LMS Virtual.Lab
Realistic Simulation in CATIA V5

Why CAE?
Design-Right/First-Time

2

LMS Engineering
Engineering Consulting and Test Services

LMS
Research
Development
Sales
Corporate

1

LMS Test
Test.Lab Software

3

LMS CAE
Virtual.Lab
Virtual.Lab Designer

Why CAE?
Design-Right/First-Time

LMS ®
ENGINEERING INNOVATION

LMS – Company Background
Research, Development, and Engineering Locations

- ● **LMS Research & Development Centers**
  Belgium, Germany (2), Netherlands, US, Romania
- ● **LMS Engineering**
  Leuven/Belgium, Kaiserlautern/Germany, Italy, US, Japan, China

Why CAE?
Design-Right/First-Time

LMS
ENGINEERING INNOVATION
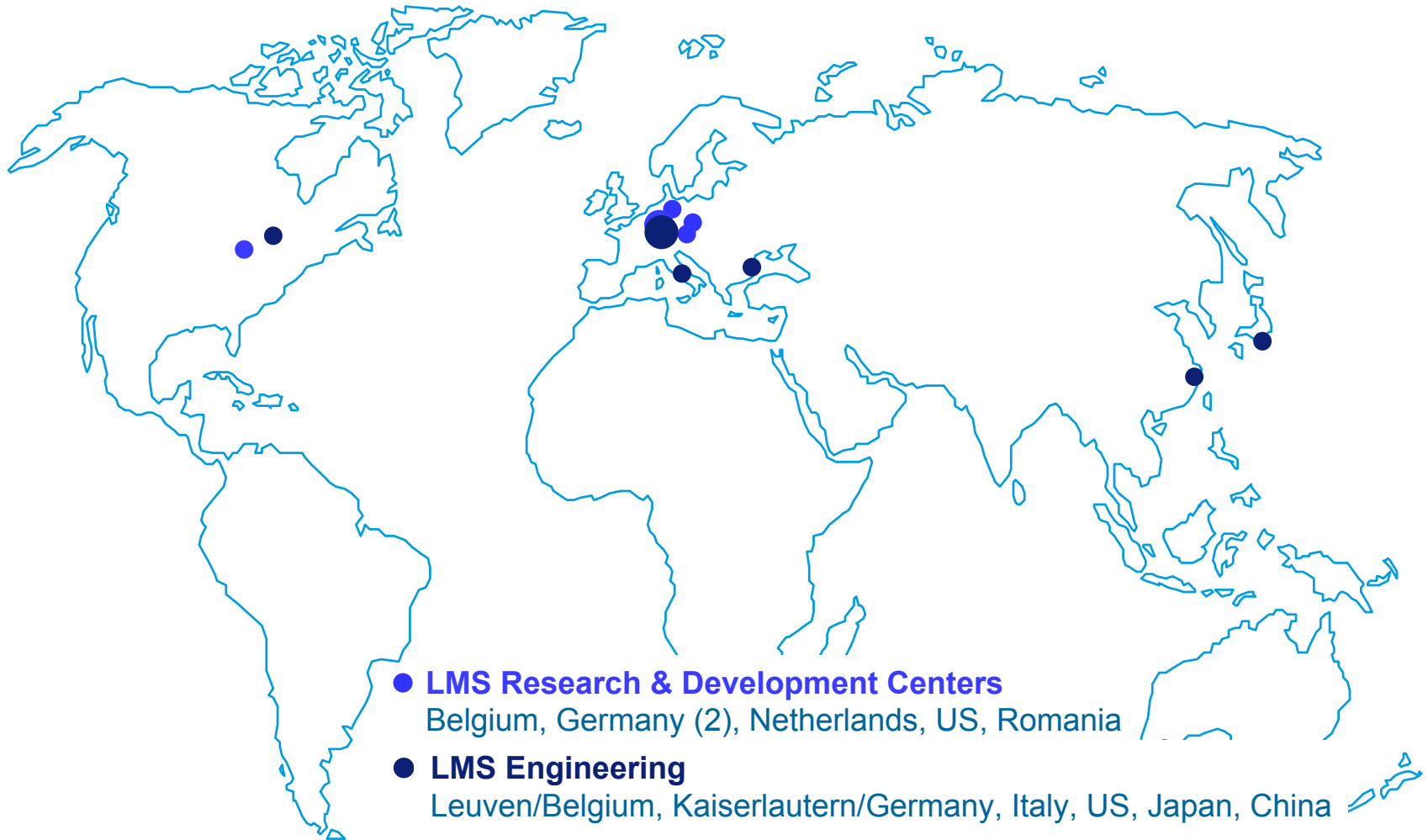
LMS – Company Background
Sales and Representative Offices

LMS HQ -
Leuven - BELGIUM

LMS UK

LMS Deutschland

LMS Russia

LMS NA - Detroit

LMS France -
Paris

LMS China -
Beijing

LMS Korea

LMS NA -
Washington D.C.

