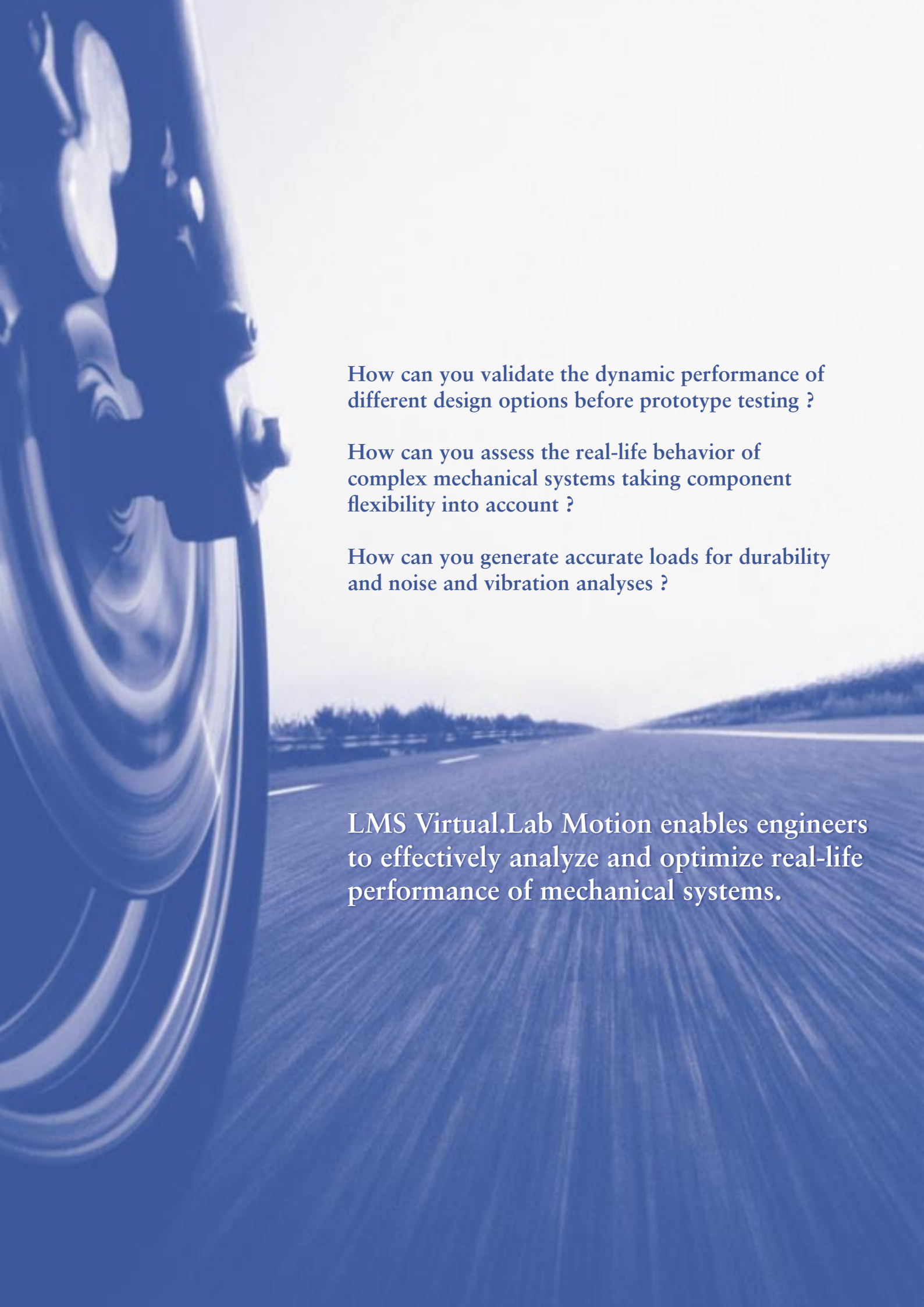
LMS Virtual.Lab Motion

Innovating Multi-Body Simulation

LMS Virtual.Lab™

LMS INTERNATIONAL

Empowering Engineering Innovation



How can you validate the dynamic performance of different design options before prototype testing ?

How can you assess the real-life behavior of complex mechanical systems taking component flexibility into account ?

How can you generate accurate loads for durability and noise and vibration analyses ?

LMS Virtual.Lab Motion enables engineers to effectively analyze and optimize real-life performance of mechanical systems.

LMS Virtual.Lab, the Integrated Environment for Functional Performance Engineering

LMS Virtual.Lab is the world's first integrated software environment for the functional performance engineering of critical design attributes such as noise and vibration, kinematic and dynamic motion, ride and handling, comfort, safety, crash, durability, and others. An open environment with seamless links to the CAD, CAE and Test worlds, LMS Virtual.Lab provides everything the multidisciplinary engineering team needs to get better products to market faster than before. It doubles the time available for value-added engineering and reduces the overall engineering process time by 30 to 50%.

LMS Virtual.Lab is based on CAA V5 (Component Application Architecture), the open middleware for PLM (Product Lifecycle Management) from Dassault Systèmes.

Integrating mission-critical applications

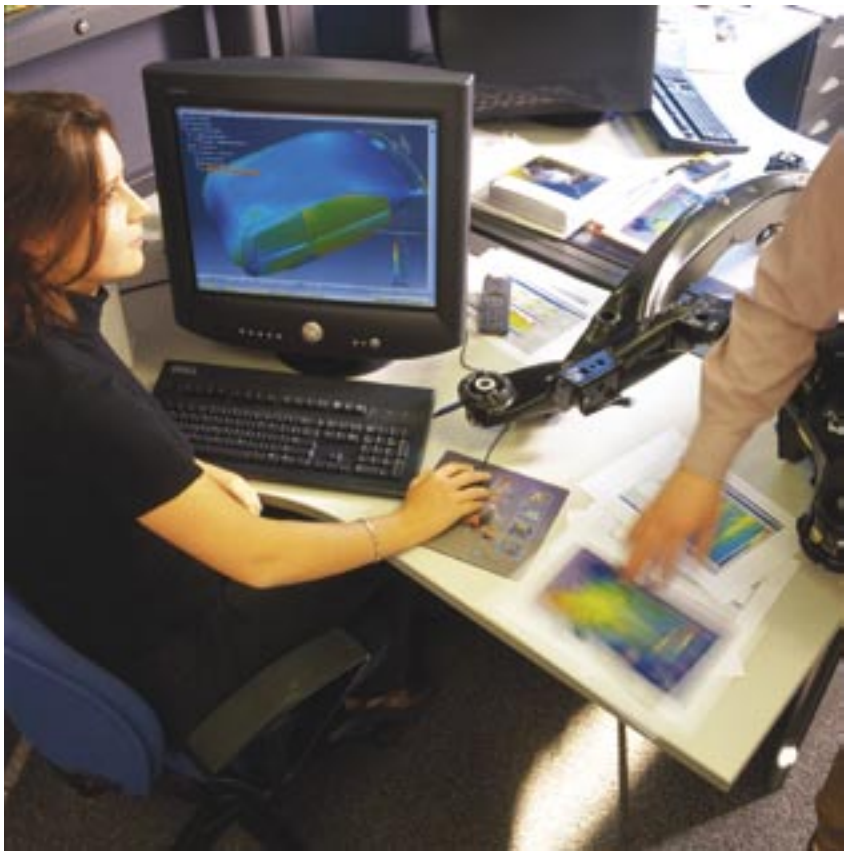
Being able to explore the design space for a given attribute already provides critical insights into the dynamics of an engineering problem. But LMS Virtual.Lab can do more. It can intelligently find the optimum point in the design space, giving a leap forward in productivity. Through a close integration of mission-critical applications, engineers will also be able to trade off multiple and possibly conflicting attributes to balance the overall design.

Enabling hybrid engineering

LMS Virtual.Lab implements a unique "hybrid simulation" approach. By combining the best of the physical test and virtual simulation disciplines, the new engineering process is not only faster, but also more accurate and robust, as test-based validation is built in. The return on investment can therefore be measured not only in terms of faster time to market and reduced development cost, but also in terms of improved product quality and a reduction in the number of expensive product recalls.

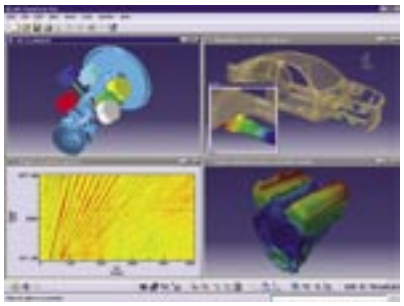
Delivering value-added engineering

LMS Virtual.Lab automatically links to leading CAD, CAE and Test tools and, by eliminating unnecessary file transfers and data redundancies, doubles the time available for value-added engineering. Virtual.Lab captures and automates the process flow to provide a very efficient parametric analysis capability. With Virtual.Lab any design change can be rippled through the analysis sequence in minutes. Such speed breakthroughs will allow companies to take weeks off the product development process, to reduce uncertainty and minimize the reliance on physical prototypes.



