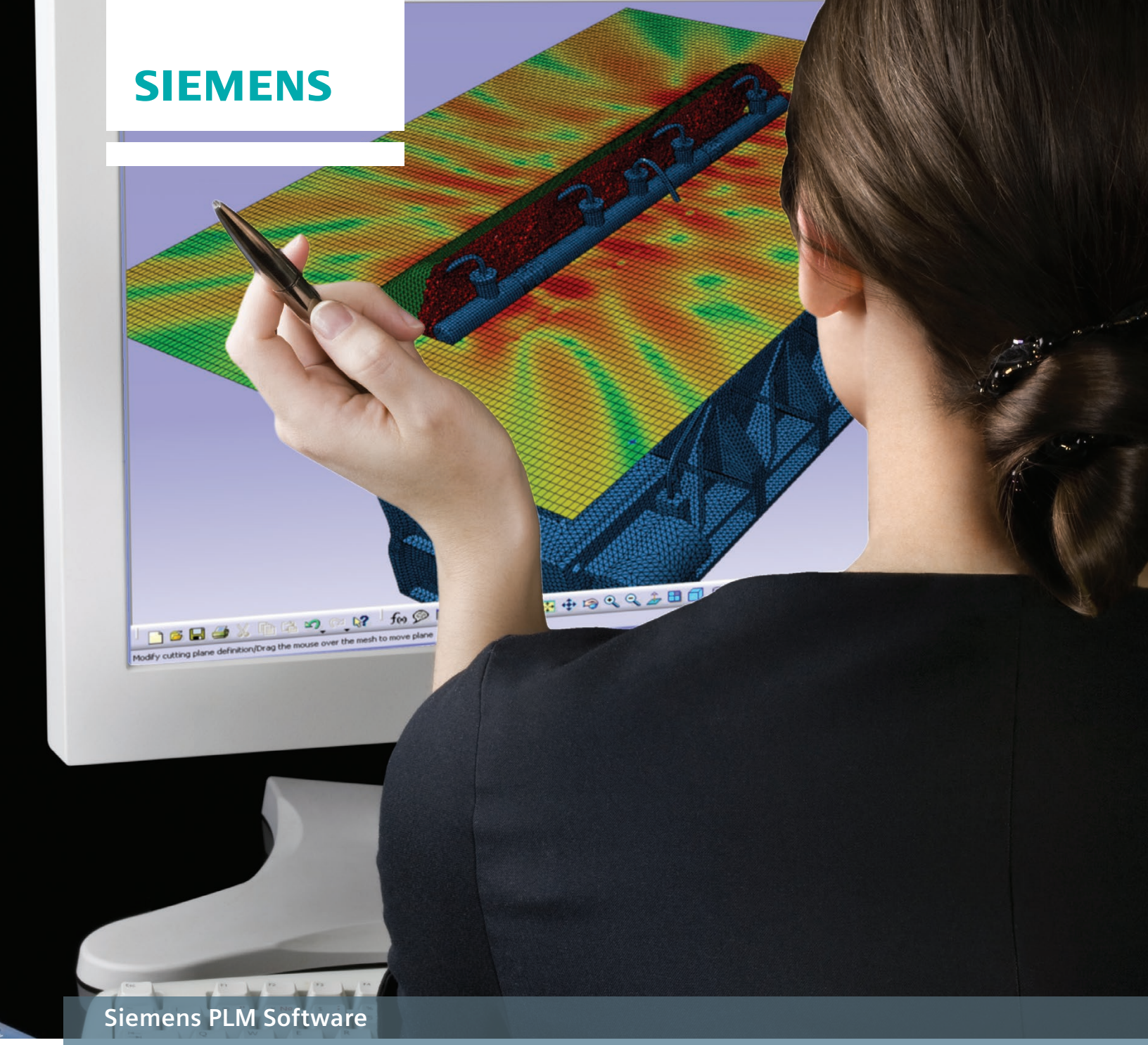
SIEMENS

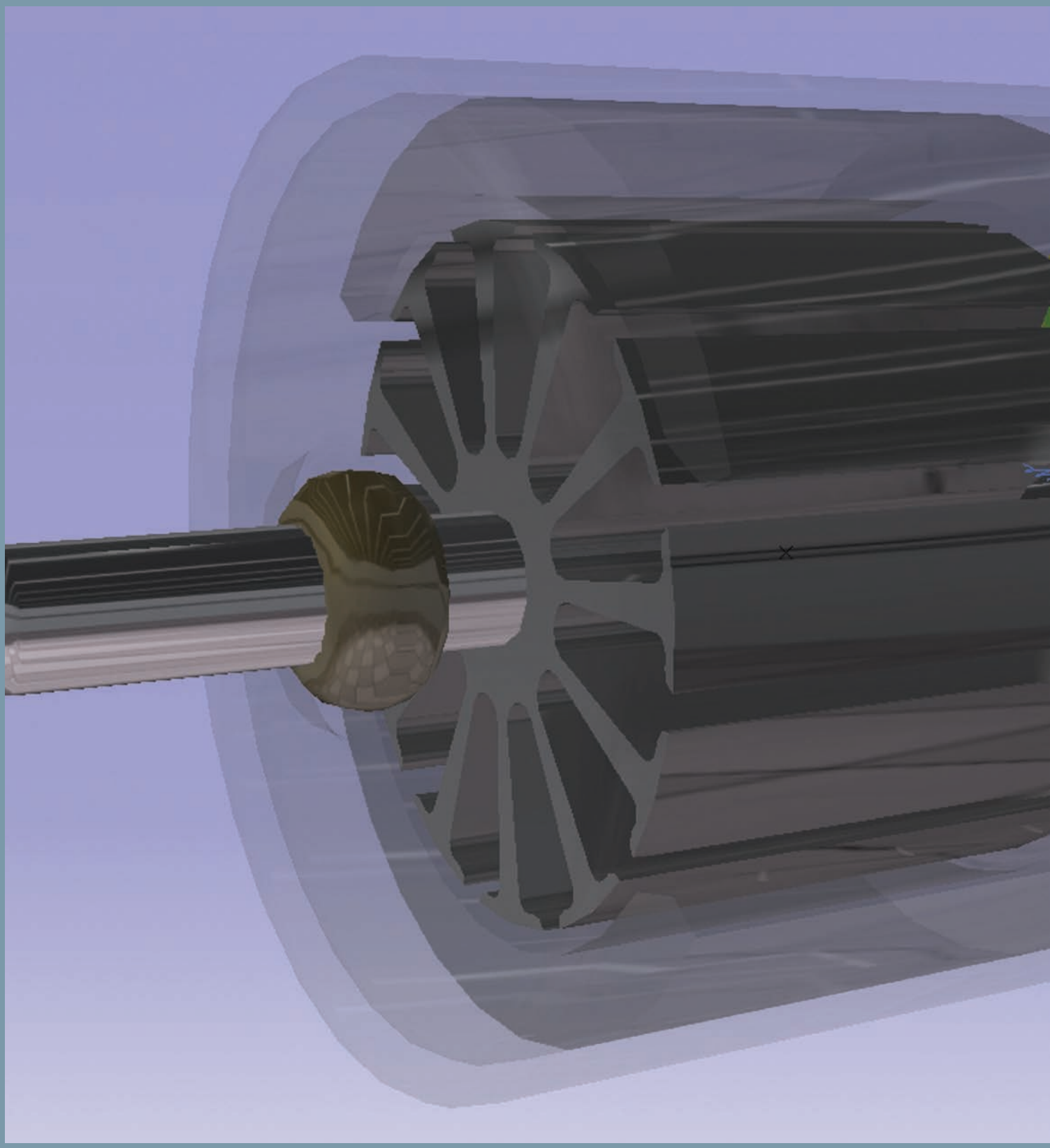


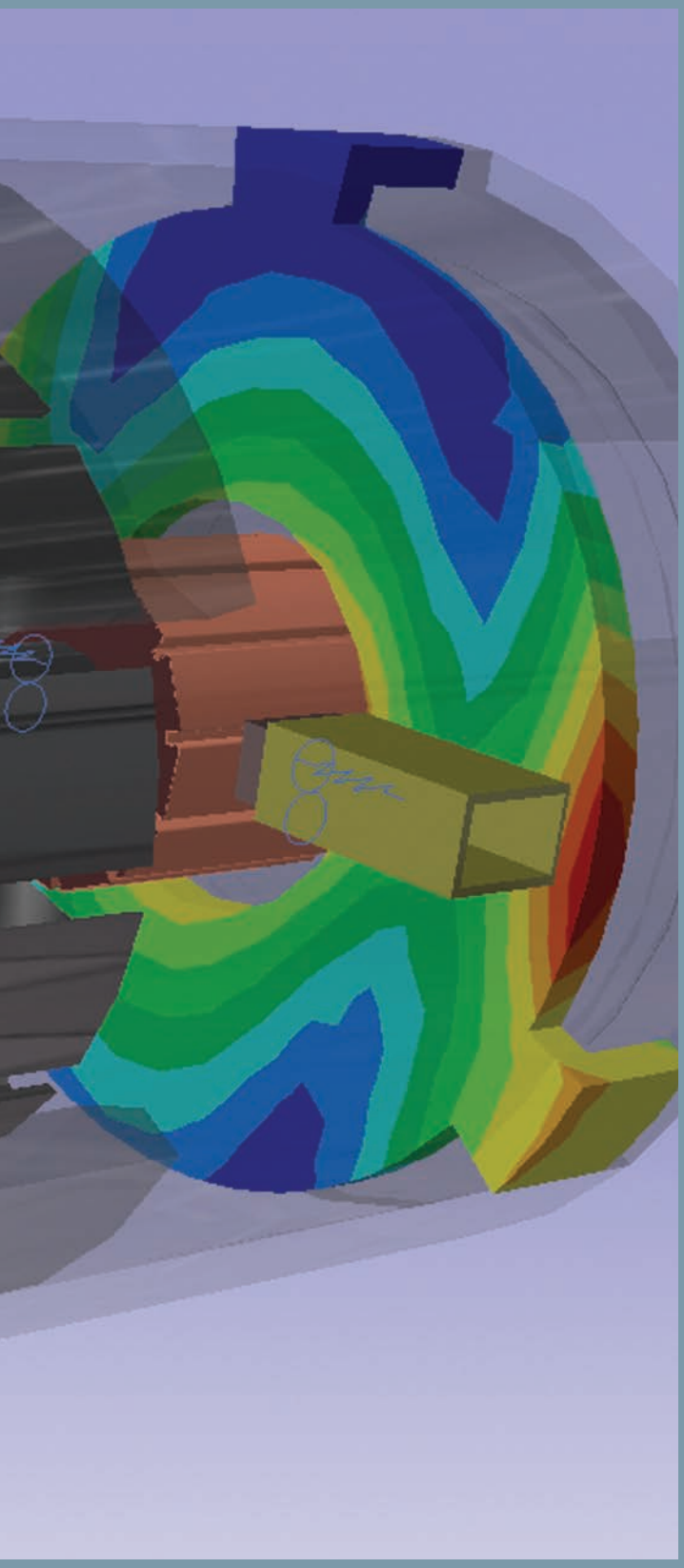
Siemens PLM Software

LMS Virtual.Lab

Accurate 3D performance simulation

siemens.com/plm/lms





LMS Virtual.Lab

