LMS solutions for
innovative mechanical industries

LMS®
ENGINEERING INNOVATION

- → Noise & Vibration
- → Durability
- → Energy efficiency
- → Dynamic behaviour
- → System performance
- → Certification
- → Sound quality
- → Weight reduction

Industrial machinery

Heavy machinery
Machine tools
Production lines
Conveyors
Packaging machines
Paper mills

Industrial equipment

Pumps
Compressors
Gears
HVAC
Valves
Bearings
Electrical motors
Robots

LMS International | info@lmsintl.com | www.lmsintl.com

Balancing sustainability and brand value with innovative systems designs

Over the years, LMS has gained significant experience in the highly advanced automotive and aerospace industries. Today, LMS adapts and translates these cutting-edge engineering applications to the broader, cross-industry markets.

For manufacturers, business success depends more than ever on the industry's capability to bring to market high quality differentiating products within the shortest possible timeframe. Furthermore, the desired product innovation will have to consider energy efficiency and will become increasingly dependent on the introduction of controlled or mechatronic systems.

Traditional mechanical engineering processes do not support an efficient balancing of the multiple design requirements and attributes. Instead, it mandates the adoption of a new hybrid development approach, integrating system simulation and validation activities. More specifically, it requires an evolution from rapid prototyping, using physical hardware, to an engineering approach using accurate simulation models at the earliest possible time frame.

As a leader in test and mechatronic simulation, LMS International provides engineers around the world with best-in-class products and right-on-target services for all phases of the product development process from frontloading controls and trial runs of system architecture in the concept phase to final certification and validation.

Our innovative vision and expertise help our customers:

- create unique brand value
- develop energy efficient products
- ensure product reliability
- optimize mechanical systems and electronic controls
- reduce cost and time-to-market

Energy

Power generation plants
Gas & steam turbines
Wind turbines
Large combustion engines
Transformers
Oil & gas equipment

Consumer goods

Household appliances
Consumer electronics
Office equipment
Handheld tools
Personal care equipment

Other advanced industries

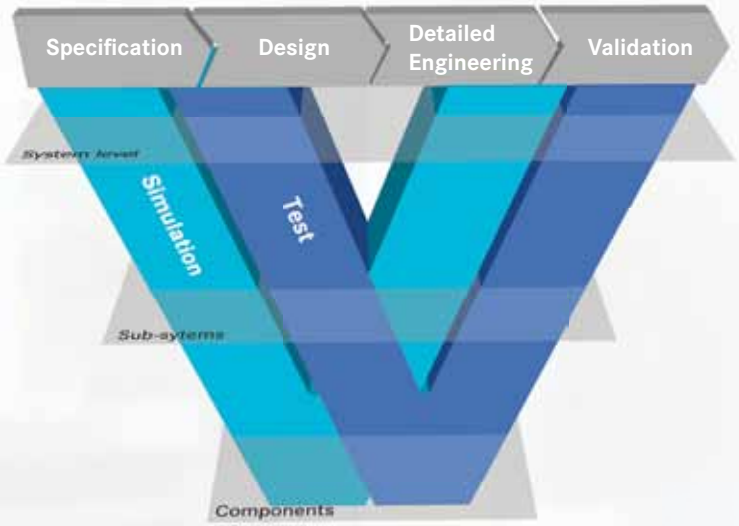
Shipbuilding
Medical equipment
Process industry
Civil construction

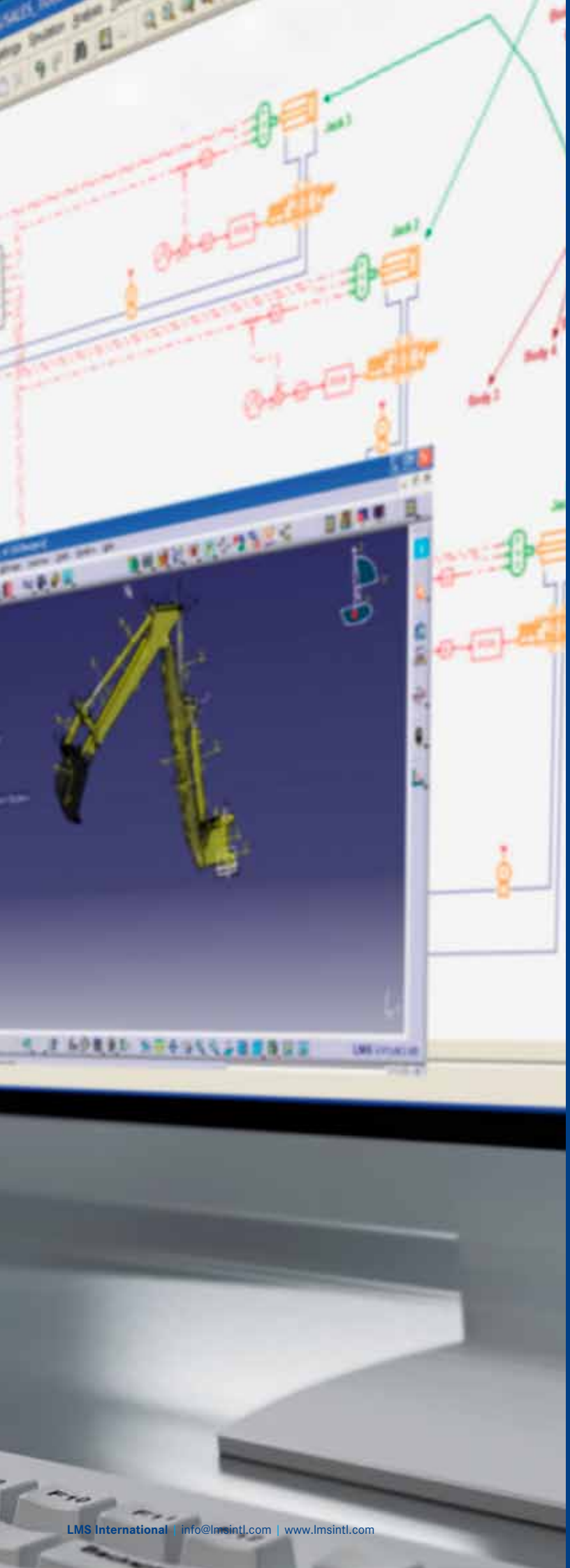
A solid test-simulation development process