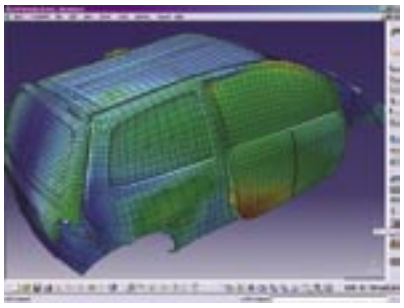
LMS Virtual.Lab Desktop

The Virtual.Lab Desktop provides a common environment for functional performance engineering. Through the Virtual.Lab Desktop, the user has seamless access to models and data of leading CAD and CAE codes, and to Test data. The Desktop also offers a complete visualization environment for part and assembly geometry, functional performance engineering data, time and frequency functions and much more.



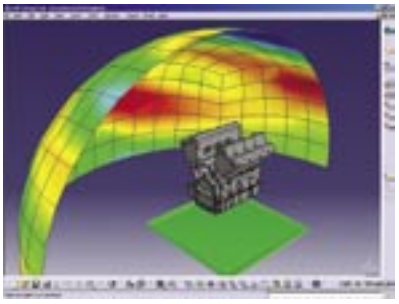
LMS Virtual.Lab Noise and Vibration

Virtual.Lab Noise and Vibration combines proven technologies with breakthrough techniques to create the world's first solution for N&V modeling and refinement at the system level. With Virtual.Lab, system-level models can be assembled quickly, reliably, and in time to benefit the ongoing development process.



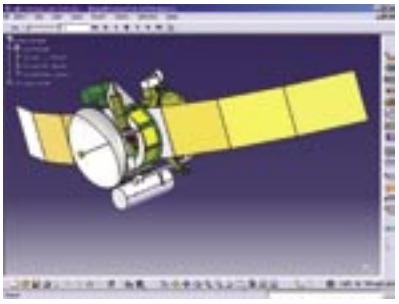
LMS Virtual.Lab Acoustics

Imagine that acoustic meshing could be performed in a couple of hours, that an engine run-up could be predicted within a day, and that any design change could be remodeled in minutes. With the breakthroughs embedded in Virtual.Lab Acoustics it has become reality.



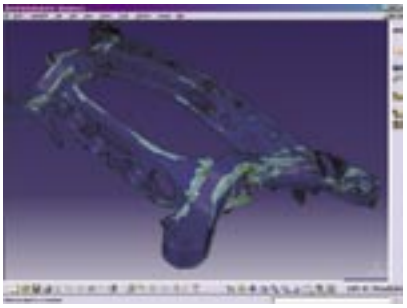
LMS Virtual.Lab Motion

How do you guarantee your mechanical design performs as expected, before signing off to a physical test? How do you make sure that the numerous components interact and move as planned? Will certain parts break under peak loads? Virtual.Lab Motion enables you to quickly analyze and optimize the real-world behavior of your mechanical design.



LMS Virtual.Lab Durability

Virtual.Lab Durability allows you to predict fatigue-life performance in time to positively affect the design process. It predicts the durability performance of large flexible welded bodies subject to hundreds of loads from all directions. Virtual.Lab Durability integrates Finite Element (FE) and MultiBody Simulation (MBS) with numerical fatigue-life predictions to provide the most advanced system-level durability solution.



Efficiently Engineering for Optimal Performance

In today's competitive economic environment, it is a challenge to deliver innovative mechanical designs that perform exactly as expected. 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 – before physical testing. The limited availability of time urges engineers to quickly trace the best design options.

Improving product quality

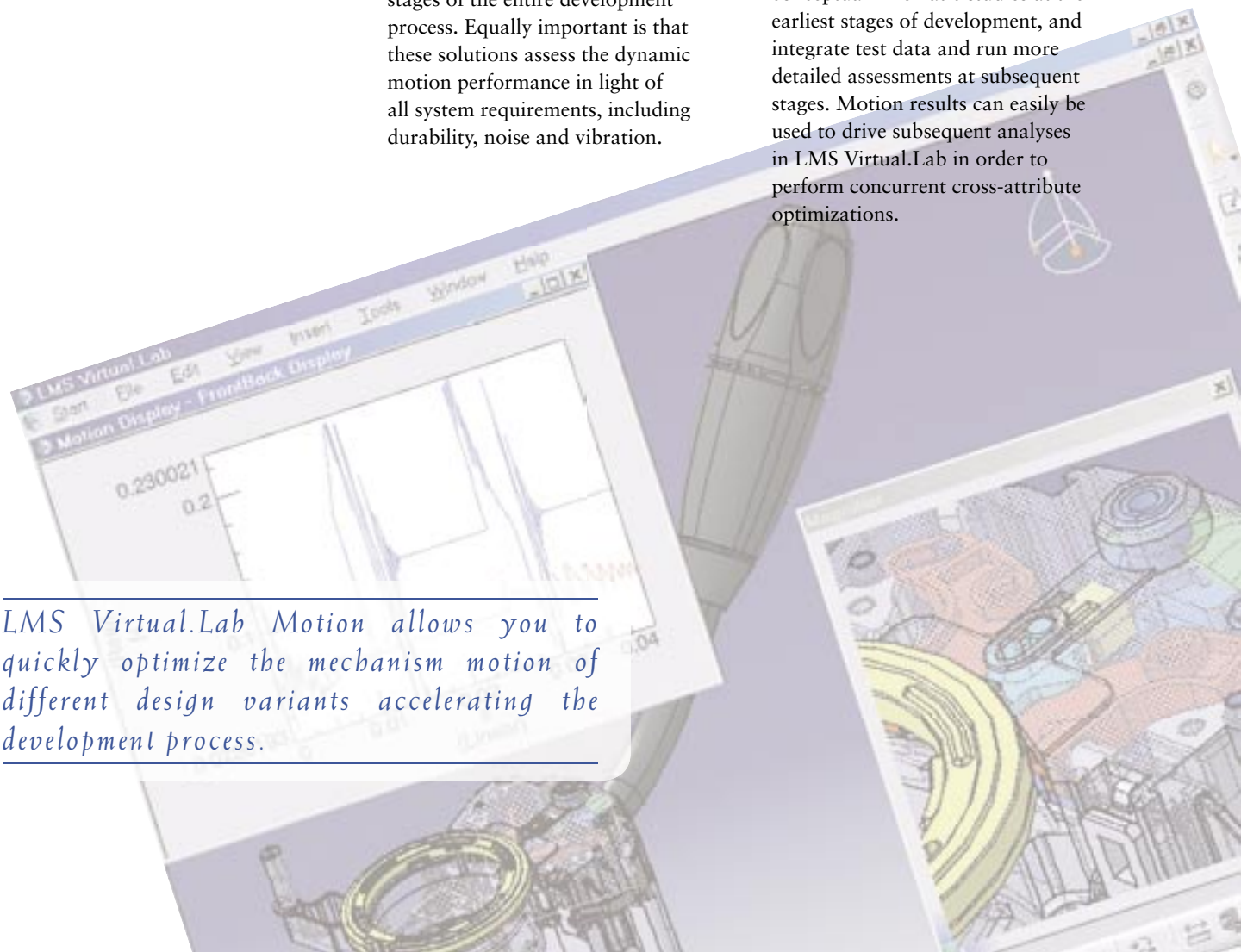
Undoubtedly the most challenging task for engineers is to guarantee that the dynamic performance of their mechanical systems will match specifications, before physical tests come into play. They need to make sure that the numerous components interact and move as planned under the influence of real-life conditions, such as gravity and frictional forces.

Only integrated and high-performance virtual prototyping technologies that deliver the right answers on time have the capacity to positively impact the ongoing 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

Based on its extensive cooperation with leading research institutes and key customers, LMS embedded its advanced multi-body simulation technology, formerly available in LMS DADS, into LMS Virtual.Lab. LMS Virtual.Lab Motion is specifically designed to simulate realistic motion and loads of mechanical systems.

It offers effective ways to quickly create and refine 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 at the earliest stages of development, and 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 optimizations.



LMS Virtual.Lab Motion allows you to quickly optimize the mechanism motion of different design variants accelerating the development process.

An Effective Process for Optimizing Designs Before 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. LMS Virtual.Lab Motion, on the contrary, simulates dynamic system behavior by including masses, inertia, stiffness, friction, … and therefore has the capacity to deliver much more valuable engineering insights throughout the entire product development process. Fast iterative simulations that accurately predict dynamic motion and internal loads empower engineers to assess the real-life performance of multiple design alternatives.

Easy mechanism modeling

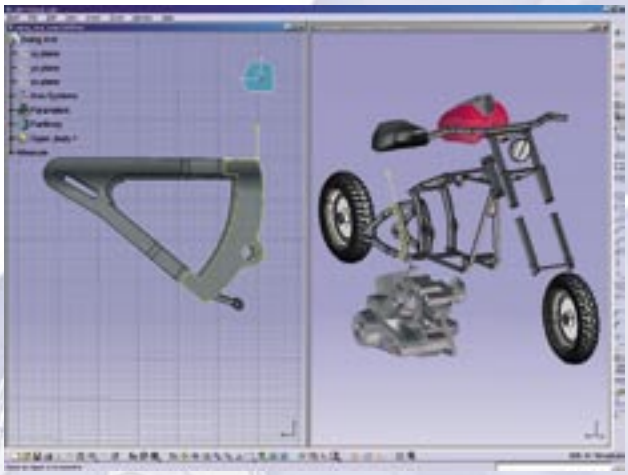
LMS Virtual.Lab allows engineering teams to quickly create and refine virtual prototype models. With LMS Virtual.Lab Motion, users can build up concept models from scratch, import CAD parts and assemblies or re-use existing multibody models. High-performance design capabilities speed up the modeling and assembly of parts. When creating a joint, the parts to be connected automatically snap together. And when modifying the dimensions of one part, LMS Virtual.Lab Motion automatically updates the entire system.