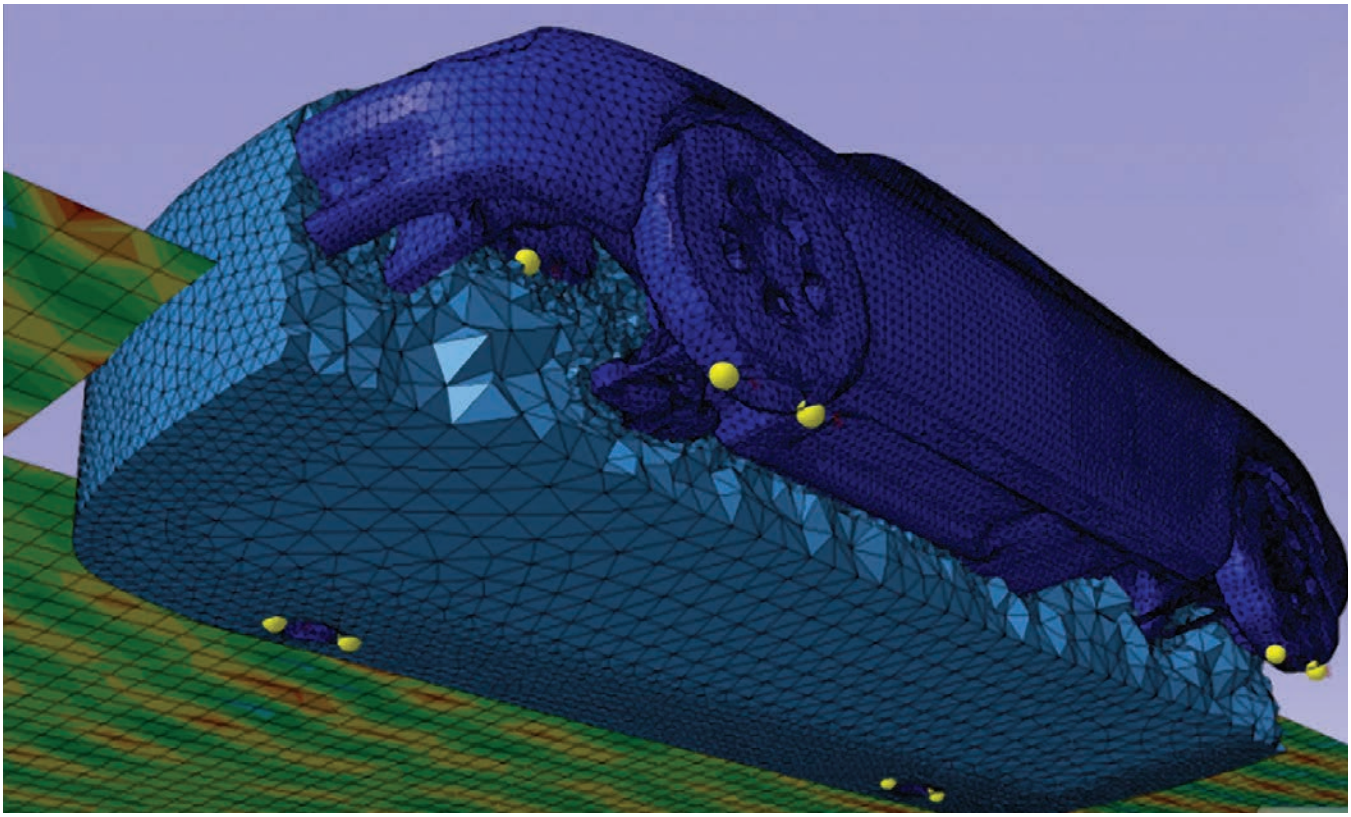
Making virtual simulation realistic

LMS Virtual.Lab™ software is an integrated CAE suite designed to simulate and optimize the performance of mechanical systems for structural integrity, noise and vibration, system dynamics and durability.