Many customers adopting the **LMS hybrid engineering approach** have achieved 30% to 50% faster time-to-market cycles, when introducing new design concepts.

LMS has pioneered a unique hybrid test/analysis engineering approach that integrates simulation data with test results. As part of this process, test-based models of predecessor designs and competitive products are combined with virtual models of newly designed components and subsystems. This innovative approach enables:

- Frontloading design decisions, enabling accurate assessment of different design concepts and performance related architectural choices
- Increasing productivity and efficiency – as efficient subsystem engineering and reliable full system performance certification are achieved – thanks to test-based refinement





LMS has become the trusted partner of more than 5,000 manufacturing companies.

Industrial machinery and equipment

Agfa | Arcelor | Atlas Copco | Bechtel Plant Machinery | Blackmer | Briggs & Stratton | Cameron | Carl Mahr Holding | CKBM | Crompton Greaves | Cummins Onan | Daifuku | Dongfang Steamer Engine | DooSan Heavy Industries & Construction | Dürkopp Adler | E. I. DuPont de Nemours and Company | Eaton Corporation | ECL | Embraco | Gleason-Pfauter Maschinenfabrik | Grasso Products | Han's Laser Technology | Hasse & Wrede | Heidelberger Druckmaschinen | Hitachi | Hydac Technology | Hyundai Heavy Industries | IFP | IHI | Ingersoll-Rand Company | Kawasaki Heavy Industries | KHS Corpoplast | Kohler Company | Komatsu | Komet | Kubota | Liebherr | Makita | MAN Turbo | Metso Paper | Mitutoyo | Moog | Moventas | MTU Friedrichshafen | MWM | Nippon Steel | Panasonic | Parker Hannifin Corporation | Perkins Engines | Picanol | Schneider Electric | Sercel | SKF-ERC | Sumitomo Heavy Industries | Sumitomo Precision Products | Sun Hydraulics | The Timken Company | ThyssenKrupp Steel AG | Tokyo Electron | Trane | Trelleborg Automotive Germany GmbH | Trumpf Werkzeugmaschinen | Uhlmann Pac-Systeme | Vanderlande Industries | Voith Turbo | WESTFALIA Metallschlauchtechnik GmbH & Co. KG | Yanmar | York International | Zenon Environmental, Inc.

Energy

Alstom Power | Areva | Bharat Heavy Electricals | Bucher Hydraulics | CG Power Systems Belgium | ECN | EDF | Emerson Climate Technologies | Exelon Corporation | Gaz de France | GE Energy | GE Power System | GE Wind Energy | General Electric Hitachi Nuclear Energy | Gidropress | National Renewable Energy Laboratory | Nordex | Schlumberger | Schneider Electric | Siemens Westinghouse | Solar Turbines | The Japan Atomic Power Company | Westport Power, Inc. | Winwind

Consumer goods

Alfred Kärcher | Alpine Electronics | Arcelik | Bauknecht Hausgeräte | Bausch & Lomb | Bose Corporation | Bosch und Siemens Hausgeräte | Canon | Clarion | Daifuku | Daikin | EMC | Festool | Fuji Xerox | Fujitsu | Guang Dong Gree | Haier | Hitachi | Husqvarna | IBM | Intel | Kenwood | Konica Minolta | LG Electronics | Microsoft | Midea | Miele | Mitsubishi Electric | Motorola | Nanjing Chervon | NEC | Nikon | Nokia | Onkyo | Panasonic | Procter & Gamble | Ricoh | Samsung | Seiko Epson | Sennheiser | Siemens | Sony | Steinway & Sons | TNO Industrie en Techniek | Toray Industries | Toshiba | Whirlpool | Xerox

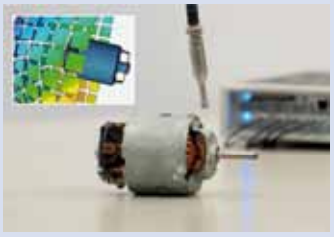
Other advanced industries

American Bureau of Shipping | Beckman Coulter | China Shipbuilding Industry Corporation | IHI Marine United | Marinbefrijf Den Helder | Mercury Marine | Olympus | Rubin | STX Engine | ThyssenKrupp Nordseewerke | Wärtsilä | Yamaha Motor

Solve your multi-attribute engineering challenges

LMS solutions cover a full range of multi-attribute engineering challenges: from noise & vibration to reliability and multi-physics system behavior. During the development process, changing one product variable can easily affect the performance of others. The aim for most engineers is to find common ground for the optimal solution. In most cases, this means comparing hundreds of different possible combinations and performing multiple trade-off studies to reach performance targets.

LMS helps finding the right way to balance all the different attributes. We tailor solutions that help optimize designs upfront in the process – ideally during the concept stage – so engineers can create the best possible product on time and within budget.