- Design of individual parts based on CATIA V5 solid modeler.
- Mass data, connections and boundary conditions are fully associative with geometry
- Interfaces with CATIA, I-DEAS, Pro/ENGINEER, Unigraphics and other leading CAD packages
- Easy import of LMS DADS and MSC.ADAMS models

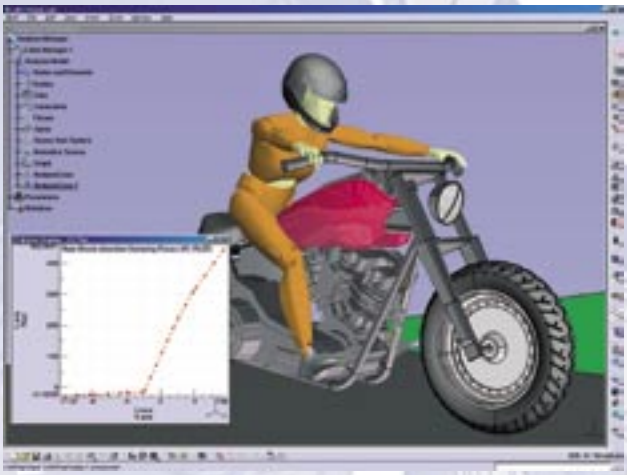
Simulate real-life performance

LMS Virtual.Lab Motion offers everything to accurately simulate system performance under real-life loading conditions. Users can easily pick elements from the mechanism modeling library to accurate model friction, gravity, spring stiffness, intermittent contacts, component flexibility and other physical phenomena. Motion and internal loads predicted by LMS Virtual.Lab Motion are essential in guiding the design of parts, connections, motors and actuators. Stable and high-performance solvers guarantee the accurate and timely handling of even the most complex dynamic problems.

- Based on LMS DADS solver, which is widely renowned for its accuracy and stability
- Kinematic, dynamic, quasi-static and pre-load analyses are available
- Calculates forces, displacements, velocities and accelerations



Effortlessly import complete CAD assemblies or efficiently design individual parts with LMS Virtual.Lab Motion's fully featured solid modeler.



Quickly set up a multibody model by creating joints between the various parts. After defining force elements, the model is ready for dynamic analysis.

Visualize and interpret results

Simulation results visualized on different types of displays allow colleagues and customers to literally step into the design and take the right engineering decisions. Synchronized graphing and animation directly associate force and acceleration extrema with mechanism positions. Dedicated post-processing features help engineers to easily identify and effectively solve the root causes of an engineering problem.

- Collision detection based on detailed CAD models
- Motion envelopes and force vector animations
- Combined animation of displacements and stesses

Quick model validation

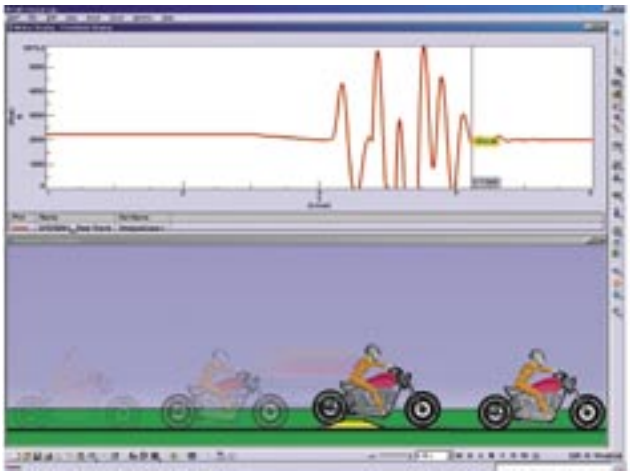
LMS Virtual.Lab Motion offers an effective and iterative correlation and validation process. It has the capacity to tune model parameter values and increase the engineering depth of a model through the definition of more complex modeling elements. It is also possible to enhance the quality of the model by importing and integrating test data in the simulation model. When changing a parameter, LMS Virtual.Lab Motion automatically updates all associated analysis results and manages all required data actions.

Effective design space exploration

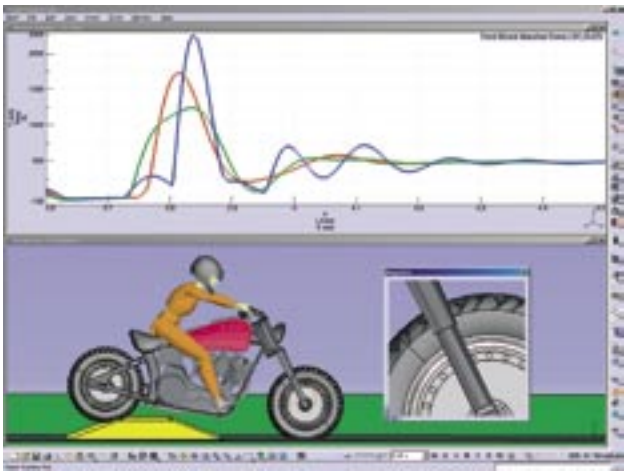
LMS Virtual.Lab Motion is capable of executing the complete motion simulation process, for multiple design options and different scenarios, in a highly automated fashion. LMS Virtual.Lab Motion eliminates administrative tasks, avoids errors and enables the automatic execution of consecutive analyses. Different parameter settings seamlessly flow through the complete motion simulation process. These automated parametric analyses enable engineers to quickly explore the design space.

- Model-oriented data management allows easy navigation through design variants
- Design tables explore multiple design options
- Optimization and robust design (six-sigma or other standards)

Mechanism simulations and the capacity to investigate the variability of model parameters enable you to efficiently optimize the robustness of your designs.



Synchronized animation and graphing offer a visual link between the displayed mechanism position and the corresponding data on the XY plot.



LMS Virtual.Lab Motion's parametric analysis capabilities allow you to efficiently explore multiple designs and identify the most important parameters.

Mechanism Simulation Throughout the Product Development Cycle

Concept stage

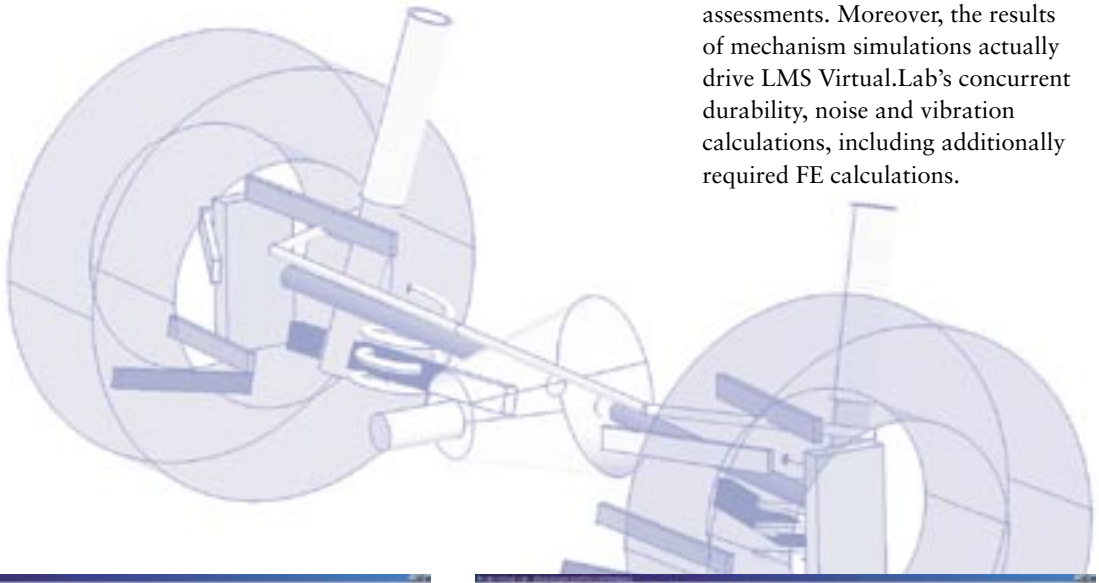
At the start of a new product lifecycle, promising design options are qualified and conceptual choices are made. With only very limited sets of information, LMS Virtual.Lab Motion is capable of analyzing the performance of multiple preliminary design candidates, long before detailed CAD models become available. Dynamic motion simulations allow engineering teams to track down critical design parameters, to identify the candidate designs able to meet overall system targets and to optimize the main mechanism dimensions.