LMS NA -
Los Angeles

LMS France - Lyon

LMS Italia

LMS China -
Shanghai

LMS Japan

LMS Singapore

☒ **LMS Offices**

● **LMS Representative Offices – 25**

LMS
ENGINEERING INNOVATION
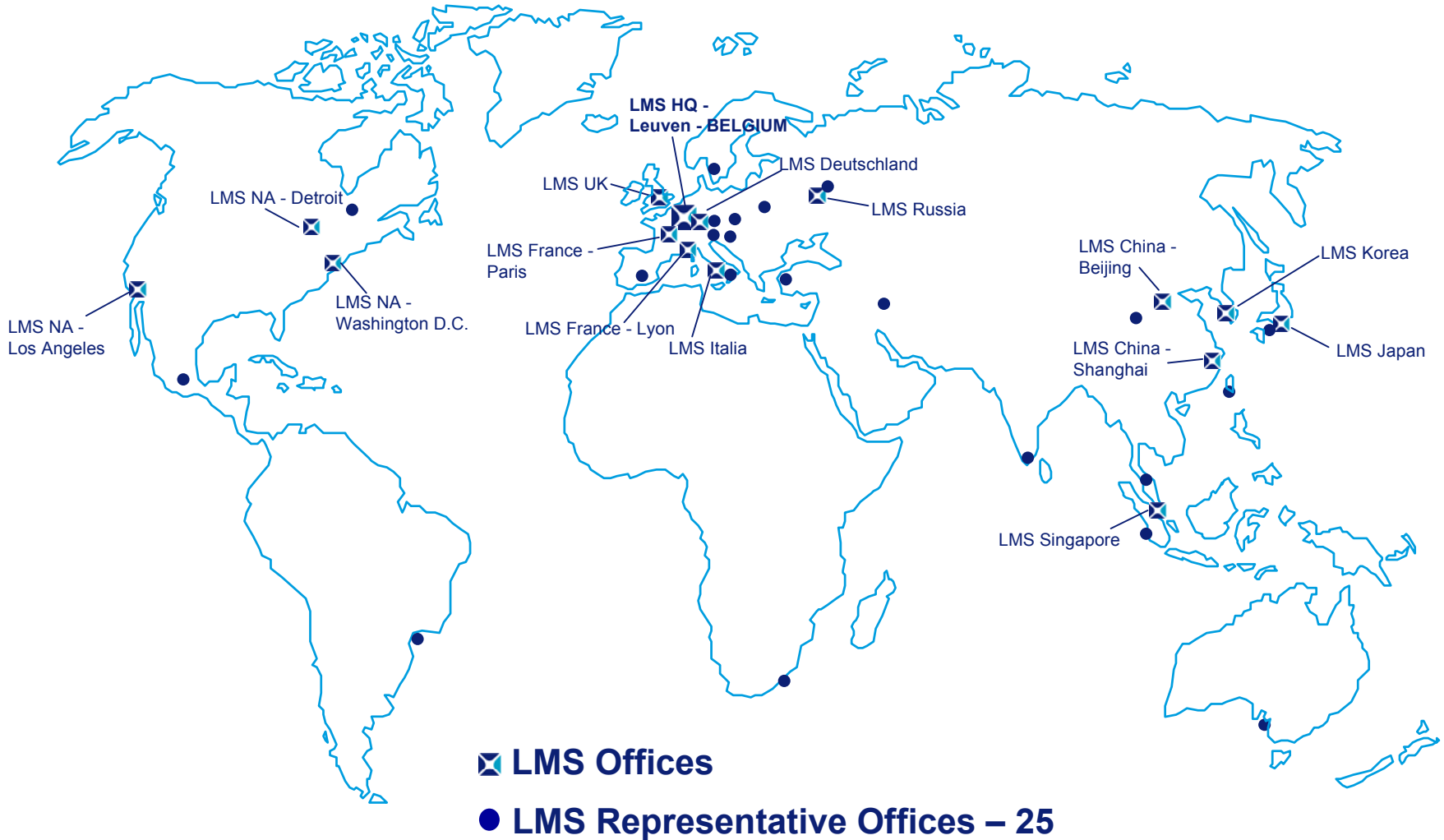
LMS – Test Business Area
Test.Lab Software for Automated Data Acquisition and Analysis

Measurements and Analyses
Innovation for New Insights
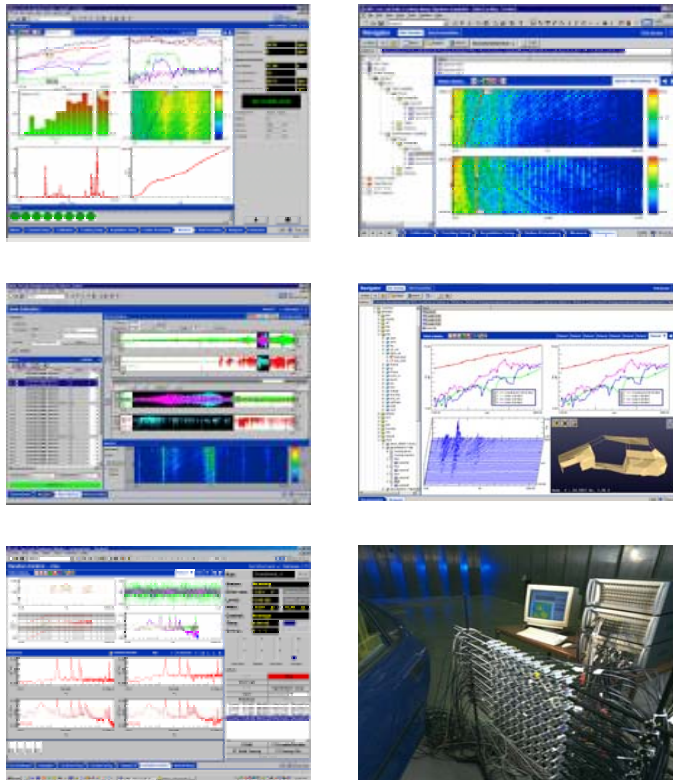
Complete Application Coverage

Structural Analysis

NVH

Acoustics

Durability

Environmental

Test Tracks

- Order Tracking
- Signature Acquisition
- Psycho-Akustik
- Real Time Oktaves
- Spektrum-Analyse
- Modale Analyse
- Operating Deflection Shapes
- Vibration Control
- Data Reduction
- Reporting
- Documentation
- Data Management

Why CAE?
Design-Right/First-Time

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ENGINEERING INNOVATION

LMS – Engineering Services Business Area
Consulting and Test Services

Full Service Provider....

