simultaneously with multi-physics controlled actuators system equations. The results are available in both LMS Virtual.Lab Motion (including 3D animation) as well as the control software tool.

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