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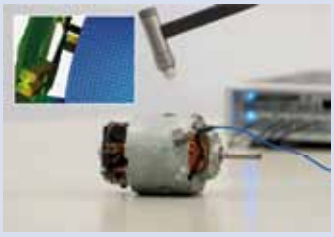
Acoustics

Meet stringent acoustic targets



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Vibration

Master product vibration

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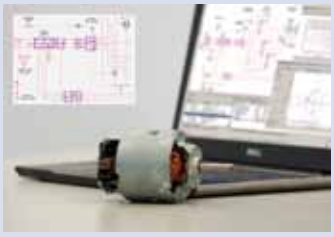
Reliability

Design for optimal durability performance



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System Performance

Optimize mechatronic system performance

A unique portfolio of test and simulation solutions to optimize product performance

In close collaboration with industry leading manufacturers, LMS has further re-enforced its position for multi-attribute engineering optimization LMS provides:

- A consolidated "**hybrid test/simulation**" development process – supporting the effective frontloading of design decisions – dramatically reducing the development timeline and cost, banking on the outstanding LMS correlation capability of prototype testing results and CAE simulation
- A market leading Noise & Vibration, acoustics and durability **testing platform**, securing fast and accurate data acquisition with an unmatched support for test preparation, result analysis and post-processing
- A state of the art **3D CAE simulation platform** enabling effective multi-attribute optimization including noise & vibration, acoustics, multi-body-dynamics and durability
- A **multi-physics 1D simulation platform** providing a wide range of validated libraries enabling scalable multi-disciplinary design optimization with the appropriate accuracy and ease-of-use, in the absence of a 3D geometry

In addition, LMS has a proven track record of successfully executing engineering projects, helping customers with:

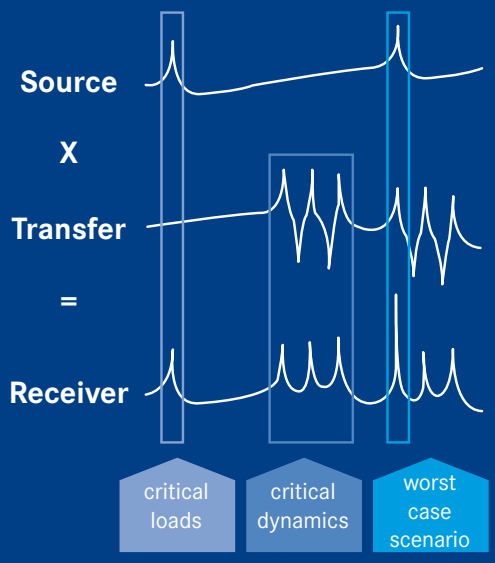
- **Consulting services**, providing manufacturers an insight of the industry best practices with respect to multi-attribute optimization processes and methodologies
- Solving design challenges as part of a **troubleshooting** task or a **full co-development project** with a specific focus on technology transfer, development process improvement and on-the-job training

Trace the real source of problems

True insight into complex product behavior

Quick fixes may seem like an easy way out when tackling engineering challenges, but changing the design to remedy a problem most likely will just cause another issue elsewhere. Engineers today no longer have time for guesswork and need solid design processes and techniques to create the best-possible next-generation products. One result-driven technique is the "**Source - Transfer Path - Receiver**" concept developed by LMS to capture noise and vibration performance in your design process. A sure route to product improvement which leads design engineers right to the root cause of any existing problem. It will help establishing a reliable and sustainable design practice for next-generation products while identifying design weaknesses of your current approach!

The "Source - Transfer Path - Receiver" approach separates the components that really cause the problem from those that actually amplify it. Any noise or vibration problem a customer experiences will be traced back and broken down into 2 phenomena: the excitation source and the design sensitivity to the excitation.
Either the source is rather strong or the structure is highly sensitive under particular operation conditions or structural resonances. The situation may be caused by both, meaning that the dynamic excitation would be amplified by one or more resonances. By using the Source - Transfer Path - Receiver approach, engineers can quantify and rank the various phenomena according to contribution to the issue at hand, and discover potential solutions immediately.



Acoustics

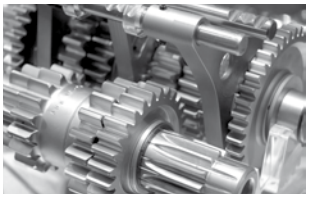
Meet stringent acoustic targets

Engineers and acoustic specialists must meet the latest noise regulations or sound quality objectives, while introducing new materials. In parallel, they need to think about reducing costs and time to market. To address this complexity, acoustic experts from both the test and simulation sides want systems and techniques that give them more fidelity and help them make the best products as efficiently as possible. To help them, LMS offers a wide portfolio of tools from basic testing according to standards to some of the market's most innovative acoustics test and simulation-based solutions for better and faster acoustics engineering.