- Development
- Process Re-Engineering
- Technology Transfer
- Problem Solutions – "Pain Relief"

... in Key Performance Attributes

- Noise and Vibration
- Reliability and Durability
- Driving Dynamics and Comfort
- Safety and Crash

... International und Multidisciplinary Teams

- International Competence Centers
- Hybrid CAE/Test Competences
- Multi-Physic Know-How

... Top-Class Simulation and Test Laboratories

- Performance CAE Infrastructure
- Various Test Platforms and Chambers
- Direct Access to Test Track Facilities

Why CAE?
Design-Right/First-Time

LMS – Computer-Aided Engineering (CAE) Business Area
## Virtual.Lab Suite of Simulation Software

CAE Specialists →

LMS Virtual.Lab

- Advanced simulation functionality for CAE specialists and analysts
- Stand-alone environment but based on CATIA V5 architecture
- Maintains geometric associativity only with CATIA V5

Development Engineers →
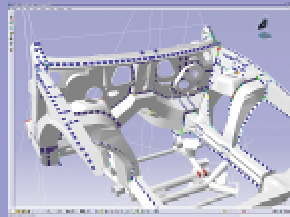
LMS Virtual.Lab Designer

- Entry-level simulation environment for development engineers
- CATIA V5 Add-On (only available with CATIA V5)
- Completes and complements the functionality in CATIA CAE
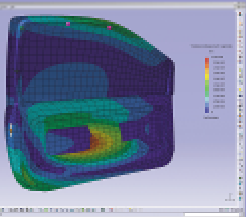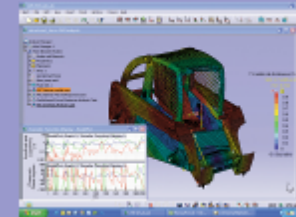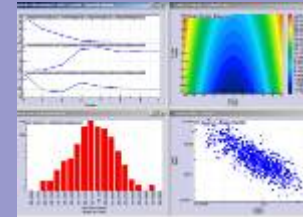
| Structures | Motion | Component Fatigue System Fatigue | Acoustics Noise & Vibrations | Hybrid CAE+Test | Optimization |
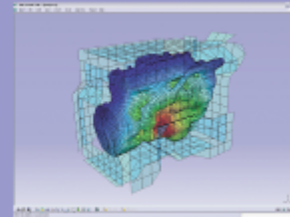
DASSAULT SYSTEMES GOLD SOFTWARE PARTNER
CAA V5 BASED
LMS ENGINEERING INNOVATION

LMS Vision: "Design-Right/First-Time"
Current Challenges in Engineering Development

Development Challenges

- **Design Optimization**
  - Performance, Cost, Weight, Manufacturability, Reliability
  - Contradictory but related performance requirements
    ..."low cost <u>and</u> quiet" or "light <u>and</u> powerful"

- **Fast Development Cycles and Time-to-Market**

- **More Design Variants with Less Platforms**

  Modular concept with same underpinnings but functional differences

- **Increase Design Productivity and Return on Investment**
  - Less sample builds and testing
  - Better utilization of development resources
  - Access to and intensive use of existing data, models, experiences, and know-how

- **Better Coordination Between Suppliers and Customers**

LMS Virtual.Lab and Virtual.Lab Designer
Simulation Tools for Development Engineers *and* CAE Specialists

V5 Environment

Extended CAE Functionality

LMS Virtual.Lab Designer

CATIA V5
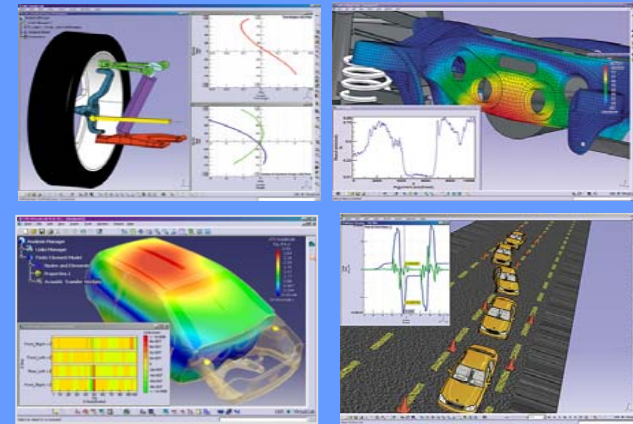
LMS Virtual.Lab

- Complete palette of extended CAE functionality in CATIA V5
- Intended for design and development engineers
- "Add-On" version only available in CATIA V5

- Stand-Alone but based on CATIA V5
- Maintains full geometric associativity with CAD when used with CATIA V5
- For CAE specialists and analysts

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LMS Virtual.Lab Products
Structures, Motion, Durability, Noise & Vibration, Acoustics, Optimization

▸ **LMS Virtual.Lab Structures**
Extended FE Pre-/Post-Processing of CATIA CAE and 3rd-Party
Solver-Driving: NASTRAN, ANSYS, and ABAQUS (2006)

▸ **LMS Virtual.Lab Motion**
Rigid-Body Dynamics and Dynamic Deformation/Stress via
automated Flexible Bodies and CATIA CAE

▸ **LMS Virtual.Lab Durability**
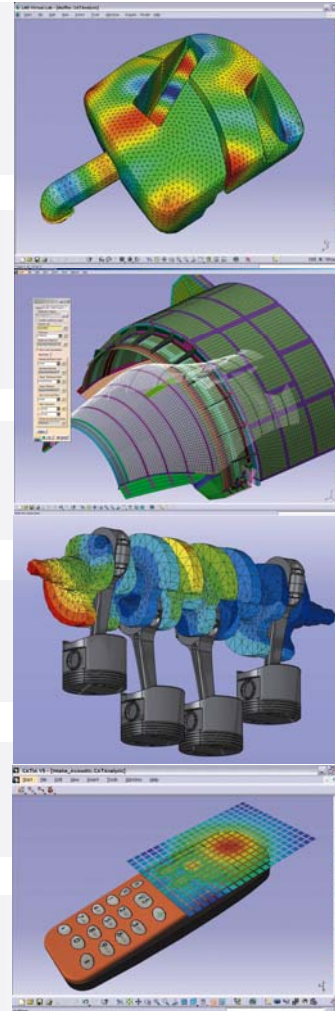Fatigue and Durability of Components and Systems