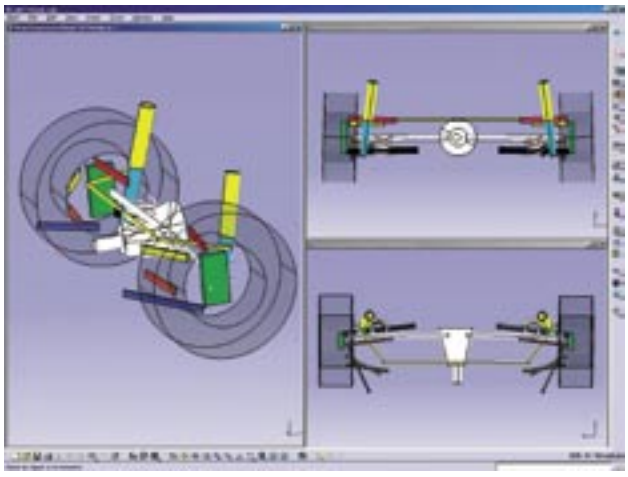
By repeating dynamic motion simulations and using models with increasing engineering depth, the motion and load targets for the full assembly can be effectively cascaded down to specific targets for individual subassemblies and components. With more detailed CAD models becoming available LMS Virtual.Lab Motion models can be enhanced, which allows to perform accurate collision detection studies and to improve the accuracy of loads prediction by taking into account realistic mass and inertia properties.

Detailed engineering

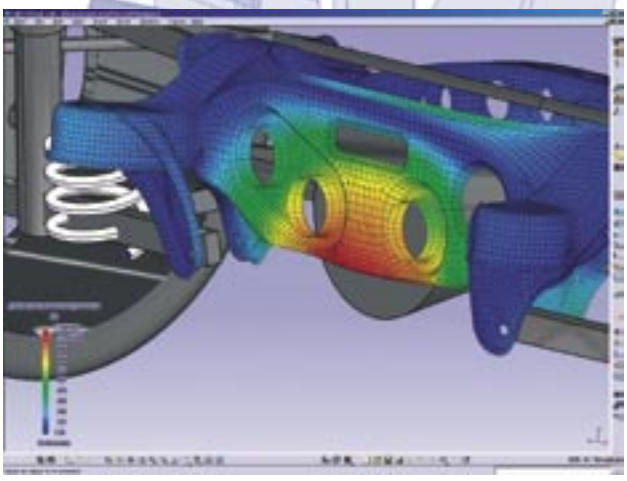
Reliable dynamic performance assessments

As the development proceeds, more and more engineering data becomes available. Scalable modeling capabilities of LMS Virtual.Lab Motion allow CAD representations of components to be easily replaced with FE meshes. Force elements can be refined based on component test data. Adding more detailed information to virtual models increases the reliability of motion and internal loading simulations required for dynamic performance assessments. Moreover, the results of mechanism simulations actually drive LMS Virtual.Lab's concurrent durability, noise and vibration calculations, including additionally required FE calculations.





Concept models make it possible to retrieve the essential dynamic characteristics of a design long before CAD, FE or Test data become available.



Refine multibody models by adding CAD and FE data and empower them to provide the necessary input for component and system optimizations.

Powerful system-level durability prediction

LMS Virtual.Lab Durability uses dynamic component loads, gained through motion simulations, to predict how many repetitions of a predefined mechanism motion will cause parts to break down, due to material fatigue. LMS Virtual.Lab's proven fatigue-life prediction solver technology combined with dedicated durability post-processing capabilities provide immediate feedback regarding all critical durability areas. Automatic load and FE stress data transfers between LMS Virtual.Lab Motion and Durability allow durability optimizations to take place at the full system level. This avoids expensive treatments late in the design process, when all flexibility to change is lost.

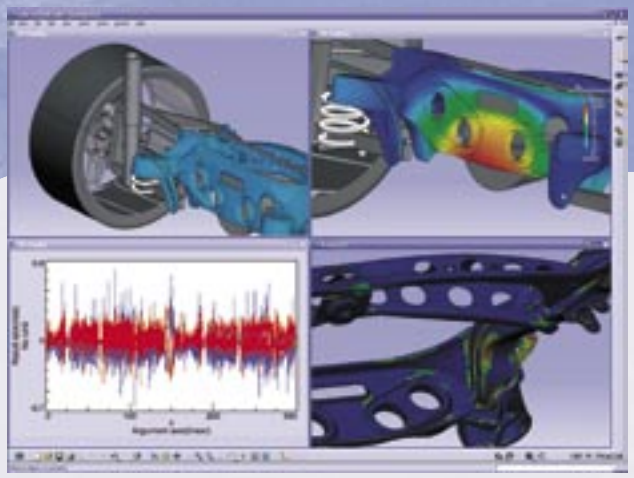
Noise and vibration optimization

Noise predictions and vibration response analyses require the availability of accurate input loads in the frequency domain. LMS Virtual.Lab Motion can efficiently and accurately simulate these excitation loads long before physical prototypes become available. With combined LMS Virtual.Lab Noise and Vibration response analyses and Motion simulations, engineers accurately predict seat vibrations or identify how energy propagates to a targeted location.

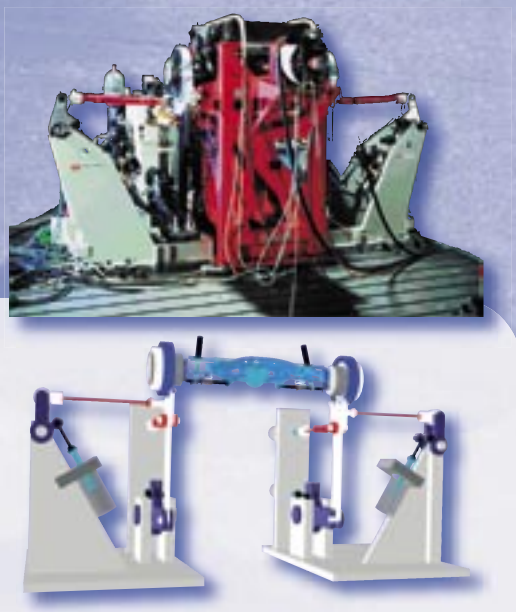
Refinement and troubleshooting

Once test data of the first design prototype becomes available, the validation of its virtual model can start. Repeating simulations on validated models helps to quickly troubleshoot the design and locate the root causes of a problem. To distinguish the most appropriate fix, engineers can evaluate the performance of multiple design variants. Successfully combining results from tests and simulations leads to more effective design optimizations and reduces the duration of development and the number of physical prototypes.

LMS Virtual.lab Motion combines results from test and simulation, to validate virtual models, effectively optimize designs and reduce the reliance on physical prototypes.



Dynamic component loads, gained through motion simulations, are used to predict how many repetitions of a predefined mechanism motion will cause parts to break down.



Simulation results make it possible to execute more detailed physical tests that focus more specifically on critical areas detected on the virtual prototype.

Refine your Models with Component Flexibility

Component flexibility can have a significant impact on the dynamic performance of mechanical systems. The deformation of individual components and excitation of their natural frequencies lead to altered mechanism motion, unwanted system vibrations and a significant change of internal loads. Without flexible bodies, realistic simulations of engine crankshaft loads or satellite solar panel deployments are simply not feasible. LMS Virtual.Lab Motion efficiently incorporates flexible bodies into dynamic mechanism simulations. Integrating FE component models not only raises the accuracy of dynamic motion simulations it also allows system-level durability and noise and vibration analysis.