With LMS Virtual.Lab engineers are able to build accurate models fast and simulate real-life performance accurately. They can quickly assess multiple design alternatives and optimize their designs way before prototype construction.

Engineer the right product
- Simulate real-life behavior
- Deliver a balanced performance
- Resolve issues using root cause analysis

Accelerate the development process
- Speed up model creation
- Automate simulation processes
- Combine physical testing and simulation



LMS Virtual.Lab Acoustics

3D vibro-acoustic simulation for early-in-the-cycle sound engineering

Make sound engineering decisions faster

Today, the fast pace of product design requires decisions to be taken as early as possible in the product development cycle. This is becoming more and more important when it comes to acoustics as well. Whether identifying critical areas of a system that contributes to noise or pinpointing areas to save weight while still reaching noise targets, engineers need a flexible and accurate tool to make the right design decision.

Sound design without prototyping

Applicable for both internal and external acoustic radiation, LMS Virtual.Lab™ Acoustics software lets users examine the various aspects of sound, increasing sound quality and minimizing noise on a system level without physical prototyping. This is essential to the modern product development cycle.

Model, analyze and refine

LMS Virtual.Lab Acoustics has what engineers need to model, analyze and refine interior sound quality. Scalable, this acoustics tool can be used to design a variety of sound issues associated with passenger cars, trucks, off-highway vehicles and trains. For example, engineers can start solving complete engine and transmission acoustic radiation problems already during the design stage.

Working from load identification based on experimental techniques or multibody analyses, LMS Virtual.Lab Acoustics can provide the accuracy required to analyze most operating conditions. Acoustic engineers can study orifice noise and shell noise caused by the mechanical and acoustic loads of lightweight components, like mufflers and air intakes. Users can also study and optimize the application of various acoustic treatments.

Standardized template models – interior and exterior acoustic radiation

LMS Virtual.Lab Acoustics is able to simulate noise inside closed cavities such as vehicles, cabins and duct systems. Users can analyze external noise radiation or exterior scattered noise such as vehicle pass-by noise or external aircraft noise.

Advanced efficient and accurate BEM and FEM solvers

The latest acoustic solvers address even more complex and vast models, even faster. This includes BEM models up to millions of nodes, solved on PCs or high-performance computing (HPC) clusters and FEM models ranging up to 50 million elements.

First-class technology

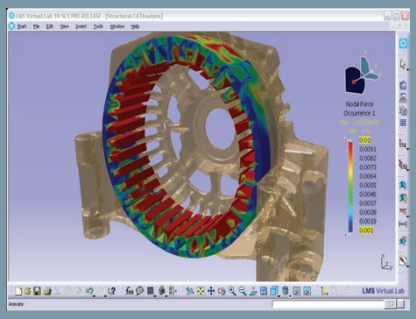
Have the right type and combination of technology to help deliver the expected level of accuracy for the job at hand. LMS Virtual.Lab Acoustics covers ATV, AML, SEA, aero-acoustics, ray-acoustics, random vibro-acoustics as well as uncoupled to fully coupled acoustic problems.

End-to-end process support

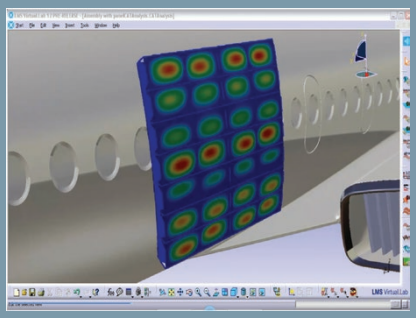
Highly automated LMS Virtual.Lab Acoustics covers three essential steps: preprocessing/meshing, solving and postprocessing. To streamline CAE processes, LMS Virtual. Lab Acoustics features embedded interfaces with external structural FEM and CFD software and electromagnetic simulation tools.

Highlights

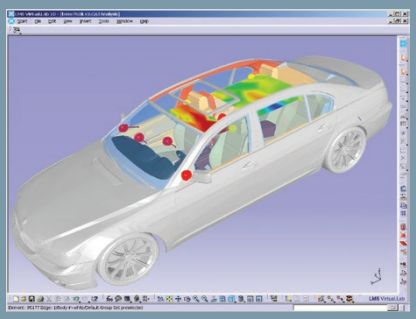
- Full audible frequency range: 20 Hz-20 kHz
- Advanced BEM solvers: indirect BEM, direct BEM, fast multipole BEM, H-matrix BEM, Padé-expansion and time-domain BEM, full and weakly coupled analyses
- Advanced FEM solvers: adaptive order schemes, iterative Krylov subspace solver, MUMPS-based direct solvers, PARDISO solvers for full and weakly coupled analyses
- AML (automatically matched layer): new-generation PML (perfectly matched layer) technology for ultra-large FEM noise radiation problems



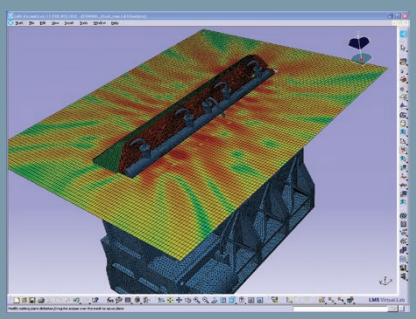
Assess sound quality and eliminate annoying tonal noise from electric motors through simulation.



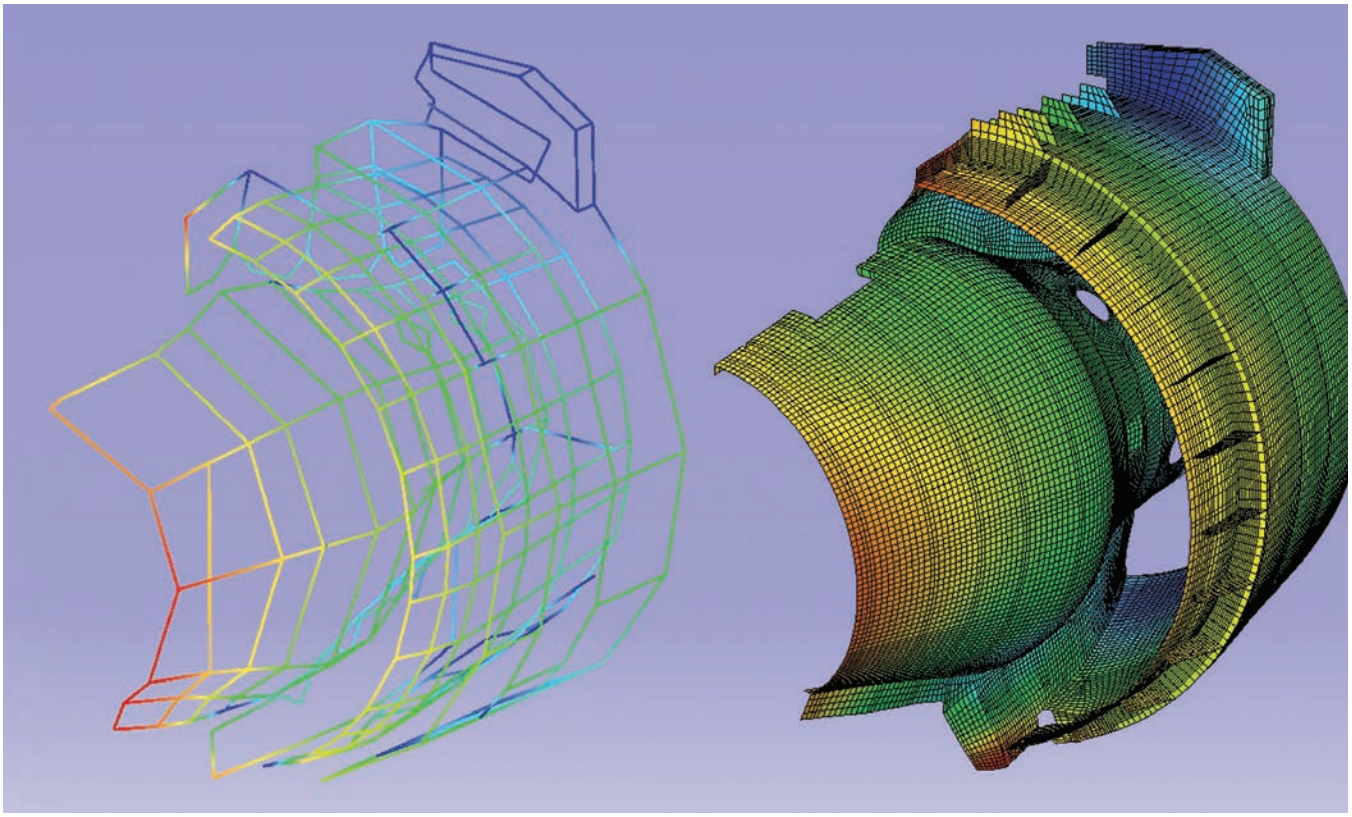
Assess sound transmission through panel fast and accurate. Reduce panel weight while maintaining noise performance.