▸ **LMS Virtual.Lab Noise & Vibration**
Frequency-Domain Based Noise and Vibration Analysis

▸ **LMS Virtual.Lab Acoustics**
External Far-Field and Internal Volume Acoustics

▸ **LMS Virtual.Lab Optimization**
Parameter Optimization

LMS Virtual.Lab Structures

General pre-/post-processing environment and 3rd-party finite-element solver driving, fully integrated in CATIA V5

- Finite-element mesh checking and editing
- Creation of non-geometric-based nodes and elements
- Seamless driving of "third-party" solvers: NASTRAN, ANSYS, and ABAQUS (2006)
- Post-processing of analysis results
- Complements and completes the already existing structural response functionality in CATIA V5 (GPS, GAS, FMS)
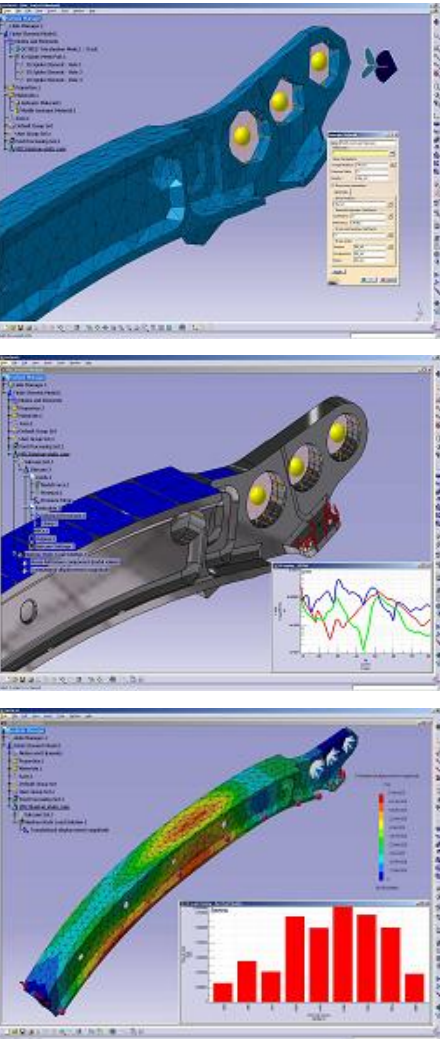
LMS Virtual.Lab
Structures
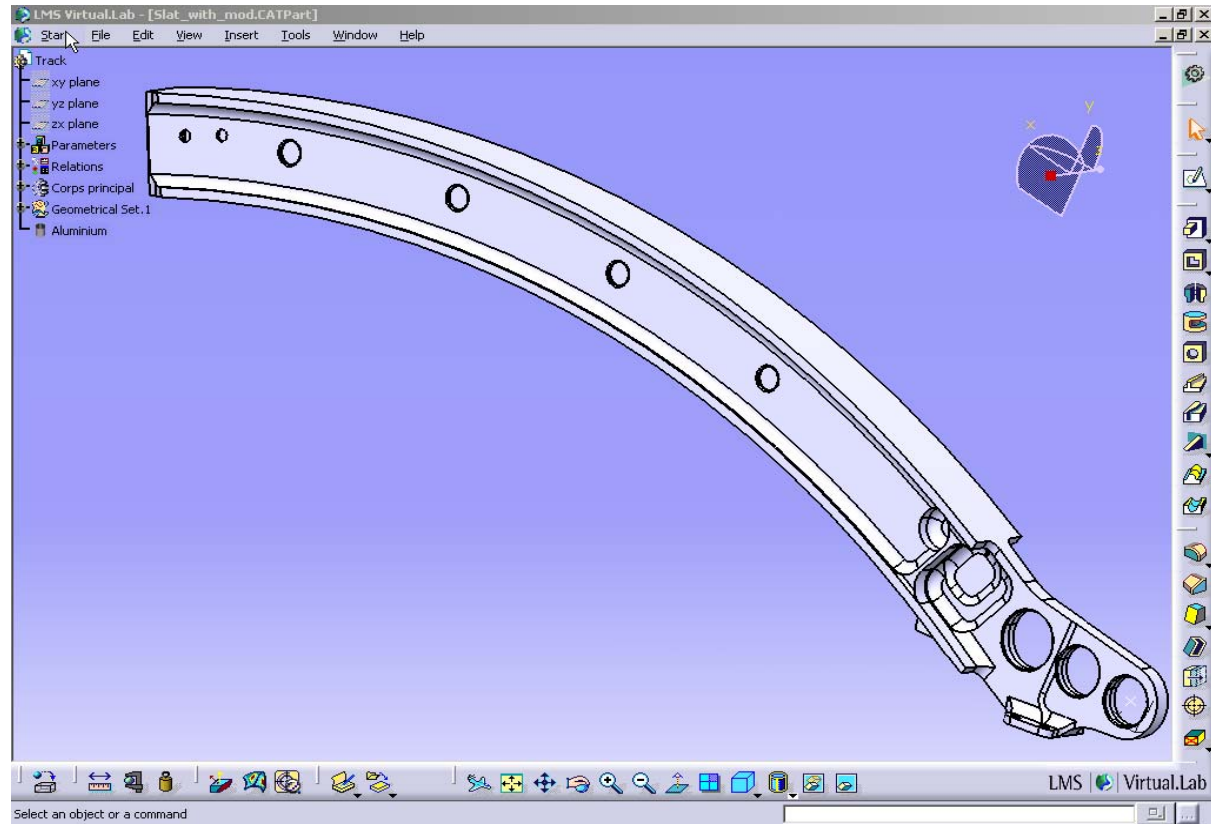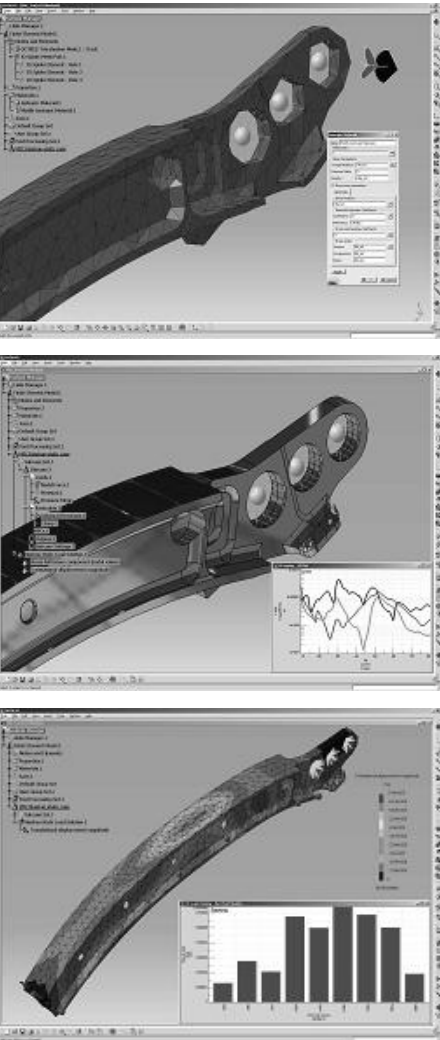
- ▸ NASTRAN solver driving in CATIA V5
- ▸ Non-geometric-based nodes/elements (Mesh Based Design)
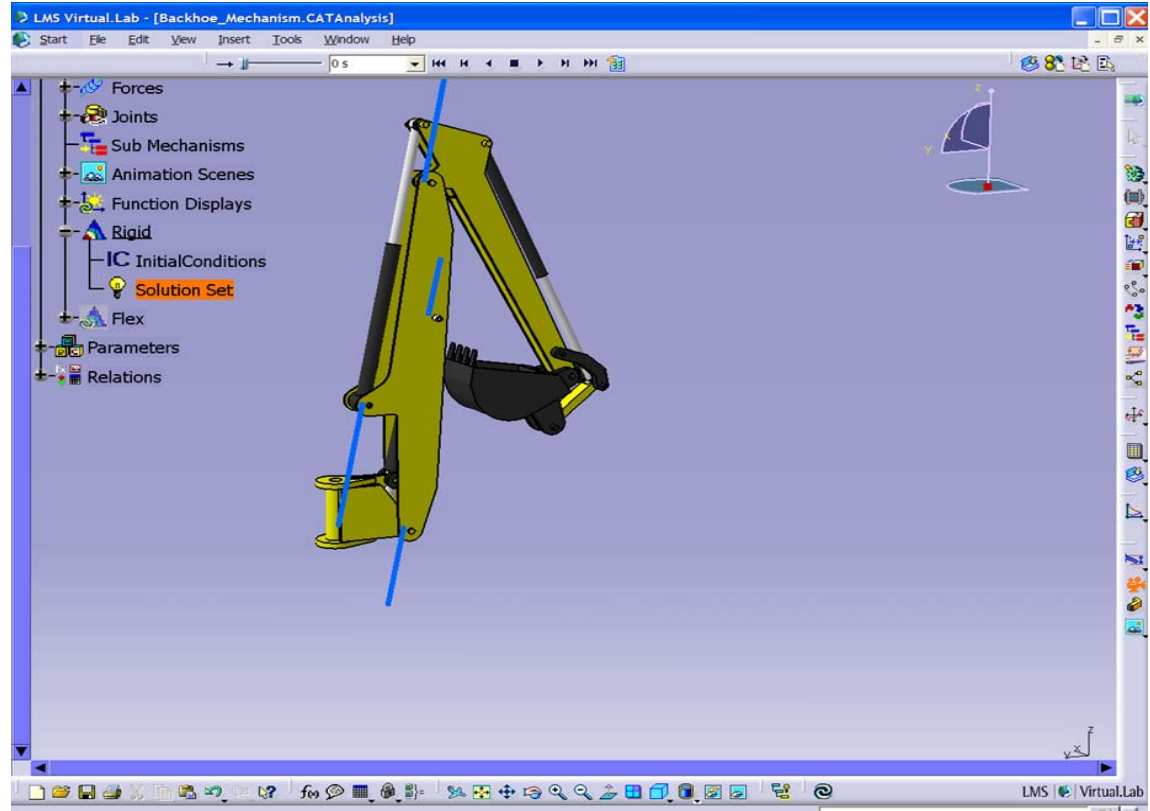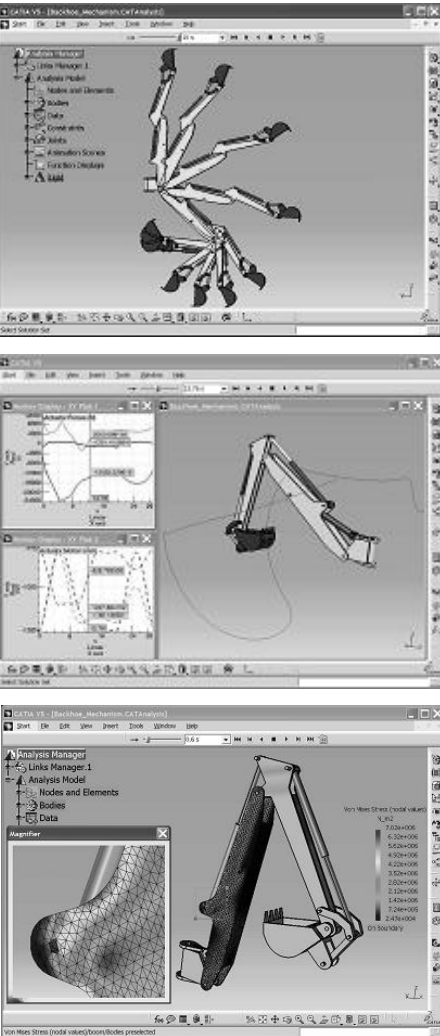- ▸ Seamless integration between CAD and CAE environments