A wide range of acoustic solutions

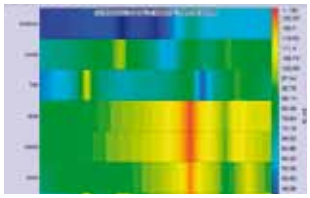
How loud is it? Does it sound right?
Acoustic analyzer

Do I meet sound power standards?
Sound power & octave testing



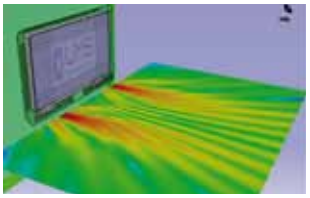
In which operating condition is the noise level critical?
Operational testing

Where is the noise coming from?
Sound source localization

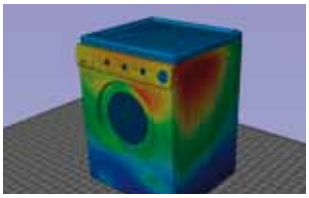


What is the root cause of the noise problem?
Transfer path analysis
Acoustic simulation

What material should I use to reduce sound levels?
Material & component testing



How to predict the sound radiated by my product?
Acoustic simulation



What will be the effect of a design modification?
Acoustic simulation

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A proven track record

GE Healthcare Systems uses LMS system extensively for modal analysis to trace the transfer path of their MRI scanners noise.
"The data acquisition and analysis capabilities of LMS Test.Lab give our engineers the insight needed to significantly lower emitted noise for an improved patient experience."
Dr. Tim Havens, Electromagnetic and Systems Engineering Manager at GE Healthcare in Florence

The **Electrolux** engineers use LMS Virtual.Lab Acoustics to analyze the acoustic behavior of products like refrigerators, dishwashers, washing machines and cookers. It saves them time and resources and creates room to explore innovative solutions, try new materials and find ways to reduce weight and material costs.
"Comparisons of test data with simulation results have proven the accuracy and reliability of the LMS Virtual.Lab Acoustics solution for a multitude of applications."
Marco Clara, Technical Leader of the acoustics and simulation group at Electrolux

Siemens simulates the acoustic performance of gas turbine combustors to improve their reliability.
"The combination of virtual simulation and adequate experimental testing allows Siemens to efficiently simulate the impact of specific design modifications on the acoustic performance of gas turbines."
Sven Bethke at Siemens

BSH Bosch und Siemens Hausgeräte GmbH counts on both LMS simulation and testing solutions for the acoustics of their superior quality dishwasher.
"Thanks to LMS, we were able to decrease the amount of acoustic absorption material in our dishwashers, increase their sound quality, and as a result, strengthen our market position and reduce costs."
Bernd Schwenk, Dipl.- Ing. (FH), Pre-development Engineer for Acoustics in Product Area Dishwasher at BSH

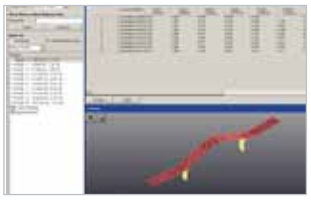
Vibration

Master product vibration

Analyzing and refining vibration issues used to be a long and complex process, involving extensive and time-consuming test setups, de-facto leading to a trial-and-error development approach. Budgets and timing however no longer allow for this. With the LMS solutions, engineers pinpoint root causes of vibration problems and apply powerful analysis tools to explore the best solution for structural weaknesses. Renowned for its modal testing experience – from impact testing of small structures to large-scale campaigns using hundreds of measurement channels – LMS solutions cover all development stages, from troubleshooting to virtual model correlation and validation.

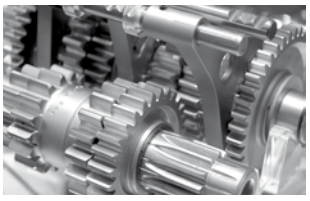
A wide range of vibration solutions

What is the vibration level?
Vibration analyzer
Vibration simulation

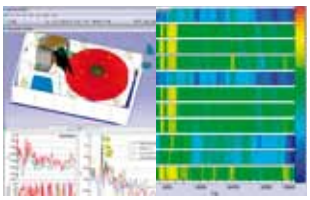


How does it move?
Geometry based animation
at critical frequency

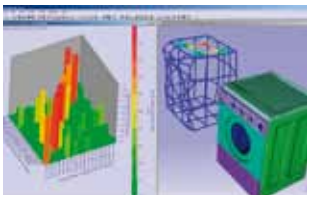
Do I meet standards?
Vibration effects
Human body vibrations



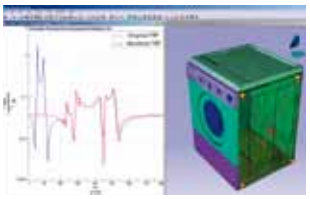
What condition is critical?
Operational testing



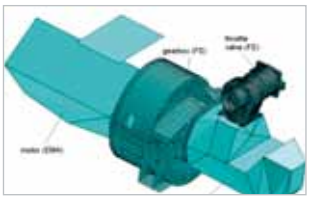
What is the root cause of my vibration problem?
Structural engineering
Transfer path analysis



How realistic is my simulation model?
Correlation between
simulation and test results



What will be the effect of a design modification?
Fast modification prediction
in test & simulation



How can I integrate my supplier model into my FE analysis?
Vibration simulation

A proven track record

Cummins, designer and manufacturer of diesel engines, increases turnaround speed by 28% in a global initiative that includes standardizing on LMS Test.Lab worldwide. The company strengthens its dominant market position by launching new products faster.
"Instead of spending weeks digging through data by hand, we got what we needed in only few hours. That's a stunning productivity gain."
Bill Bederaux-Cayne, Director of Worldwide Applied Mechanics at Cummins

Eaton Corporation selected LMS Test.Lab to optimize the NVH performance of hydraulic systems and components. It covers the full scope of their diverse testing needs, from operational noise measurements on hydraulic driveline systems up to the analysis of the modal characteristics of a hydraulic pump assembly.
"LMS Test.Lab enables us to execute any laboratory and field test assignment, and to realize significant productivity gains. In combination with our new process for low-noise design, we expect to cut down NVH development cost and time by 50%."
Mike Beyer, Engineering Specialist – NVH at Eaton Hydraulics