Design the sound system of a car interior for higher sound quality through LMS Virtual.Lab ray-acoustics.



Run hundreds of intake designs automatically overnight and identify the most performant design for minimal noise radiation.



LMS Virtual.Lab Noise and Vibration
LMS Virtual.Lab Correlation

Predict noise and vibration and perform systematic validation

LMS Virtual.Lab™ Noise and Vibration software helps analyze, refine and optimize the noise and vibration of a system under development, from the component- to the system-level. LMS Virtual.Lab™ Correlation software allows engineers to validate and further improve simulation models.

LMS Virtual.Lab combines the necessary tools to create system-level hybrid (combining FE and test) models, build realistic load cases and simulate noise and vibration responses. It includes a wide range of visualization and analysis tools to explore noise and vibration performance and accurately pinpoint the most critical contributors. User-friendly tools enable engineers to quickly perform design modifications and assess the effect on noise and vibration performance in minutes.

LMS Virtual.Lab Noise and Vibration and LMS Virtual.Lab Correlation offer direct access to standard FE and test data including a unique export to LMS Test.Lab™ software. It allows quick comparison and validation of FE models to test data and identify possible modeling errors to systematically improve existing simulation models.

Premium NVH structural FEM solver

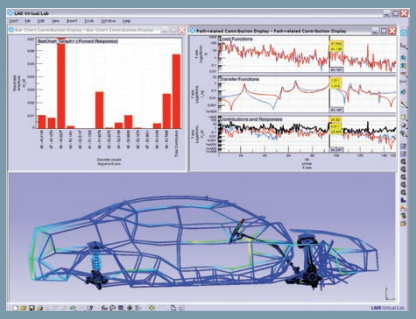
A comprehensive FEM solver included in the NVH product portfolio supports the NVH hybrid engineering process. Test components (e.g. from LMS Test.Lab) can be coupled to FE-based components, calculated through the newly integrated NVH FEM solver. The element library supported in this solver is comprehensive, including 1D, 2D and 3D elements made of isotropic, orthotropic, anisotropic, layered and composite materials.

Kinematic connectors in system-level NVH

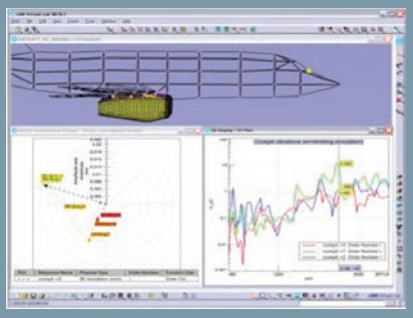
The NVH modules allow coupling the dynamics of individual components represented by modes or transfer functions or by FE or test. The coupling properties between these components are now extended to include kinematic connectors, beyond the existing flexible and rigid connectors. As such, system-level transfer functions or system-level modes can be calculated efficiently through the integrated FBS or modal coupling solver, where the subsystems are coupled by kinematic connectors.

Highlights

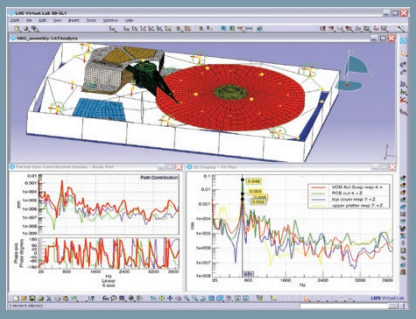
- Assess full vehicle NVH performance for road noise or engine noise based on efficient system-level NVH solvers (FRF-based or modal-based)
- Efficiently apply the loading adapted to the situation including full engine run-up or road load inputs
- Get responses fast for full operating conditions using the integrated vibration response solvers (FRF-based or modal-based)
- Perform detailed contribution analysis to pinpoint the cause of NVH problems
- Analyze the effect of design modifications on the NVH performance within minutes using the Fast Modification Prediction Tools
- Optimize the NVH performance of assembled systems using the integrated DOE and optimization tools, e.g. in support of mount optimization, component optimization and more



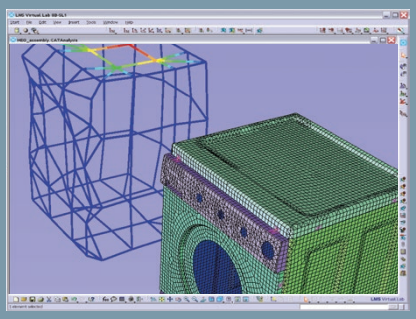
Full vehicle NVH performance assessment.