LMS Virtual.Lab Motion

Rigid-body dynamics and flexible bodies, fully integrated in CATIA V5

- Extends CATIA Kinematics with system dynamics Forces and Moments

- Simulation of complex motions and accurate calculation of often difficult-to-measure forces and moments

- Dynamic displacement and stress within components during motion through automated "flexible bodies" option

- Automatic calculation of forces and moments for design purposes or subsequent fatigue and acoustic analyses
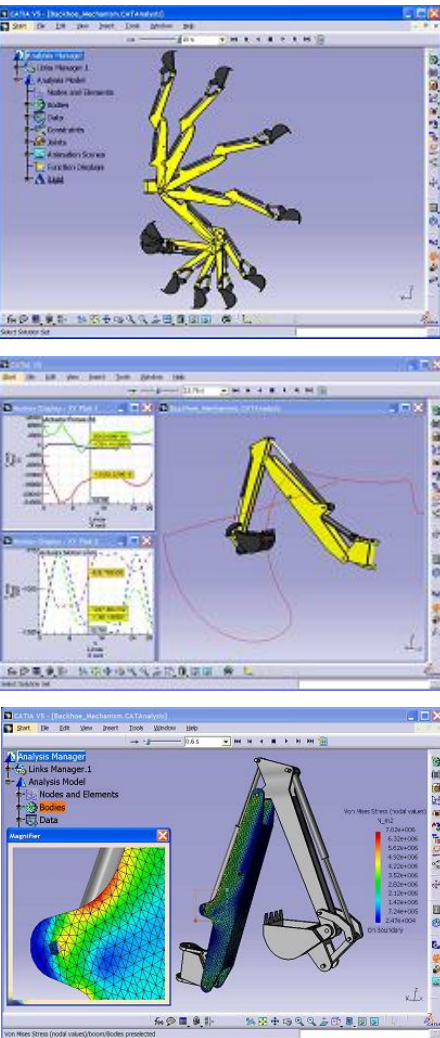
▸ Rigid-body system dynamics

▸ Flexible bodies with dynamic stress via GPS + ELFINI

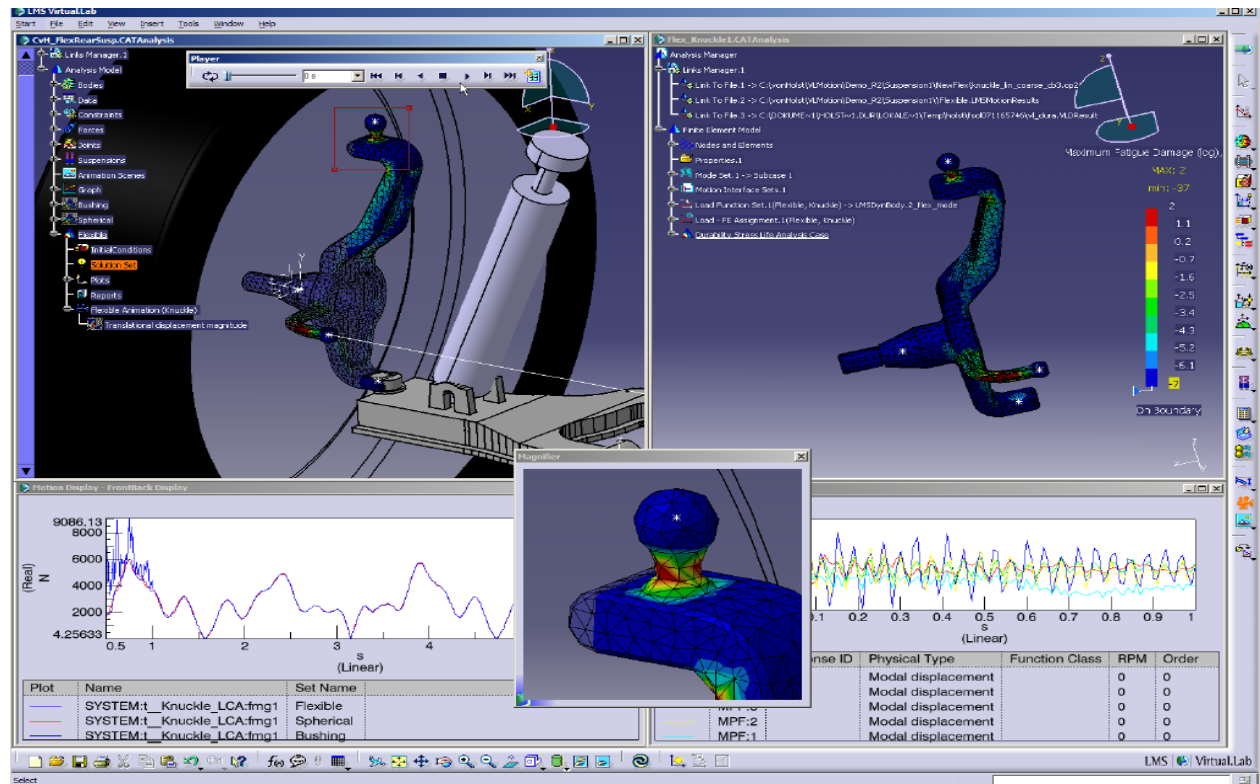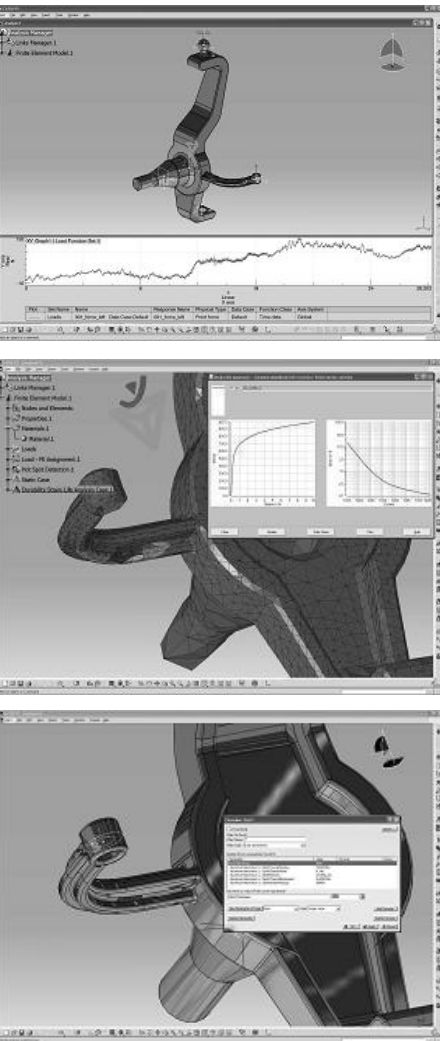▸ Seamless integration between CAD and CAE environments