LMS Test.Lab allows **Heidelberger Printing Machine Company** engineers to pinpoint the root cause of vibrations and find optimal solutions at product development centers, manufacturing plants and customer sites.
"LMS Test.Lab meets our demanding requirements in quickly investigating vibration issues and modifying machine dynamics anywhere in the world."
Dr. Stefan Schreiber, Senior Manager of Mechanics and Measurement Technology at Heidelberg Printing Machine Company

System 3R relies on LMS testing systems in developing an innovative workpiece-clamping chuck that absorbs machine tool vibrations.
"Looking at animations of the clamping mechanism, System 3R came up with a new design that absorbs the machine vibrations, resulting in a machine that can run twice as fast with improved (doubled) accuracy. Having all the vibration modules we need on a single, integrated platform lets us work faster with fewer mistakes."
Dr. Amir Rashid, Manager of Research and Development at System 3R

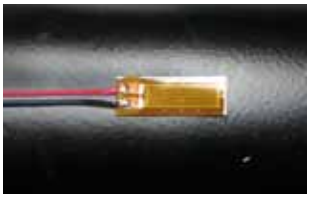
Husqvarna adopts LMS solutions for efficient noise and vibration testing. LMS Test.Lab and LMS SCADAS III help Husqvarna to further improve the comfortable handling of its outdoor equipment products.
"LMS Test.Lab helps us understand the root causes behind noise and vibration problems and supports us designing outdoor equipment with strengthened brand values."
Bruno Erdmanis, Senior Measurement Engineer at Husqvarna

Reliability

Design for optimal durability performance

Designing fail-safe products in the most efficient manner remains a challenging task. System parts with insufficient fatigue strength may cause permanent structural damage and potentially life-threatening situations. Mistakes or shortcuts can cause product recalls that will negatively influence brand image. Shorter design cycles, more design variants and new lightweight materials also add to the complexity. The LMS durability solutions are highly efficient as they correlate test and simulation results to offer the best possible engineering solution from data acquisition for realistic load data to FE fatigue life prediction.

A wide range of reliability solutions

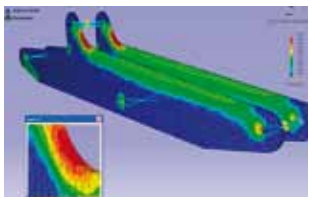


Why does it break?
Stress measurement & fatigue assessment (using strain-gauge)

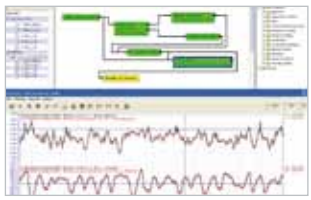
How is the product used?
Real-life loads measurements

Will my prototype survive the specifications?
Vibration control

What will be the loading conditions?
Dynamic load simulation



Will my design survive the specifications?
FE fatigue life prediction

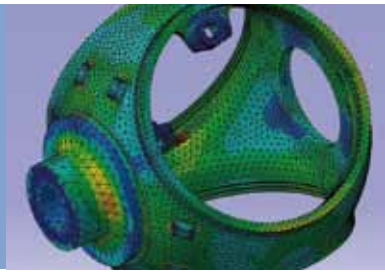


How can I accelerate design/validation?
Accelerated testing

A proven track record

Schaeffler optimizes roller bearing designs with LMS durability solutions.
"Using LMS TecWare, we can duplicate years of key fatigue cycles typically in just a few days of testing. Because operating loads are precisely identified by the system, our engineers can better develop parts with adequate fatigue life without being over-designed, allowing us to minimize product size, weight and cost."
Rüdinger Dupke, Durability and Load Data Analysis Group Manager at Schaeffler

TÜV SÜD uses LMS Virtual.Lab Durability software to identify fatigue hotspots and assess their effect on component reliability of wind turbine designs. The LMS Virtual.Lab Durability template and scripting features using Visual Basic for Applications (VBA) enable TÜV SÜD to capture the best practices and to automate repetitive tasks in the fatigue life prediction process.
"The easy to use and state-of-the-art LMS Virtual.Lab Durability technology enables TÜV SÜD to evaluate more wind turbines faster and in far greater detail than is otherwise possible through physical testing."
Albert Limmer, Dipl. Ing. at TÜV SÜD



Moventas, supplier of gearboxes for wind turbine, power generation and pulp&paper industry, counts on LMS products and engineering services to meet challenges linked to the growing demand.
"With its mobility, test set-up, on-line monitoring, visualization and report-generation capabilities – LMS Test.Lab boosts our test productivity immensely. Now we can complete routine tests in a few days instead of weeks. LMS Engineering Services' industry-wide expertise in performing this work and fast response made us look good in the eyes of our customers and made a lasting impression that has immeasurable business value for us."
Jari Toikkanen, Manager of Research and Test Group at Moventas

Hidromek, a Turkish construction equipment manufacturer, uses LMS Durability solutions for its backhoe loaders and excavators.
"It was better for our design vision and helps us to understand the real loads capability. In the end, this translates to improved equipment performance, better ergonomics and longer lifecycles."
Ferhan Ficici, R&D Director at Hidromek

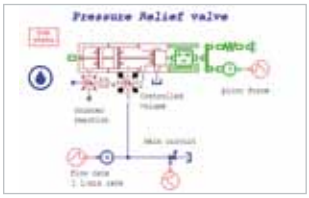
CETENA Ship Research Center uses LMS Test.Lab for a variety of maritime equipment testing. Qualification tests validate that shipboard equipment will maintain normal operation while subjected to shock and vibration.
"We need the precise control and data acquisition speed of the LMS solution to accurately control the test profiles so they deliver precisely the right frequency and amplitude profile."
Stefano Qualich, Senior Test Engineer Sea Trials Department at CETENA