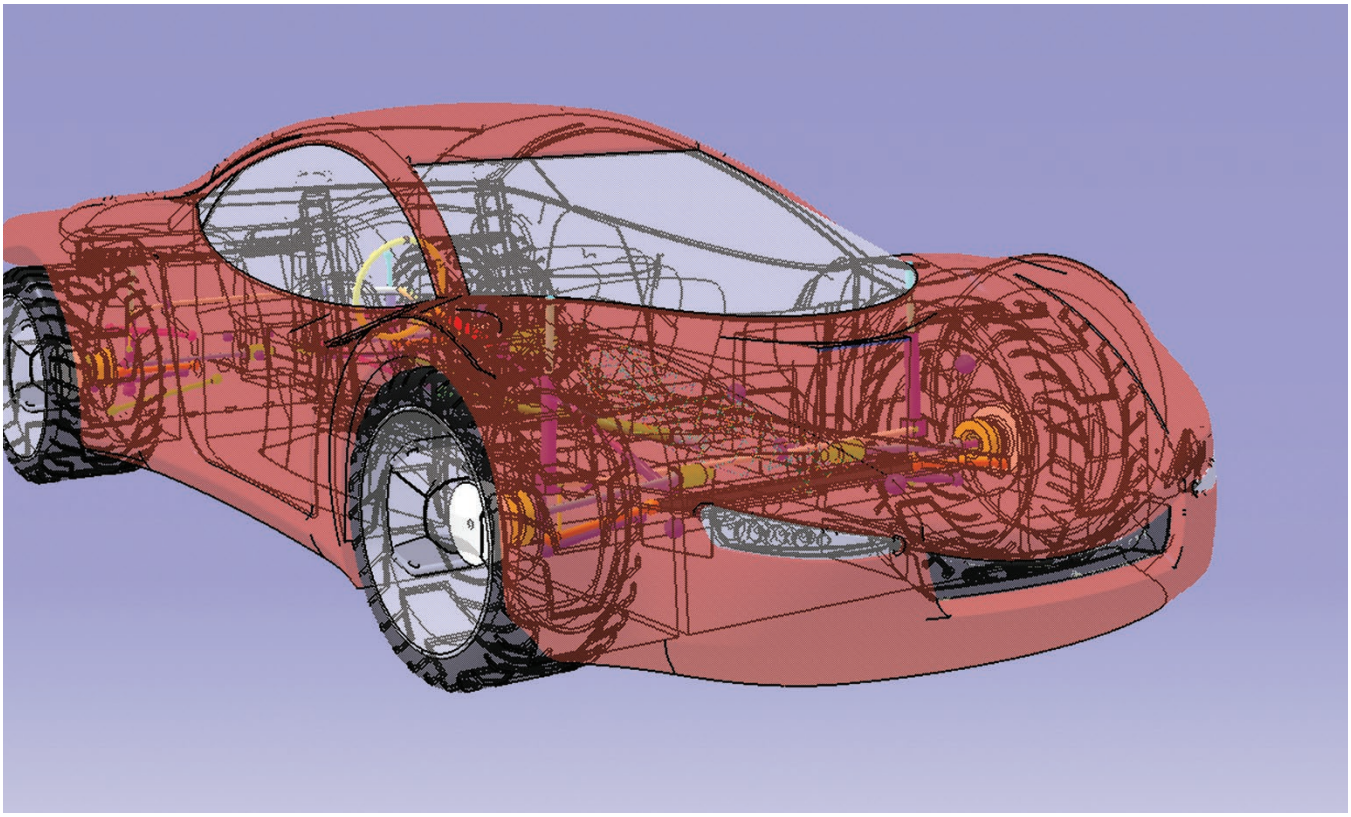
Engine unbalance-related noise prediction.



Transfer path analysis of a hard drive system.



Finite element models validation.



LMS Virtual.Lab Motion

3D optimize real-life performance of mechatronic systems

LMS Virtual.Lab™ Motion software is a highly efficient and integrated solution used to build multi-body models that accurately simulate the full-motion behavior of complex mechatronic system designs.

LMS Virtual.Lab enables users to easily create accurate system models from scratch. They can also choose to import the geometry of models from any industry-standard CAD system. LMS Virtual.Lab Motion applies forces and motion to simulate the actual operational behavior of the new design, taking mechatronic (hydraulic, electronic, pneumatic, etc.) subsystems into account through efficient simulation schemes.

Built on more than 30 years of proven solver technology, the resulting simulation provides excellent input data to optimize the design's dynamic performance. The loads obtained can also be used for structural analysis and durability, noise and vibration studies.

The flexibility of individual components can be simulated with the help of integrated or external linear and nonlinear FE solvers.

Customized applications for template-driven simulation

LMS Virtual.Lab Composer allows the creation and easy customization of industry-specific applications, which streamlines the simulation process, from reading input data, through solving different variants, to postprocessing. The applications are constructed using libraries of template models created in LMS Virtual.Lab Motion, typically built by a multibody expert. LMS Virtual.Lab Composer supports drag-and-drop GUI creation, enabling the rapid design of customized end-user applications.

Driving dynamics GUI for efficient vehicle simulation

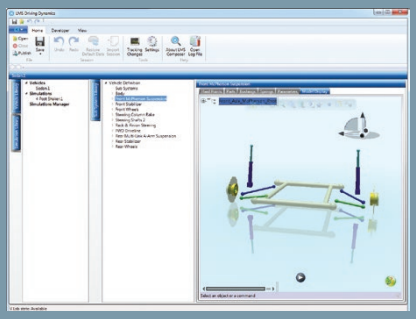
Built on the LMS Virtual.Lab Composer framework, the Driving Dynamics GUI provides a dedicated interface for vehicle dynamics analysis. It allows vehicle selection, population, solution and postprocessing for platform design. The application also helps users optimize vehicle subsystems (suspension, steering, driveline) for driving dynamics performance. Furthermore, it can be easily customized and tailored to in-house processes and simulation requirements.

Seamless integration of mechatronic subsystems

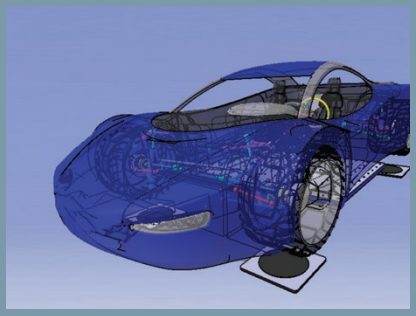
Complex interactions between the different subsystems – which may independently behave correctly – need to be simulated with ever-increasing accuracy and efficiency to systematically guarantee that the integrated end-product will function properly. LMS Virtual.Lab provides co-simulation interfaces to LMS Imagine.Lab Amesim™ software (typically for hydraulic, pneumatic or electric subsystem modeling) and the Simulink® environment (for controllers).

Highlights

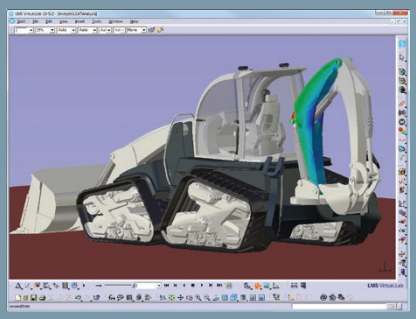
- Use accurate multibody models for HIL controller testing
- Achieve accurate simulation of nonlinear flexibility through co-simulation
- Accurately model leaf springs to correctly account for the leaves' geometry, mass properties, and friction
- Replace the full FE-model of an airplane fuselage with a condensed stiffness matrix to improve computational performance
- Increase your productivity significantly



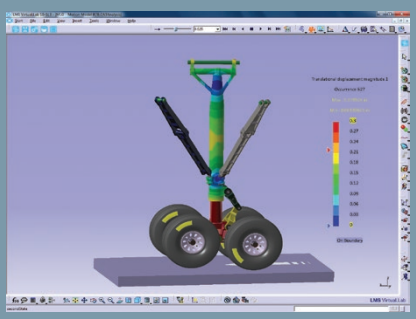
LMS Virtual.Lab Composer.