LMS Virtual.Lab Durability

Component strength and fatigue analyses under varying load conditions and for different materials, fully integrated in CATIA V5

- Automatic input and editing of force and moment load data
  - → Calculation via Virtual.Lab Motion
  - → Raw test data
- Seamless integration with finite-element meshes generated by CATIA CAE (GPS, GAS, FMS, …)
- Accurately predicts strength and fatigue performance before expensive prototype builds and lengthy test cycles
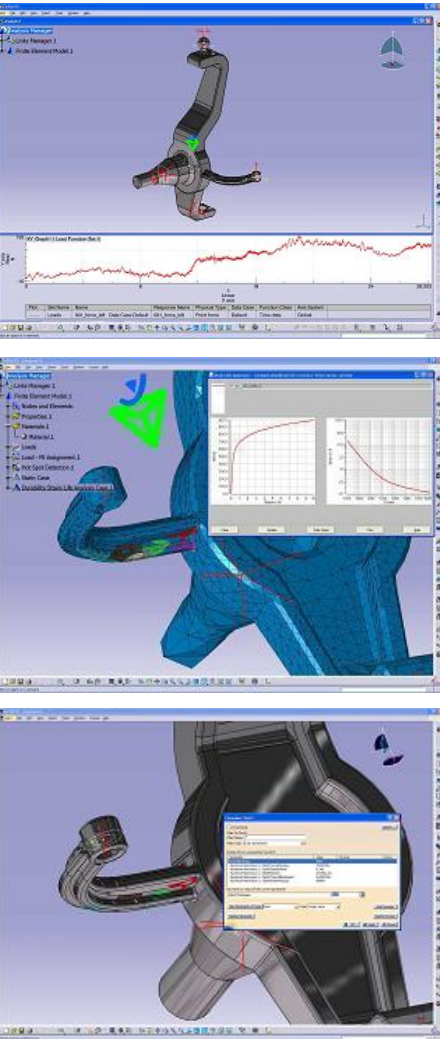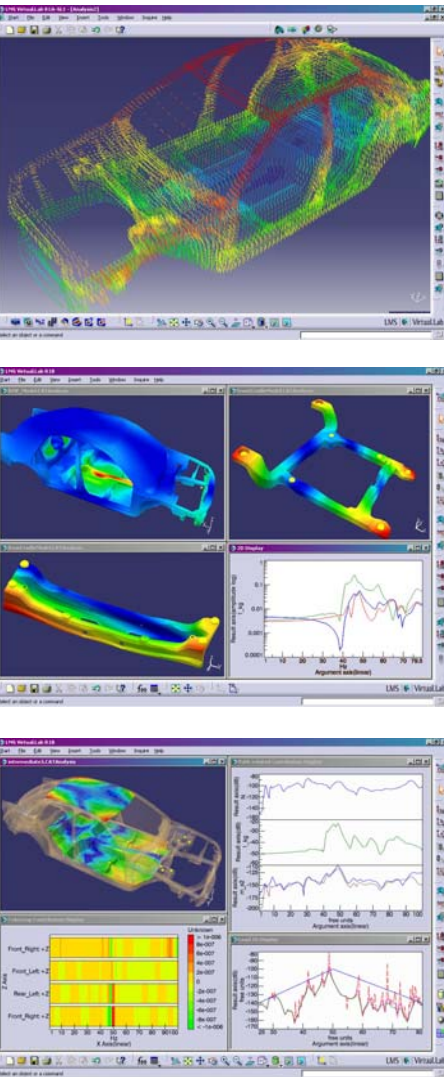
LMS Virtual.Lab
Durability