System performance

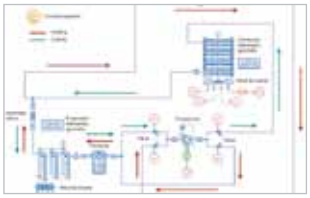
Optimize mechatronic system performance

Today's product innovation is increasingly dependent on the introduction of controlled or mechatronic systems. This implies a fast expansion of Electronic Control Units (ECU) and their flawless integration with the underlying mechanical subsystems. Rather than working on each area separately, all the mechanical, electronic and software need to be simultaneously optimized into a single, integrated mechatronics system.
By focusing on purely function-driven design, engineers can analyze intelligent system functionality right from the start. Optimizing the mechanical, hydraulic, pneumatic, thermal and electric/electronic system interaction takes place way before any testing phase. This enables to pro-actively engineer strategically critical design functionality for best overall product performance and quality.

A wide range of system performance solutions

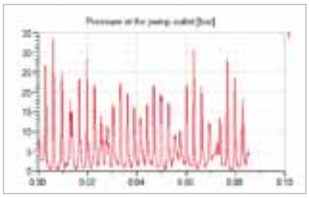


How to fit to the system performance requirements?
Sizing and dynamic performance



How to reduce energy consumption?
Energy flows analysis
Thermal exchanges

How to integrate more and more electronics?
Plant modeling
Controls strategies evaluation



How to ensure systems durability and reduce noise?
Stability analysis

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A proven track record

Kawasaki Precision Machinery uses LMS Imagine.Lab AMESim to shorten development time of its hydraulic pumps.
"Anyone who sees the multi-domain model understands immediately what is represented and how all the different parts relate to one another. Engineers can identify potential problems, compare various alternatives and optimize designs up front."
Isamu Yoshimura, Assistant manager Components Engineering Department at KPM

Schneider Electric computes multi-physics modelling and system analysis of electrical distribution network devices (thermal relays and differential relays) with LMS Imagine.Lab AMESim.
"LMS Imagine.Lab offer a wide environment that allows designers to share their viewpoints, model and simulate devices on the whole, and find solutions quicker."
François CAZALS, System and Mechatronic expert designer at Schneider Electric

IIT, the Italian Institute of Technology opted for the LMS Imagine.Lab AMESim software to effectively simulate their robot's hydraulic actuation.
"LMS Imagine.Lab AMESim was instrumental to design and assess the performance of the hydraulic system, thanks to its comprehensive libraries. Concretely, we were able to reduce the development cycle significantly."
Emanuele Guglielmino at IIT

Wärstilä, leading manufacturer of diesel engines for the marine and the energy markets, creates unified physics-based model that showed the interrelated behavior of hydraulic, mechanical and electrical signals of the entire system with LMS Imagine.Lab AMESim.
"This unified multi-domain approach is not only more convenient and easier but much faster - days instead of months - and more accurate."
Dr. Frank Wrona, Team Leader for Fuel Injection and Hydraulics Analysis at Wärtsilä

KYB, leading Japanese hydraulics company improves its hydraulic simulation model development cycle with LMS solutions
"LMS Imagine.Lab AMESim helps us to reduce our design cycle by two months."
Mr.Kazuhide Maehata, Hydraulic Components Operations General Manager at KYB

An unrivalled suite of test-based engineering solutions

LMS Test.Lab, LMS Test.Xpress and LMS SCADAS

Testing experts count on the productivity and efficiency of the comprehensive LMS tool set for integrated noise, vibration and durability engineering. LMS provides solutions for full system and component applications, including:

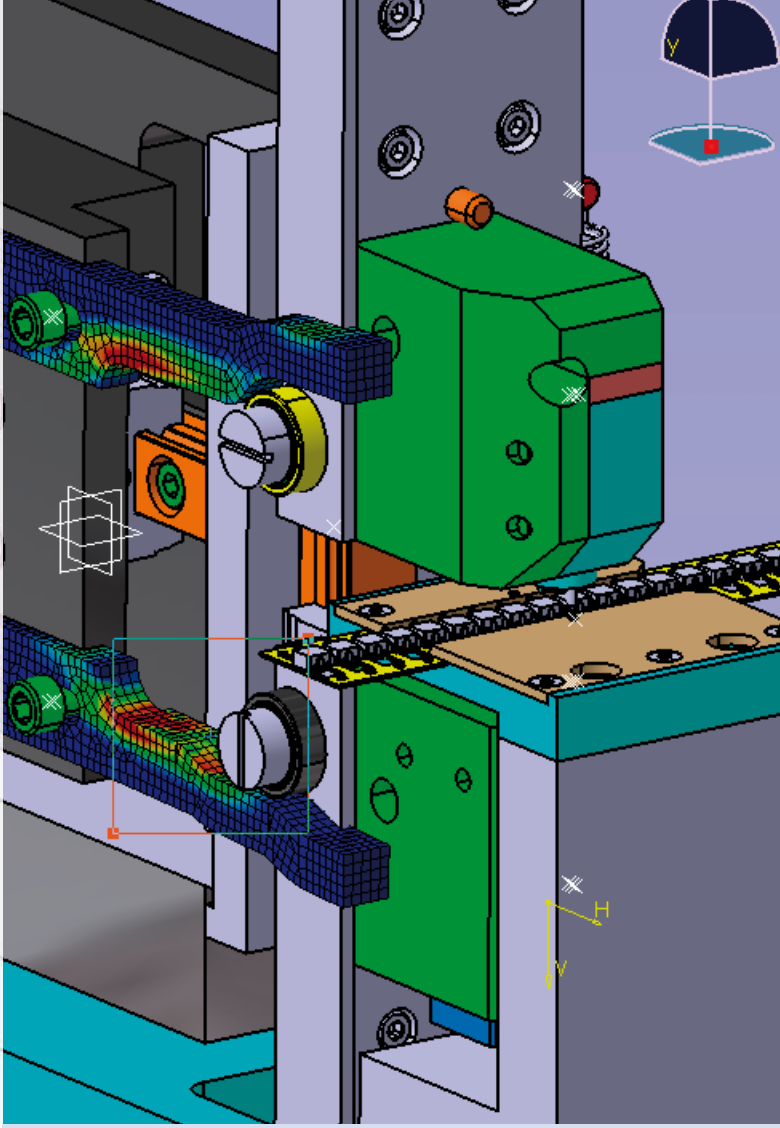
- Structural testing and modal analysis
- Acoustic testing
- Rotating machinery testing
- Field testing and certification
- Vibration control
- Durability testing and analysis