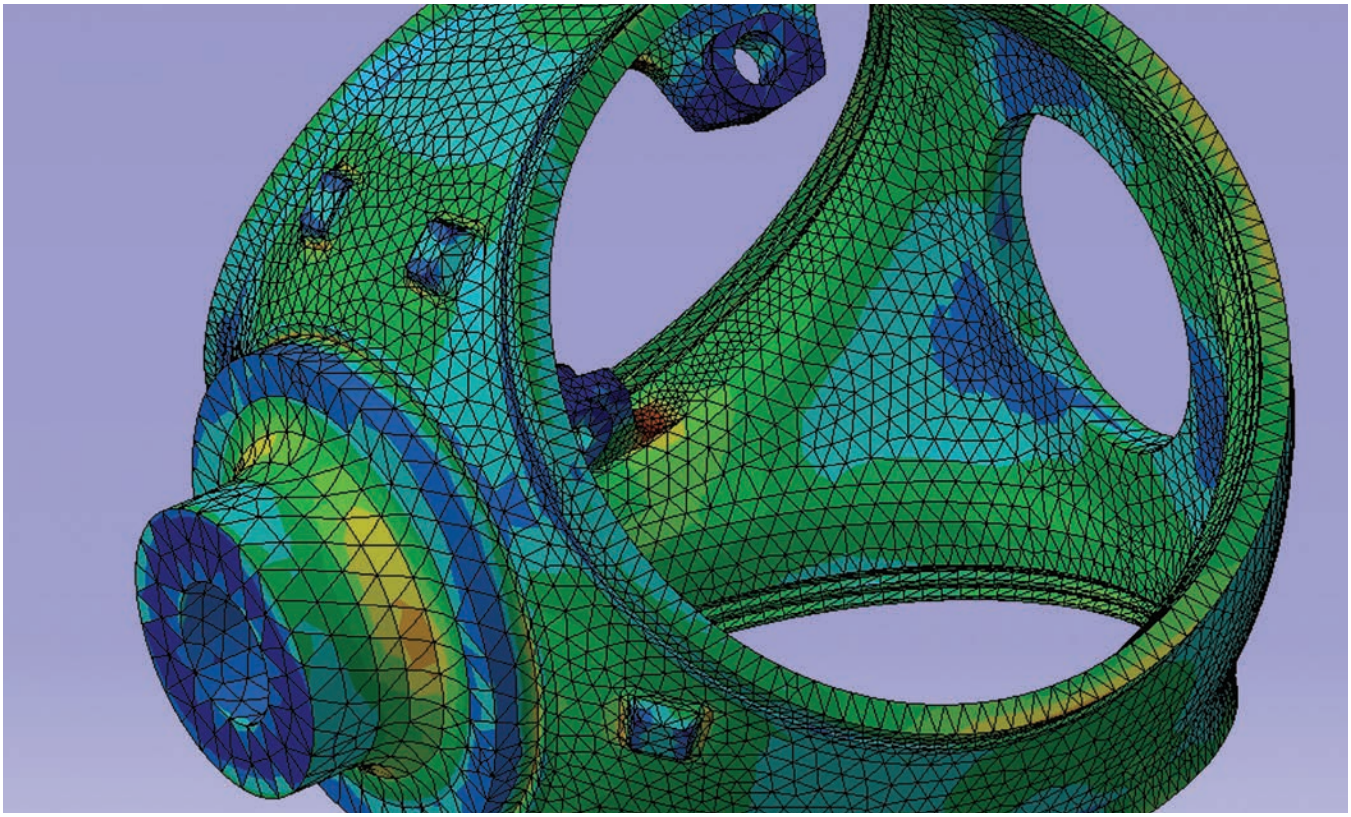
Model created with the driving dynamics GUI.



Co-simulation for a backhoe arm.



Landing gear modeled as a flexible body.



LMS Virtual.Lab Durability

Design for optimal durability performance

LMS Virtual.Lab™ Durability software offers an integrated solution in designing lightweight, reliable and fatigue-resistant products right from the start. It predicts fatigue hotspots on the component and the full system. This feature proves to be of great value for making the right design decisions early in the development process.

LMS Virtual.Lab Durability provides direct feedback on critical fatigue areas and the root cause of fatigue issues. This immediate insight enables engineering teams to validate more design variants in relation to fatigue life within ever-shorter development cycles.

LMS Virtual.Lab Durability offers one of the most complete and accurate methodologies to assess seam weld fatigue and spot weld fatigue. An analysis of lightweight materials like composites is also possible, taking into account the influence of the production process. In addition, the user can incorporate factors such as temperature and creeping. The analysis can be seamlessly integrated into load prediction and test rig simulation with LMS Virtual.Lab Motion. This allows the simulation and improvement of complex multi-axial fatigue tests as well as shaker table validations.

Ensure reliable connections: more accurate and faster simulation of seam welds

LMS Virtual.Lab Durability provides an enhanced tool to automatically identify typical seam weld topologies in an FE-mesh. It eliminates the need for engineers to tediously model each seam weld connection manually, and it offers significant speedups for large welded assemblies.

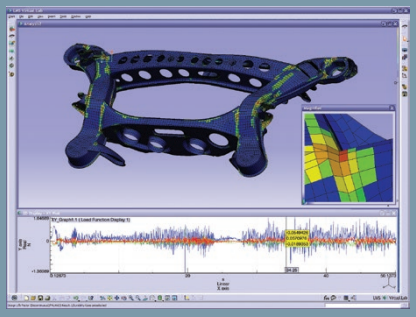
Most commonly accepted methodologies from structural stress to notch stress methods can directly be applied to the welds detected without modifying the FE-meshing. Size effects in the notches can be accounted for by the new effective stress concept. This widens the applicability from very thin (<1 mm) to very thick (>100 mm) sheets. The extension of the shell element seam weld techniques to solid element meshes enables the user to analyze the notch stresses without modeling the notches in the finite element mesh. This makes accurate weld fatigue analysis much more accessible to engineers in different industries.

Lighter but durable design: fatigue for short-fiber composites

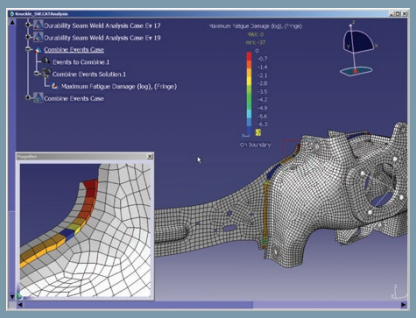
The accurate simulation of short-fiber composite structures is possible through the interfacing of LMS Virtual.Lab fatigue methods and e-Xstream Digimat™, a software solution that allows the modeling of short-fiber composites among others.

Highlights

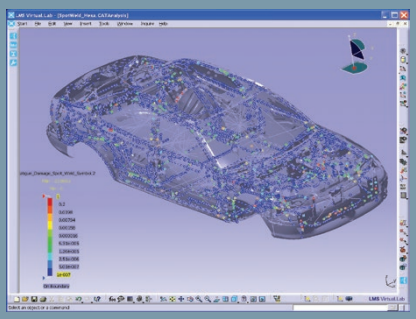
- Take into account mean stress influence by the interpolation of several SN-curves
- Complete application for certification easily by allowing multiple load events of a fatigue test schedule to run concurrently
- Support Abaqus fasteners spot weld mesh
- Include creeping and thermal fatigue in a fast and accurate manner



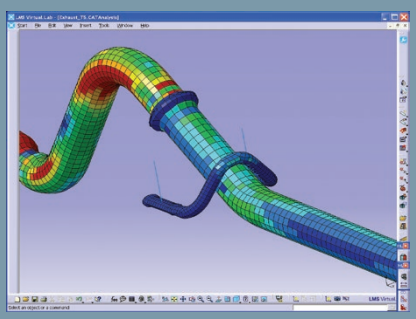
Reliable solver for durability simulation.