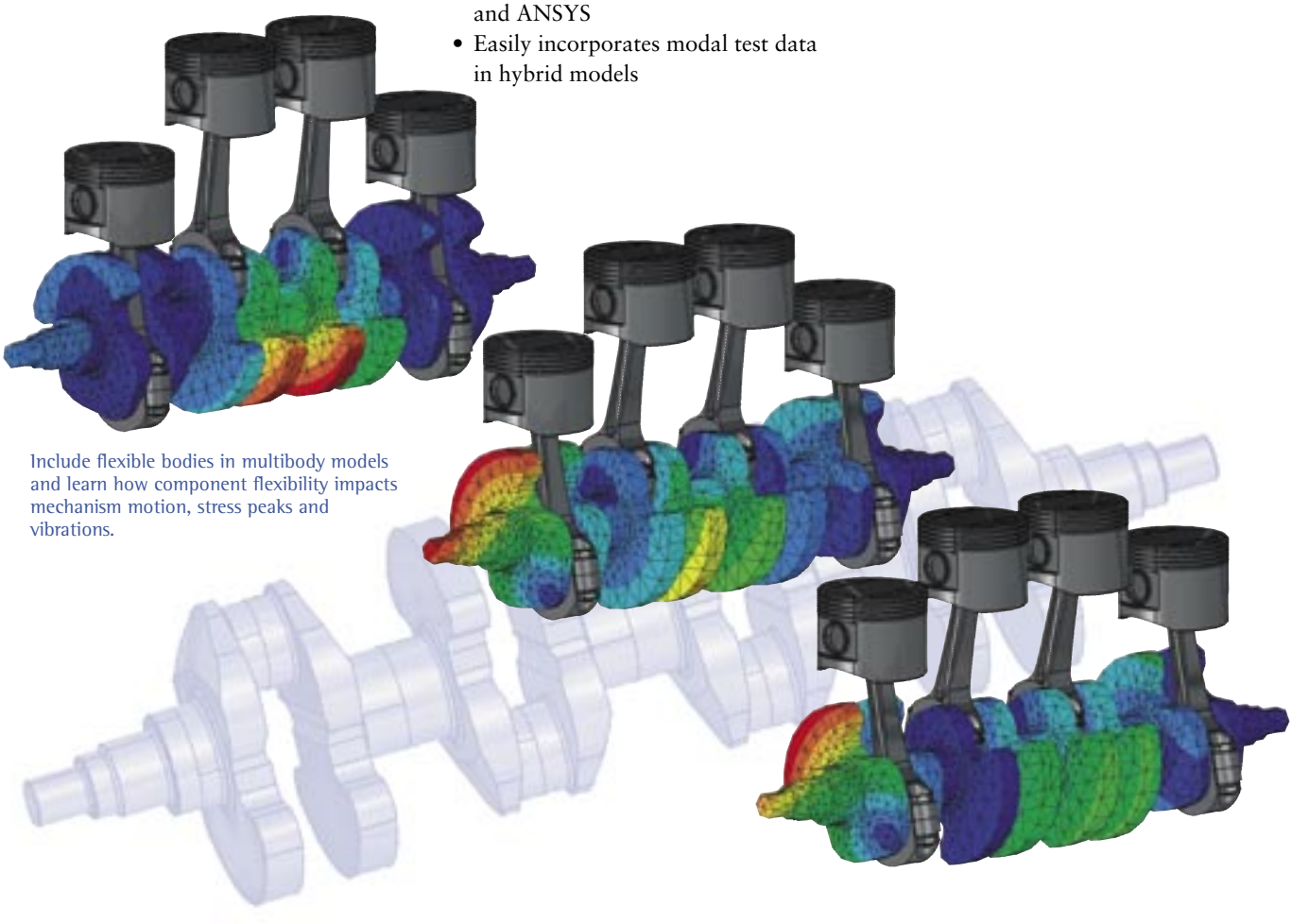
Flexible bodies in just a few clicks

In LMS Virtual.Lab Motion, the previously error-prone job of integrating a flexible body now just takes a few mouse clicks. Dragging the FE mesh in the graphic display of the mechanism assembly automatically establishes all body connections, based on the detected attachment nodes. Any preferred FE solver can be automatically launched and driven, eliminating all concerns about data handling and file transfer. The resulting FE modes can be visualized and edited before motion calculations are started.

- Seamless access to structural FE meshes from CATIA V5 CAE, MSC.Nastran, I-DEAS, ANSYS, PERMAS and ABAQUS
- Automatic driving of MSC.Nastran and ANSYS
- Easily incorporates modal test data in hybrid models

Fast and accurate handling of large models

Today, the use of large FE models in industrial development processes depends on the efficiency and speed of the way such large models are handled. With its effective modal superposition method and advanced data reduction techniques, LMS Virtual.Lab Motion is perfectly capable of processing large-size FE models. The algorithms implemented in the solver are optimized to provide the right accuracy and to deliver results fast. When motion simulations are ended, complete deformation and stress histories become available for all flexible bodies of the assembly.



Include flexible bodies in multibody models and learn how component flexibility impacts mechanism motion, stress peaks and vibrations.

Design Reliable Control Systems Validated on Realistic Mechanism Models

Today, many mechanical systems are driven by control systems, hydraulics or pneumatics. Cars and airplanes contain numerous control systems and the use of hydraulics and pneumatics is common practice in construction machinery and manufacturing equipment. Assessing the coupled behavior of controls and mechanics is the major challenge when designing such mechatronic systems. LMS Virtual.Lab Motion allows engineers to define and optimize the control strategy on the virtual prototype.

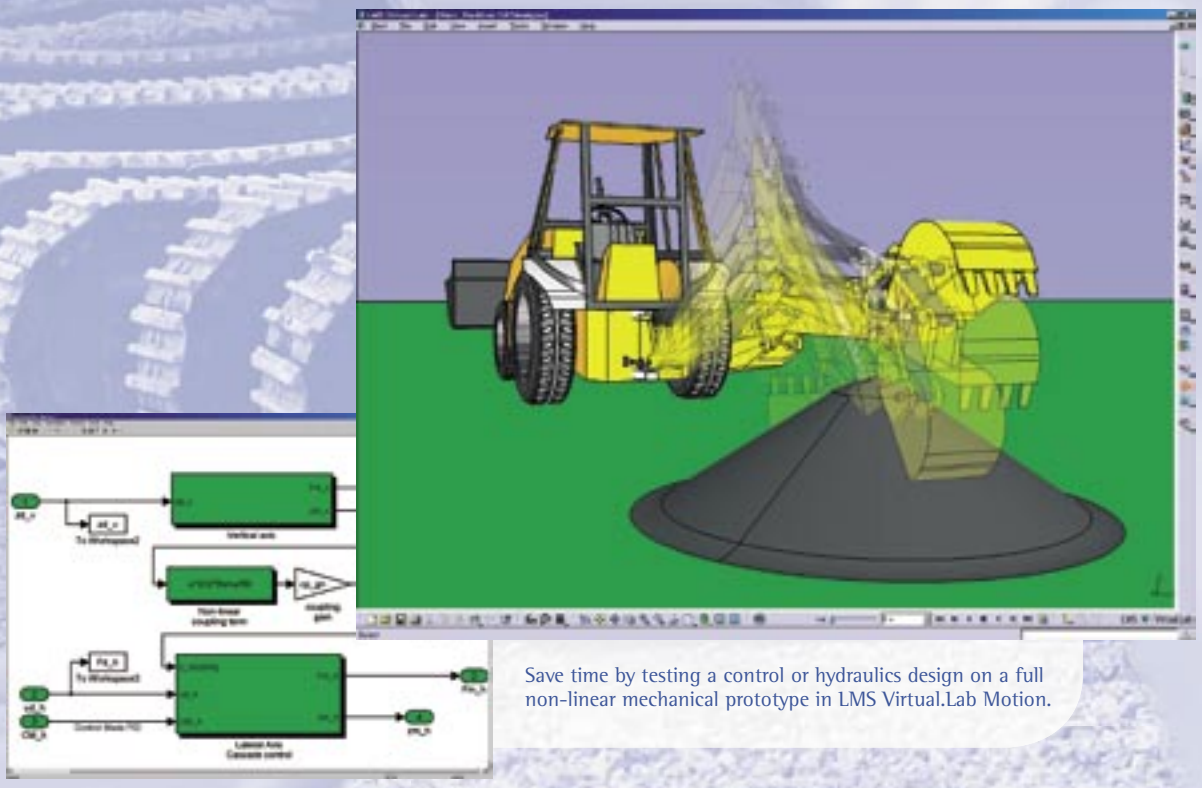
Designing reliable controls …

At the beginning of the control design process, LMS Virtual.Lab Motion assists the engineer by linearizing the mechanism that needs to be controlled. Applying automatic linearization saves time and avoids errors. Once a control design is available, the controller can be tested on the full non-linear virtual prototype. The complete motion range of the controlled mechanism can then be thoroughly simulated, while taking into account gravity, friction, material elasticity and other physical phenomena.

… in the most efficient way

Connecting the mechanism with the control scheme only takes seconds. In Matlab/Simulink or Easy5, LMS Virtual.Lab Motion creates a simple building block, which represents the mechanics of the system and all inputs and outputs. During coupled simulations, control and mechanism equations are both solved while sensor outputs and actuator inputs are automatically exchanged. Such advanced simulations offer accurate and reliabile insights that could never be obtained with any separate control or mechanism model.

- Interfaces to Easy5 and Matlab/ Simulink
- Extensive controls & hydraulics library



Save time by testing a control or hydraulics design on a full non-linear mechanical prototype in LMS Virtual.Lab Motion.

Design Suspension Systems for Ride and Handling, Durability and Comfort

What really counts when designing a suspension system is delivering the right driving experience while maintaining optimal comfort and durability.

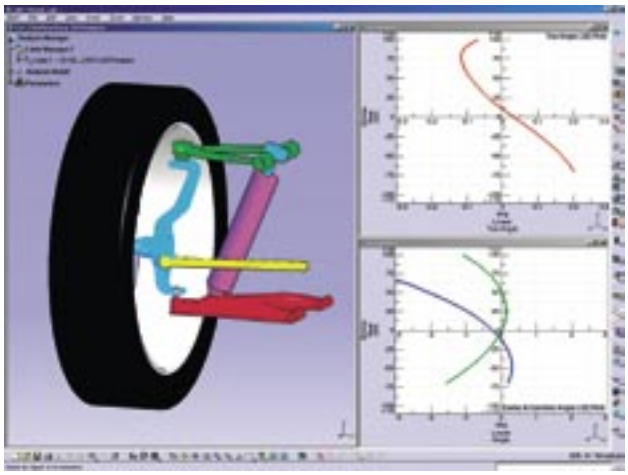
The suspension solution of LMS Virtual.Lab Motion offers vehicle engineering teams a dedicated environment to efficiently set up and analyze suspension models. From the early concept stages on, engineers can tune and optimize suspensions to meet full-vehicle targets. LMS Virtual.Lab Motion supports different types of simulations at the various stages of the development process. Scalable models enable engineers to quickly alternate between vehicle-dynamics investigations and comfort and durability analyses, making it possible to concurrently optimize multiple attributes.