Based on its 30 years of experience, **LMS Test.Lab** offers a complete integrated solution for test-based engineering, combining high-speed multi-channel data acquisition with a full suite of integrated testing, analysis and report-generation tools. The solution guides engineers directly to the source of problems using LMS' unique "Source - Transfer Path - Receiver" methodology. LMS helps engineers increase test productivity while maintaining the utmost quality and ultimately achieving a higher return on investment from existing test facilities.

LMS Test.Xpress, a no-compromise analyzer, combines operational simplicity with the high-speed quality performance of an advanced measurement system.

LMS testing solutions are seamlessly integrated with the **LMS SCADAS** data acquisition hardware. The hardware of the LMS SCADAS family, ranging from compact mobile units, autonomous smart recorders up to high channel count laboratory systems, is developed on a common and interchangeable platform, delivering high-fidelity and lightening-speed performance for simple test runs to advanced engineering applications. Guaranteed data quality and built-in set-up controls make test re-runs a thing of the past.

The integrated 3D solution platform for functional performance simulation

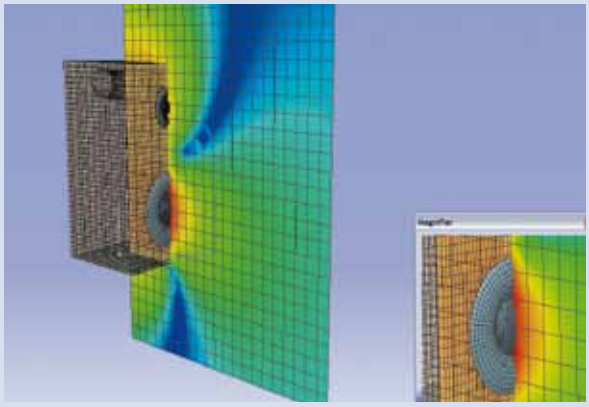


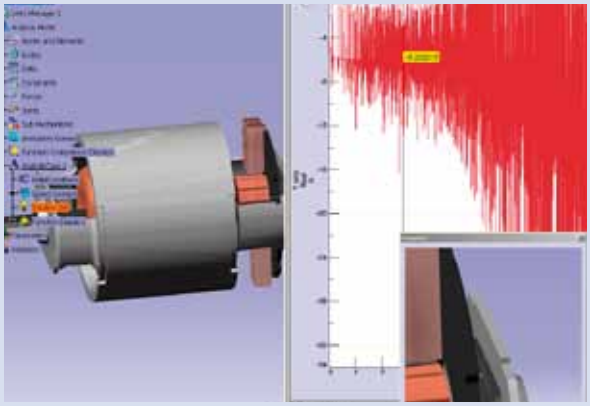
LMS Virtual.Lab

LMS Virtual.Lab offers an integrated 3D CAE simulation software suite to simulate and optimize the performance of mechanical systems for structural integrity, noise and vibration, system dynamics and durability. LMS Virtual.Lab covers all the process steps and required technologies to perform an end-to-end design assessment for multiple attributes. Next to general purpose structural analysis – supporting multiple industry standard FE solvers – and CAD integrated model assembly, LMS provides a range of dedicated simulation tools for :

- **Acoustics**: LMS Virtual.Lab Acoustics offers an integrated solution to minimize radiated noise or optimize the sound quality.
- **Noise & vibration**: LMS Virtual.Lab Noise and Vibration is developed to efficiently analyze, refine and optimize the vibro-acoustic behavior of a design.
- **Multi-body dynamics**: LMS Virtual.Lab Motion offers a highly efficient, completely integrated solution to build multi-body models that simulate the full-motion behavior of complex mechanical system designs.
- **Durability**: LMS Virtual.Lab Durability allows engineers to design reliable products right from the start.
- **Correlation**: LMS Virtual.Lab Correlation allows users to combine test-based and virtual component models into system-level models for more productive simulation.

Using LMS Virtual.Lab, engineering teams can build accurate simulation models, simulate their real-life performance, quickly assess multiple design alternatives and optimize designs before prototype construction.
LMS Virtual.Lab smoothly handles system synthesis and refinement, banking on best-of-class solver technology and superior process integration.