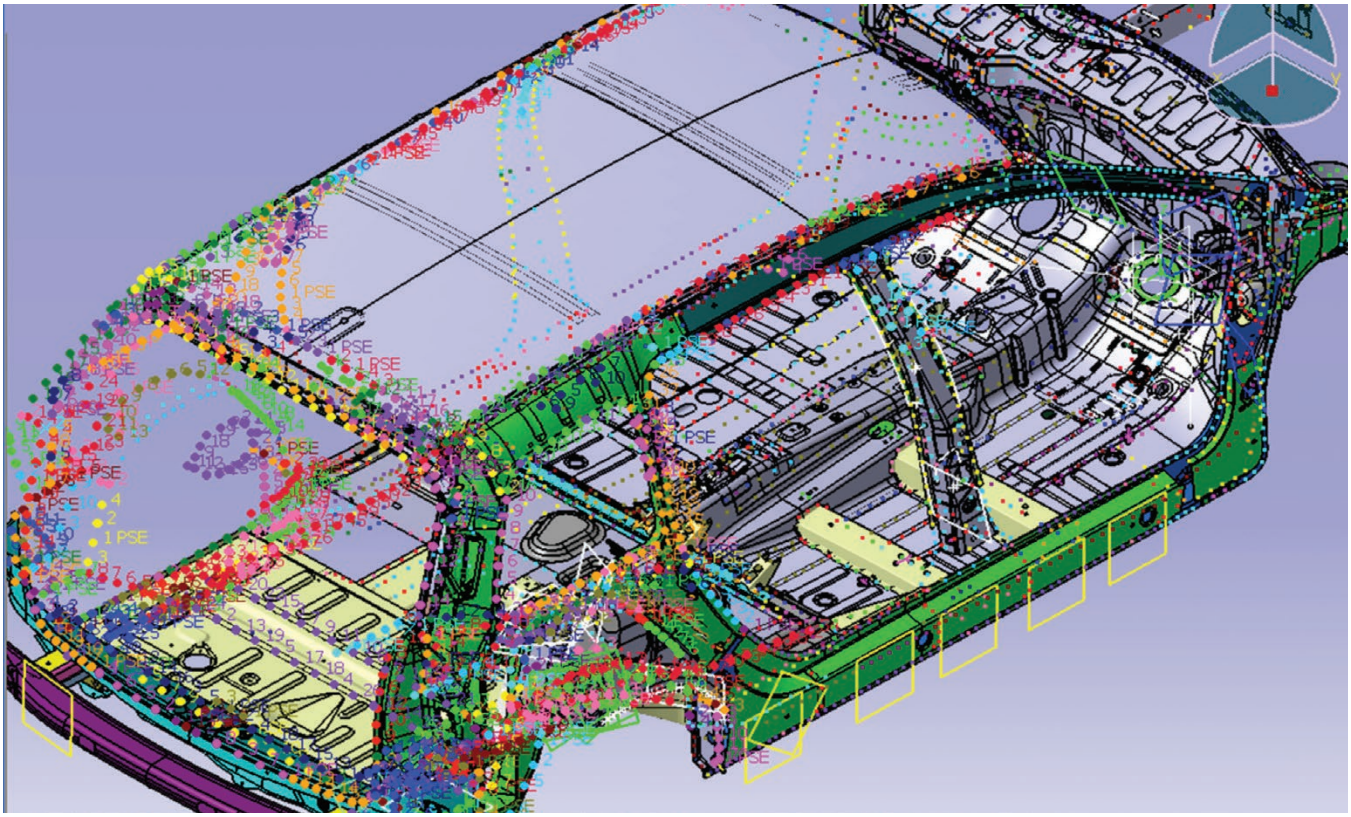
Accurate fatigue life prediction of seam welds.



Accurate fatigue life prediction of spot welds.



Effect of high temperature changes .



LMS Virtual.Lab Structures

Unified modeling and multi-solver pre- and postprocessing

LMS Virtual.Lab™ Structures software offers a scalable solution for structural modeling and analysis, integrating advanced model creation and manipulation tools to generate component, subsystem and full-system models in a far more efficient way. Its versatility is the result of specifically being designed to save time and costs.

LMS Virtual.Lab Structures offers an integrated solution for component-, subsystem- and full vehicle-level analysis by integrating model creation elements into a single platform, which delivers extremely high efficiency in simulation model creation.

The solution fits easily into the user's existing architecture. It interfaces with industry standard solvers like Nastran™, Abaqus™, LS-Dyna™, Radioss™ and Madymo™ for linear, nonlinear, crash and safety analysis.

Not only does LMS Virtual.Lab Structures support traditional mesh-based scenarios, it primarily enables integrated CAD-based scenarios, effectively eliminating costly translation steps. Generic assembly and unified modeling, full process associativity, end-to-end integration, support of CAD and/or mesh-based scenarios and capabilities to automate processes are key elements delivering value-added engineering time.

Faster and easier assembly solution

The generic assembly solution offers greater insight into quality of the assembly and enables faster correction of connection issues, for instance by interactively repositioning the geometry points used to define a spot weld. Furthermore, tools are available to efficiently cut models and clean up non-used features, to derive from a full vehicle crash assembly model a variant for front, side or rear impact, for example.

High performance and usability for crash

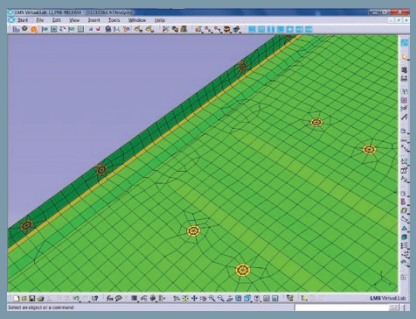
The focus on performance and usability for crash, especially in areas like section definition, time step treatment, intersection and penetration checking and model checking in general are key to fast and accurate model creation.

Unified modeling for durability

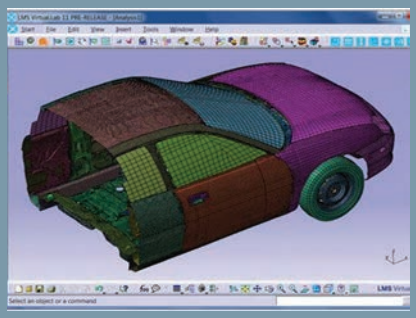
The quality of the durability models created for the unified assembly model is empowered by a new remeshing algorithm. Fine durability spot weld pattern meshes are improved where required, employing the intelligent orientation of the regions, and selecting the transition area and mesh correction functions via Ansa™ services.

Highlights

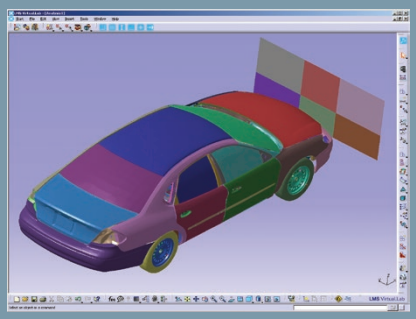
- Nastran vibro-acoustic extensions, including grid contributions next to panel and modal contributions
- Various extensions to Nastran SOL200 pre- and postprocessing functionality
- Upgrade of Abaqus interface, including non-flat structures and import of spot weld definition from *.odb and detection of Abaqus spot welds from imported models
- Upgrade of Ansa™ support and remeshing services for meshes including fine spot welds
- Extensions for Radioss preprocessing: new or enhanced properties for composite, pre-tension springs, kinematic joints or screws
- Feature browser, automation and mass overview extensions



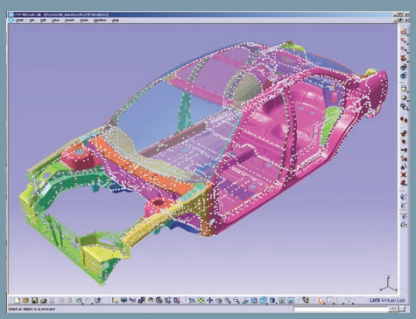
Spot welds durability preprocessing.



Model cutting function.



LMS Virtual.Lab crash preprocessing.