Efficient suspension design for ride and handling

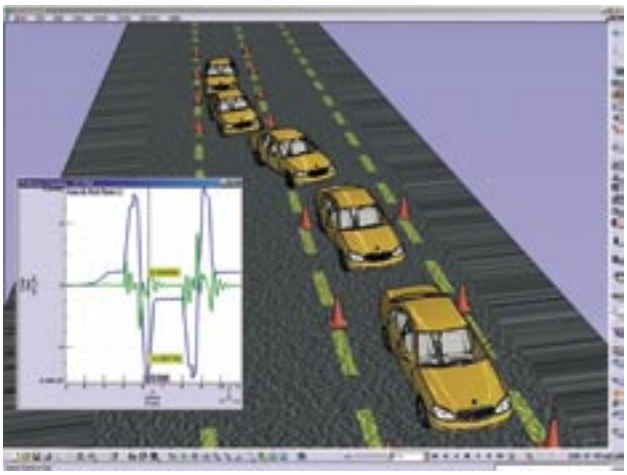
Efficiently translating system requirements into correctly dimensioned suspension components is quite a challenge for chassis engineers. LMS Virtual.Lab Motion supports this highly iterative design process by offering dedicated suspension templates, which radically reduce the time required to set up suspension models. Predefined wheel strokes and steering analyses combined with dedicated suspension post-processing enable users to focus on their real job, rather than on multibody modeling details. Engineers can optimize hard point locations with kinematic studies at the early stages of development and can investigate suspension characteristics of compliant models at subsequent stages.

Upgrading from a kinematic to a compliant model involves the modeling of bushings, springs, dampers, anti-roll bars and flexible components. Quickly toggling between both model types makes it easy to efficiently evaluate and compare suspension characteristics for traction, braking, cornering and vertical load conditions.

- Suspension models are fully compatible with all other LMS Virtual.Lab Motion models
- Kinematic variation studies and hard point optimizations firmly reduce development time
- Wheel envelope calculations for packaging studies
- Dedicated suspension post-processing includes Ackerman angle, wheel camber, caster, toe, etc.



Dedicated suspension templates which accelerate suspension modeling are combined with visualization of simulated suspension characteristics.



Simulate full-vehicle maneuvers and get immediate feedback on the vehicle's ride and handling performance before testing the first prototype on the track.

Improved full-vehicle maneuverability

Suspension models can be easily integrated in a virtual vehicle, together with the steering system, brakes, powertrain, tires and electronic controls. Simulating the vehicle dynamics of motorcycles, cars, trucks and buses helps save on costly instrumentation and test track time, and minimizes the repeatability problems associated with physical vehicle testing. Full-vehicle models in LMS Virtual.Lab are used to quickly simulate straight-line braking, acceleration, cornering, potholes and curb strike and closed loop lane changes, J-turns and constant radius curves.

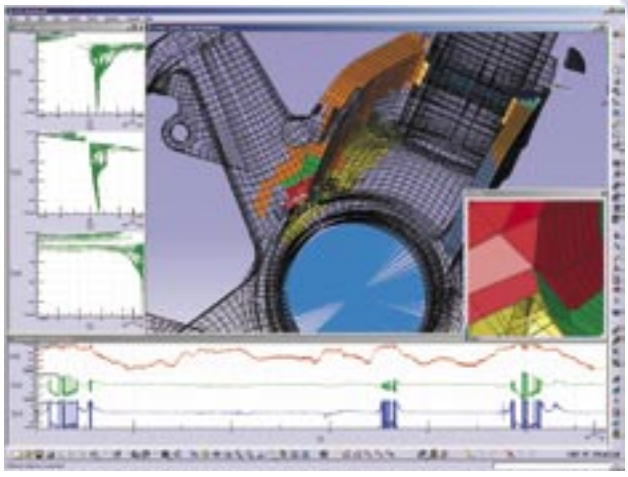
- LMS CD Tire models (Comfort and Durability Tire) capture tire vibrations up to 80 Hertz.
- High-fidelity Monroe shock absorber model

Accurate durability predictions

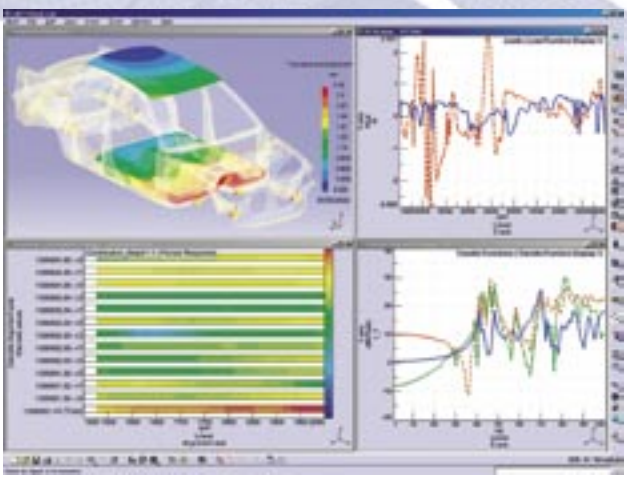
Durability design problems at the full-assembly level, for example a complete suspension system or a full vehicle, are too often discovered very late in the development process. Therefore, the ambition of durability engineers is to optimize suspension systems as a whole. This is exactly what LMS Virtual.Lab has to offer. Whether the focus is on suspension knuckles, control arms and auxiliaries, on brake calipers or steering system parts, or on large flexible welded subframes, LMS Virtual.Lab Durability accurately traces the fatigue performance of each involved chassis component. Top-class accuracy is achieved by using LMS Virtual.Lab Motion's realistic dynamic component loads and stresses as the starting point.

Optimized interior comfort

Reliable interior comfort predictions undoubtedly require the dynamic excitation forces that will act on the vehicle body and/or the full vehicle. LMS Virtual.Lab Motion predicts the engine and suspension mount loads that are essential in system-level noise and vibration response analyses. LMS Virtual.Lab Noise & Vibration, and Acousics enable engineers to accurately predict seat vibrations and interior sound. With this effective approach, it is also very easy to accurately determine how energy propagates through structure-borne and air-borne transfer paths to any targeted location.



LMS Virtual.Lab Durability uses loads and stresses from LMS Virtual.Lab Motion to predict how many motion sequence repetitions lead to failure and where fatigue hot spots are located.



LMS Virtual.Lab Noise & Vibration, and Acoustics predict interior sound pressure levels and seat vibrations responses, based on loads predicted by LMS Virtual.Lab Motion.

Dedicated Powertrain Capabilities Accelerate Engine Development

What does it take to design a powertrain that will meet performance and reliability requirements, comply with emission legislation and stay within budgets?

Customers, including BMW, Cummins, DaimlerChrysler, General Motors and Toyota, use LMS solutions to accurately predict the dynamics of engines. LMS Virtual.Lab Motion accurately predicts internal response loads needed to determine the resulting fatigue life, vibrations and engine sound. Investigations of shaft whirl, gear rattle and torsional vibrations are key in optimizing the dynamics of drivelines. From new engine concepts, such as cam phasers, variable valve-lift devices and variable compression-ratio engines, the most promising concepts can be retained quickly through virtual simulations.

Powertrain modeling with unlimited flexibility

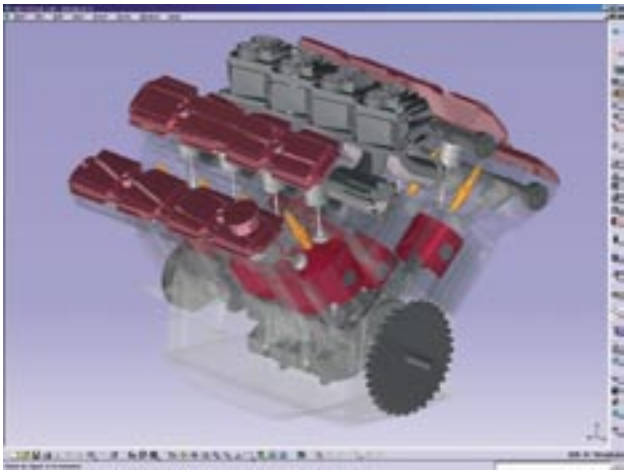
LMS Virtual.Lab Motion offers dedicated templates and a highly interactive wizard that help compress the time required to model powertrain assemblies from weeks to hours! Users quickly get to complete virtual models that are built according to today's best practice, regardless whether they are optimizing a cranktrain, valvetrain, timing drive, driveline, accessory drive or an entire powertrain. Unlimited design flexibility maintained throughout all development stages allows more effective evaluations of new innovative design concepts.

- Automatic setup of valvetrain 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.

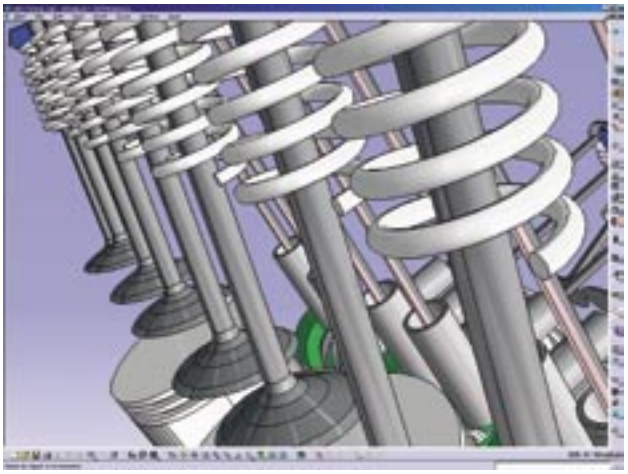
Optimal valvetrain performance

Accurately addressing the dynamic aspects of engines at high speed or heavy-duty operation requires advanced modeling capabilities. Detailed motion simulations enable engineers to improve engine performance and to discover potential areas of concern. LMS Virtual.Lab Motion offers its users everything to effectively refine valvetrain models by integrating cam contact, hydraulic lash adjusters, flexible valve springs and cam shafts. Irregular engine dynamics, due to cam lift-off and spring surging, can be effectively traced on plotted motion characteristics.