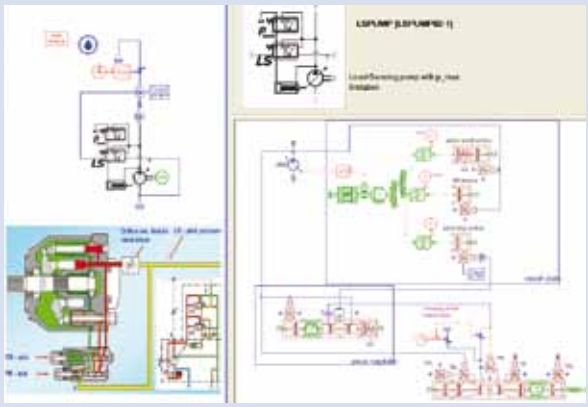
The innovative approach for mechatronic system development

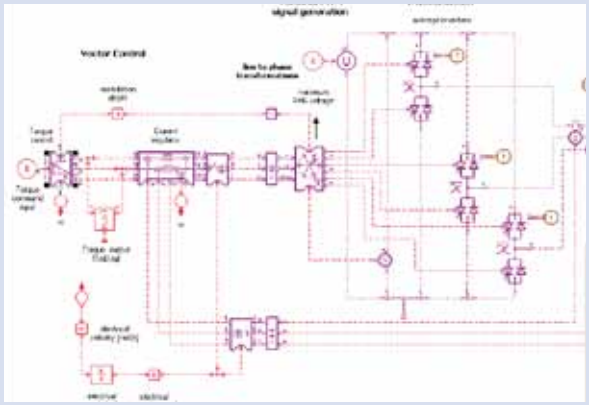
LMS Imagine.Lab

LMS Imagine.Lab is an open software platform to support mechatronic system development. The 1D system simulation platform (AMESim) models and analyzes multi-physics, intelligent systems and predicts multi-disciplinary performance. Thanks to extensive pre-defined components from validated libraries, the software can accurately simulate the actual hydraulic, pneumatic, electric or mechanical behavior of controls. These simulation models are scalable in complexity from simple map-based models to full detailed physics models. They are tuned to fast and efficient calculation, capable of addressing the transient usage scenarios.

Geared towards mechatronic system simulation, the LMS Imagine.Lab platform offers an open approach starting from functional requirements to physical modeling and simulation. The platform consists of three modules:

- **LMS Imagine.Lab AMESim**
  Create and run multi-physics simulation models to analyze complex system behavior and support the design of controlled system from early specification to subsystem testing. It helps engineers to design complete fluids hydraulic and pneumatic systems, to define straightforward strategies throughout the design process of electrical or electromechanical systems, and much more.
- **LMS Imagine.Lab SysDM**
  Store and organize system mechanical and controls models and data across the organization
- **LMS Imagine.Lab System Synthesis**
  Synthesize ever more complex systems and create product architectures based on performance requirements





Development partner of choice

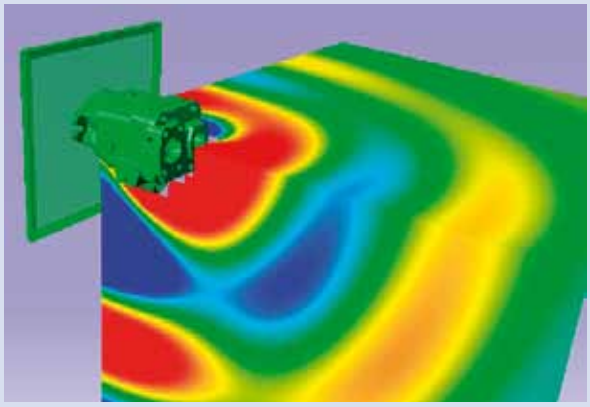
LMS Engineering Services and LMS Customer Services

Based on its multi-disciplinary and multi-attribute expertise, the worldwide LMS services team is uniquely positioned to drive innovation in a wide variety of industries.

The LMS consulting team offers a unique combination of engineering skills, development experience, and **application know-how** to support your product development programs:

- **Troubleshooting** interventions to solve critical engineering problems
- Supporting your development group **from concept to final validation**
- Openly **sharing know-how** and best practices with your team

LMS co-operates side by side (or takes full responsibility) for the detailed design analysis and optimization. LMS relies on its application experience and its leading technologies across multiple domains including prototype testing and CAE simulations. These competences allow a significant shift from late stage prototype optimization to a frontloaded, simulation-based approach.



Additionally to the proven development process, the LMS approach offers significant benefits over any other engineering company as it secures the deployment of the software tools and models to be used in future projects. LMS maintains the software delivered, providing continuous support and release updates for the duration of the project. LMS has a culture of open technology sharing including models, data and milestone-reports. Furthermore, LMS organizes regular on-site technology exchanges. This process of cooperation not only guarantees achieving the project targets, but it also deploys a simulation-based methodology with full technology transfer.

Most important, LMS firmly believes in “on-the-job” engagements, securing an intimate customer relationship, key for the success of the program. **Extensive training, seminars, and on-site services** help our clients’ technical staff gain and maintain their software and system know-how.

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LMS has become a trusted partner of the world's leading automotive manufacturers and their suppliers, leading aerospace companies, major energy producers and innovative manufacturers of other high tech equipment. LMS offers a unique combination of best-in-class mechatronic simulation and testing solutions, and engineering services. We help to get better products faster to the market and turn superior process efficiency into key competitive advantages. Through 30 years of engineering innovation and worldwide expansion, we are servicing more than 100.000 R&D engineers in more than 5.000 manufacturing companies. LMS partners with all of the Fortune 500 top auto and aero manufacturers.

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