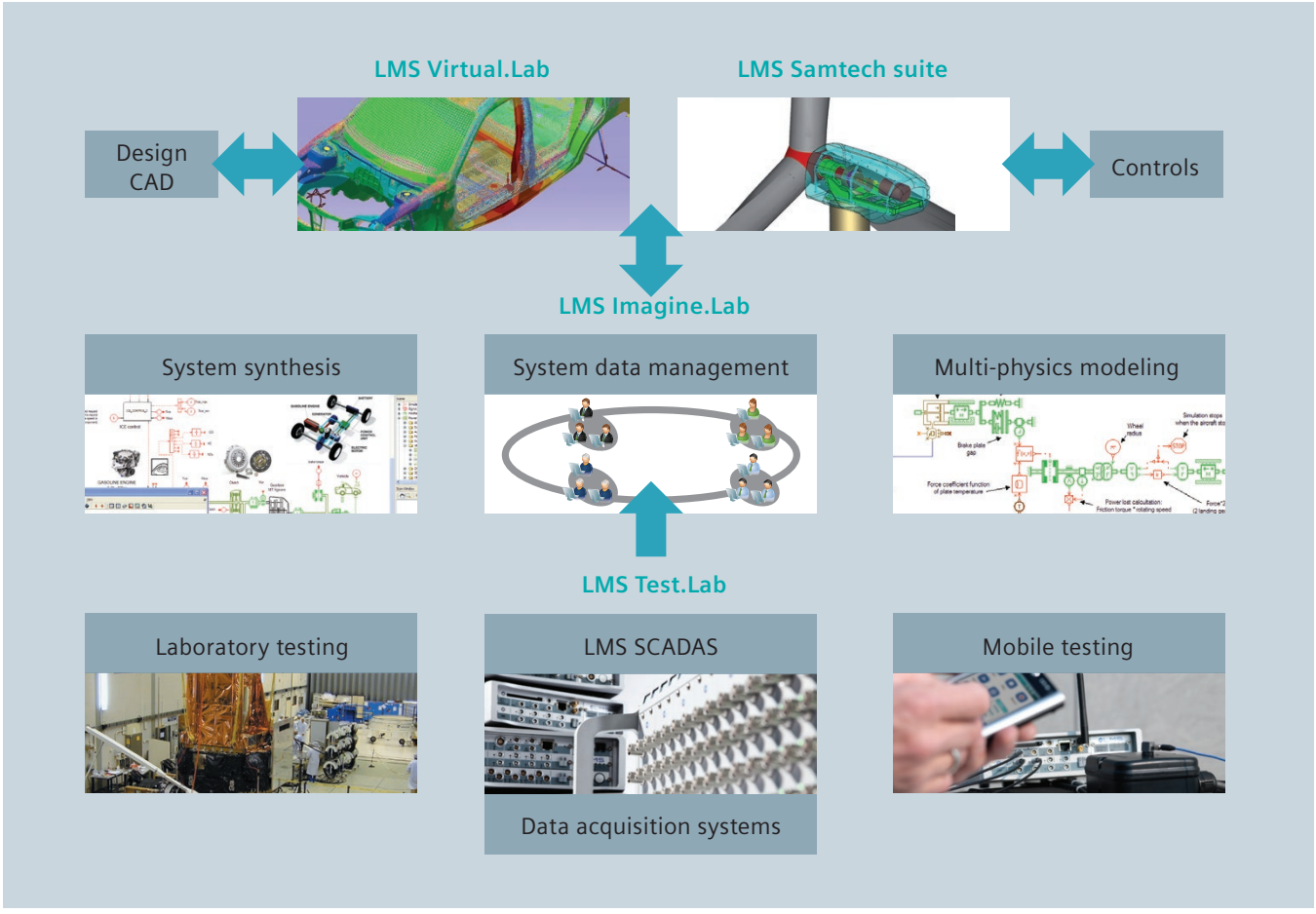


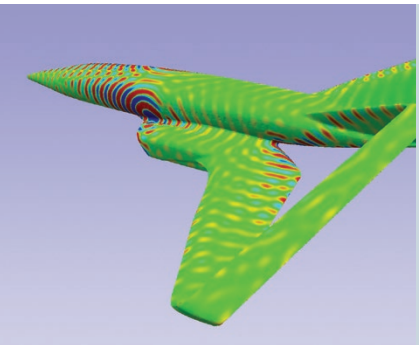
Automatic detection of spot welds .

A unique portfolio of software platforms and engineering services

Much of the potential gains individual tools offer are lost in developing unique interfaces and error-prone data translations. Each major application family has been built with a consistent user interface paradigm and data model resulting in a consistent platform for numerous application modules. Each modular family is packaged in such a way that users are assured maximum flexibility at the most economical price point.

- Structural integrity
- System dynamics
- Vehicle dynamics
- Comfort
- Noise and vibration
- Sound quality
- Durability
- Safety
- Performance
- Power management
- Fuel economy and emissions
- Fluids
- Electromechanical systems
- Thermal management



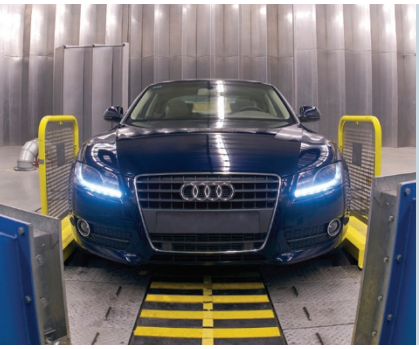


LMS Virtual.Lab platform and LMS Samtech suite for 3D performance simulation

The LMS Virtual.Lab and LMS Samtech combination is an ideal solution for functional performance simulation that offers an integrated software suite to simulate and optimize the performance of mechanical systems for structural integrity, noise and vibration, system dynamics, durability, ride and handling, dynamic motion and other attributes. LMS Virtual.Lab, empowered by LMS Samtech Samcef™ software linear and nonlinear capabilities, supports 'hybrid' engineering in which test data are used in simulation context and vice versa.

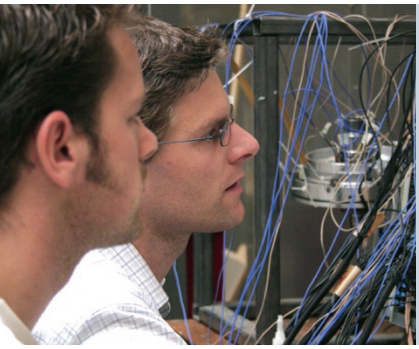
LMS Imagine.Lab platform for mechatronic system simulation

LMS Imagine.Lab is a comprehensive 1D system simulation platform to model and analyze multi-domain, intelligent systems and predict multi-disciplinary performance. Model components are described using validated analytical models that represent the system's actual hydraulic, electric or mechanical behavior. LMS Imagine.Lab frontloads mechatronic system simulation for multi-physics modeling and full system analysis.



LMS Test.Lab platform for test-based engineering

LMS Test.Lab is an integrated platform offering a comprehensive software and hardware portfolio for noise and vibration testing including solutions for acoustic, rotating machinery and structural testing, environmental testing, vibration control, reporting and data management. With its unified interface and seamless data-sharing capability between different applications, LMS Test.Lab offers users tremendous efficiency gains and ease-of-use.



LMS Engineering

LMS engineers work with customers to solve their most critical problems and often make the difference between successful product launches and costly repairs or even failures. Experienced in critical performance attributes, the team's unique balance of skills, engineering experience and process know-how turns attribute engineering into a strategic competitive advantage.

LMS Customer Services

LMS supports its customers with engineers who not only understand the hardware and software, but also master the related engineering applications. Extensive training, seminars and onsite services help our clients' technical staff gain and maintain their software and system know-how. LMS offers a broad portfolio of professional services, including full installation management, onsite training and support, and continuous knowledge transfer.

About Siemens PLM Software
Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a world-leading provider of product lifecycle management (PLM) software, systems and services with nine million licensed seats and 77,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software helps thousands of companies make great products by optimizing their lifecycle processes, from planning and development through manufacturing and support. Our HD-PLM vision is to give everyone involved in making a product the information they need, when they need it, to make the smartest decision. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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