- Cam profile synthesis tool
- Helical spring element captures mass effects and coil collision of valve springs



Avoid error-prone and tedious modeling by using engine templates for modeling cranktrains, valvetrains and timing drives according to today's best practice.



By taking the dynamic behavior of high-fidelity valvetrain models into account, LMS Virtual.Lab Motion enables you to optimize cam profiles and reach the prescribed valve motion.

Maximum powertrain reliability

Accurate prediction of dynamic stresses is key in guaranteeing powertrain reliability. LMS Virtual.Lab Motion's detailed simulations enable engineers to predict the reliability of engine parts, which typically undergo high pressures, cyclic load patterns and high inertial forces under different operation conditions. The combination of flexible crankshaft and engine block models with dedicated hydrodynamic bearing models guarantee accurate oil film behavior and correct transfer of loads.

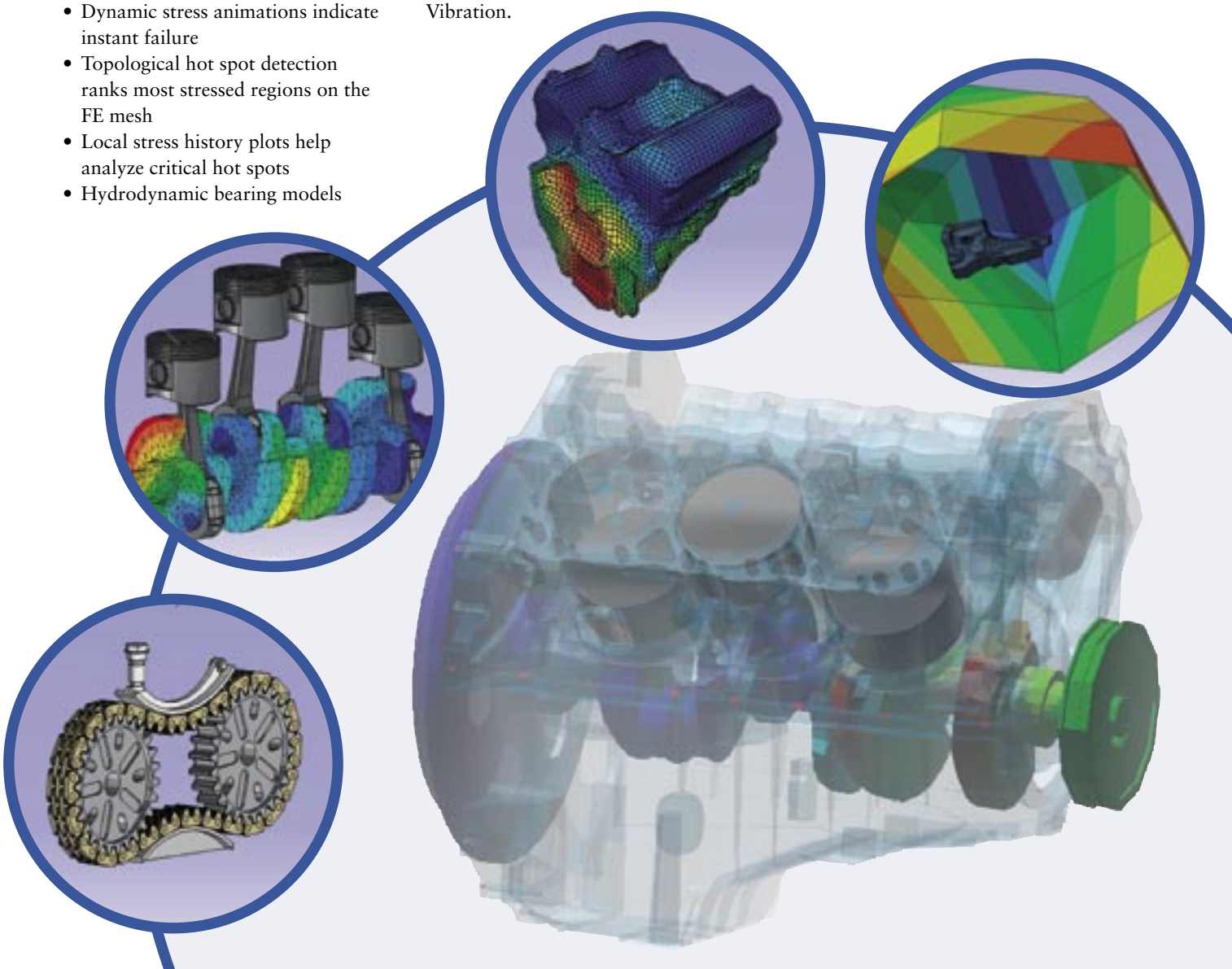
- Dynamic stress animations indicate instant failure
- Topological hot spot detection ranks most stressed regions on the FE mesh
- Local stress history plots help analyze critical hot spots
- Hydrodynamic bearing models

Controlled vibrations

To optimize engine vibrations, it is important to identify the engine speeds where critical levels of gearbox rattle, prop shaft whirl and driveline vibrations occur. You can efficiently assess complete drivelines by making use of dedicated driveline templates, which include the engine, power transfer units, prop shafts, axles, differentials, wheels or dynos. These templates allow accurate simulations of specific driveline events, such as shift clunk, driveline boom and idle shake loads. The predicted engine mount loads form direct inputs for comfort studies in LMS Virtual.Lab Noise and Vibration.

Efficient sound predictions

Tuning engine sounds and controlling emanated acoustic power are real challenges of today's car manufacturers. Based on simulation results of engine speed sweeps in LMS Virtual.Lab Motion, noise and vibration engineers can immediately perform sound-radiation simulations, at different rpm values. Time-domain bearing loads and engine block surface vibrations are capable of driving LMS Virtual.Lab Acoustics. The use of combined multibody and acoustic simulations cut down the execution time of comprehensive engine acoustic predictions from weeks to days.



Multi-Body Simulation in Aerospace ...

Engineering safer and lighter aircraft

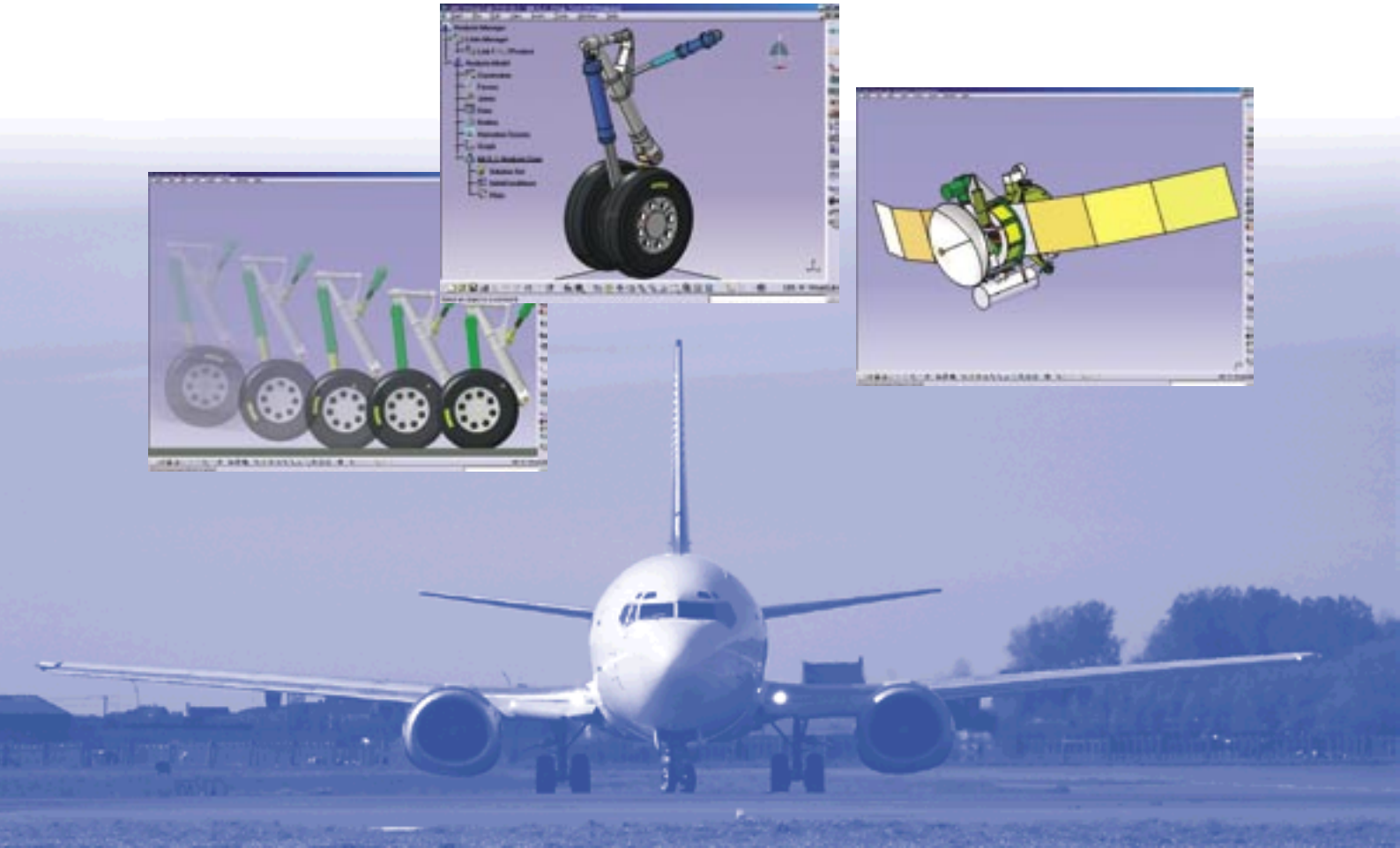
A major challenge facing aerospace engineers when designing mechanical systems is to meet functional specifications while decreasing weight and increasing reliability. Interactions between mechanisms and control systems must be completely trustable in order to ensure safety, durability and stability. This requires the use of accurate dynamic simulations that provide the internal mechanism loads, way before prototypes become available. This is exactly what LMS Virtual.Lab Motion has to offer. Engineers at Boeing, Cessna, Embraer, Gulfstream Lockheed Martin and other manufacturers use LMS Virtual.Lab to effectively improve the reliability and safety of their designs and to automatically assess the steadily rising number of load cases today's design processes need to consider.

From initial sketches of control surfaces, over complete designs of landing gears and doors, up to advanced full-aircraft landing simulations… today, many aircraft manufacturers execute dynamic mechanical simulations to set new standards and to stand out from the competition. When simulating flaps, LMS Virtual.Lab Motion assesses their performance by subjecting them to complex aerodynamic loads and taking into account component flexibility and control system interactions. Also a wide range of aircraft take-off, landing, braking and towing maneuvers can be assessed to provide accurate component, assembly and fuselage loads. These forces are essential in downstream durability analyses, which locate the weakest spots on parts of landing gear systems and other assemblies.

Designing space systems, no second chance

It is often impossible, or at least impractical, to duplicate the zero gravity conditions present in space by means of physical testing. LMS Virtual.Lab Motion is ideally suited to evaluate the dynamic behavior of components and systems that are designed for operation in space, under a wide range of different simulation conditions. Virtual assessments of boosters, fairings and satellite separations help space engineers to determine flight paths and structural loads, while at the same time ensuring secure separations and avoiding disastrous collisions.

Stochastic analysis on simulations executed on multibody models helps specialists to further explore the uncertainties inherent to space.



... and a Wide Spectrum of Other Applications

Other ground vehicles

As extreme operating conditions and low-volume production series are common for agricultural, construction and all-terrain vehicles, successive prototype testing is not an option. To determine the safety limits LMS Virtual.Lab Motion is capable of simulating their performance under hazardous working conditions, without putting people or equipment at risk. The comfort experienced by off-road truck drivers or drivers of tracked vehicles can be drastically improved by assessing the dynamics of these vehicles on different surfaces and under real-life circumstances. Secure operation and reduced maintenance costs can be achieved through durability optimizations, which use the predicted loads from LMS Virtual.Lab Motion as a basis.

White goods

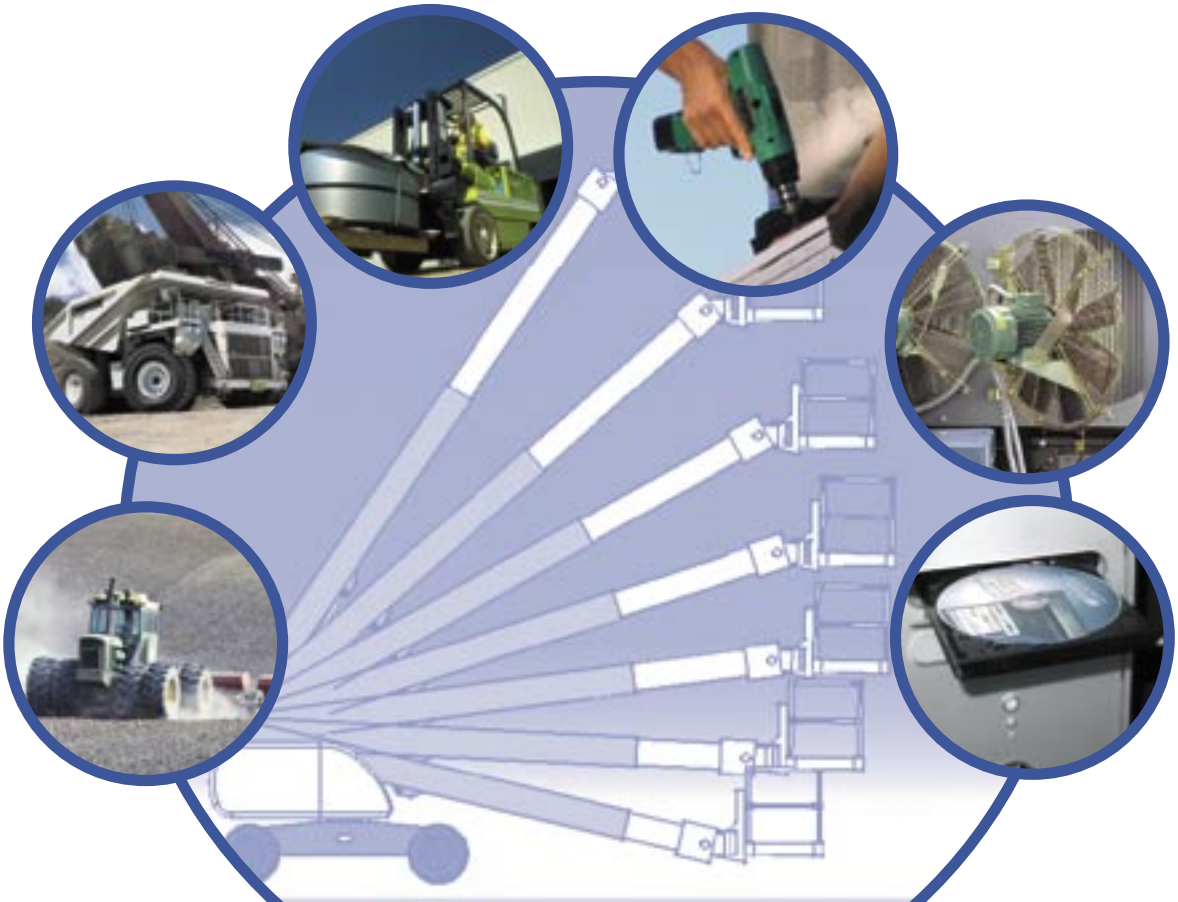
Silent operation and limited vibrations are always ranked high on the priority list of buyers when purchasing a washing machine, tumble dryer or refrigerator. Suspension and bearing simulations performed in LMS Virtual.Lab Motion help to further reduce operational noise and vibrations of white goods, despite ever-increasing rotating speeds and ever-decreasing sales margins.

Consumer and business electronics

Dynamic simulations of rotational mechanisms with high-precision mechanics enhance the operational reliability of CD players, hard disk drives and high-speed DVD drives. Other simulations advance throughput rates and noise levels of office equipment, such as faxes and printers.

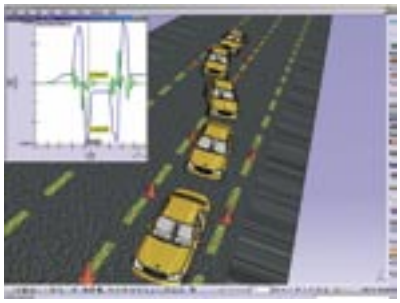
Industrial machinery

Offering the best return on investment is what matters for manufacturers of industrial equipment, such as weaving machines, packaging machines, elevators, cranes and robots. Higher speeds, more accurate movements and increased operational reliability can be realized through simulations in LMS Virtual.Lab Motion. For hammer drills, disk saws and other power tools, simulation delivers crucial engineering insights in terms of component loads, vibrations and product reliability.



LMS International,
Empowering Engineering Innovation

LMS enables customers to engineer functional performance targets into their products, creating and maintaining distinctive brand values. LMS' unmatched understanding of the product development process is captured through a unique combination of products and services supporting physical and virtual product development: Test systems, CAE software products and engineering services. Critical attributes such as noise and vibration, ride, handling, motion, acoustics and fatigue are turned into a competitive advantage.



LMS Virtual.Lab

LMS Virtual.Lab is the world's first integrated software environment for the functional performance engineering of critical design attributes, such as noise and vibration, ride, handling, comfort, safety and durability.

LMS Test.Lab

LMS provides the most complete portfolio of applications for test-based noise and vibration engineering. It comprises modules for structural, rotating machinery and acoustic testing and analysis, environmental testing, reporting and data sharing.

LMS Engineering Services

Through its Engineering Services Division, LMS provides vehicle development support from overload contracting and troubleshooting, technology transfer, up to co-development projects.

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