- ▶ Automatic access to data from Virtual.Lab Motion
- ▶ Use of mesh produced by GPS
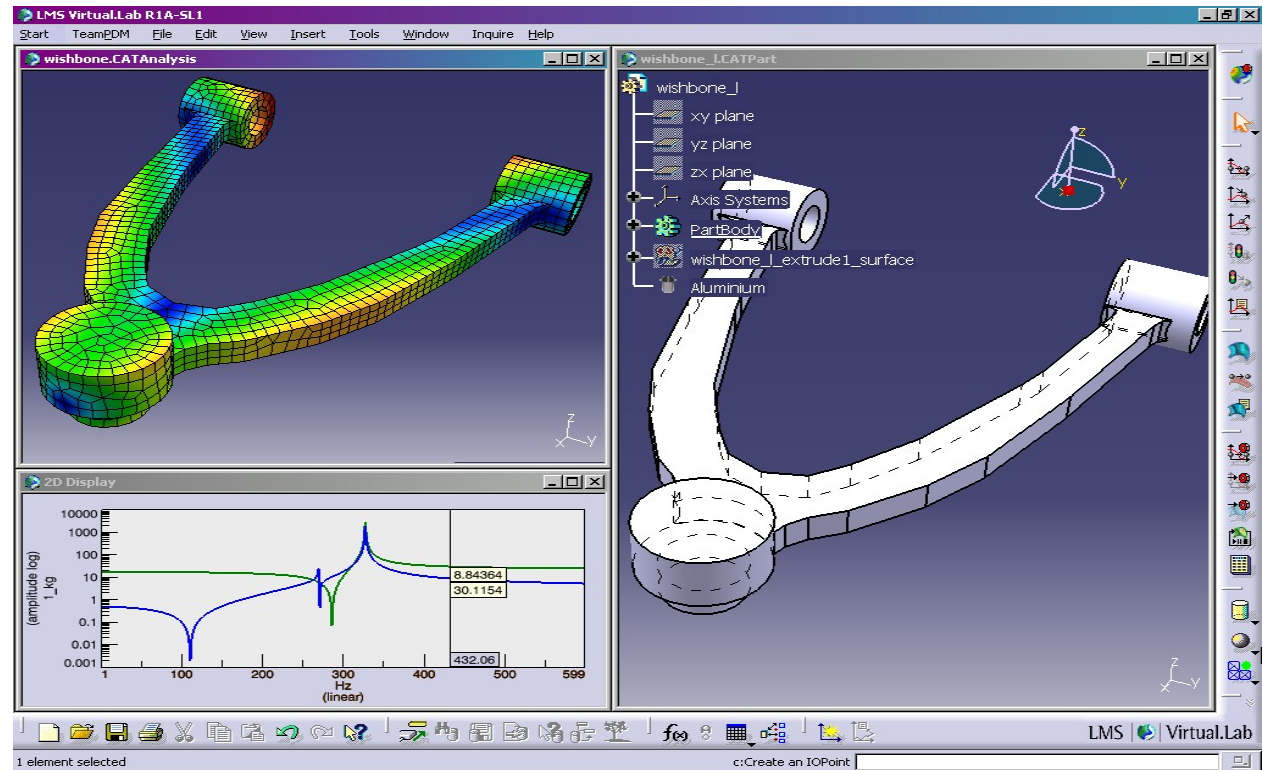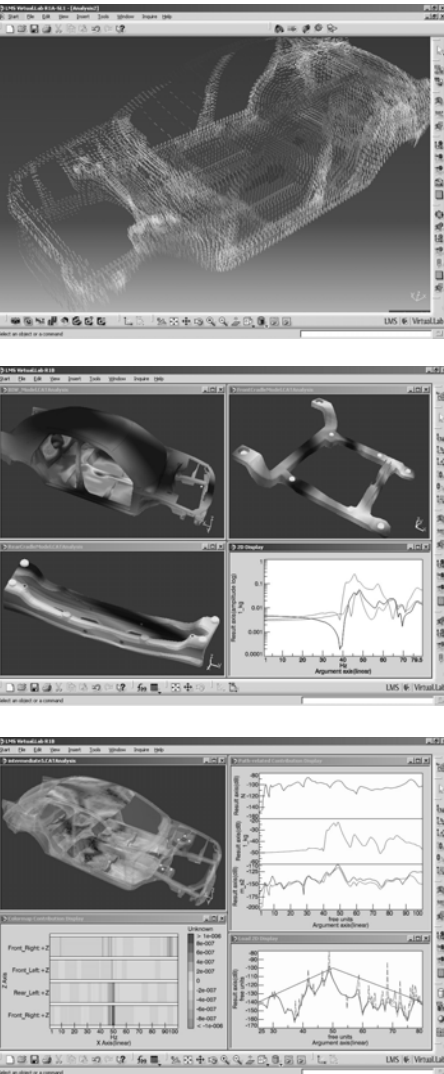- ▶ Seamless integration between CAD and CAE environments

LMS Virtual.Lab Noise & Vibration

Frequency-domain based analysis of system response to discrete and random vibrations, fully integrated in CATIA V5

- Automatic input of frequency-domain based loads
  - → Assignment via Virtual.Lab Noise & Vibration
  - → Test data from different packages including LMS Test.Lab
- Modal solution approach; original system modes provided by 3rd-party finite-element solvers
- In-depth functionality including
  - → Transfer path analyses
  - → Contribution analyses
  - → Hybrid simulation with inclusion of test data
  - → Correlation option to determine validity of simulation results

LMS
ENGINEERING INNOVATION
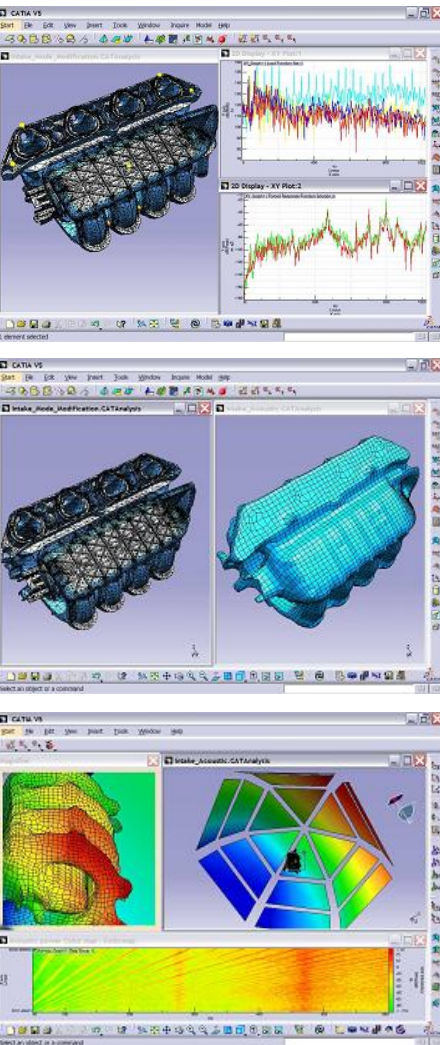
LMS Virtual.Lab
Noise & Vibration

- ▶ Analysis of structure-borne noise in frequency-domain
- ▶ Uses modal solution sets to calculate transfer functions $H_{ij}(\omega)$
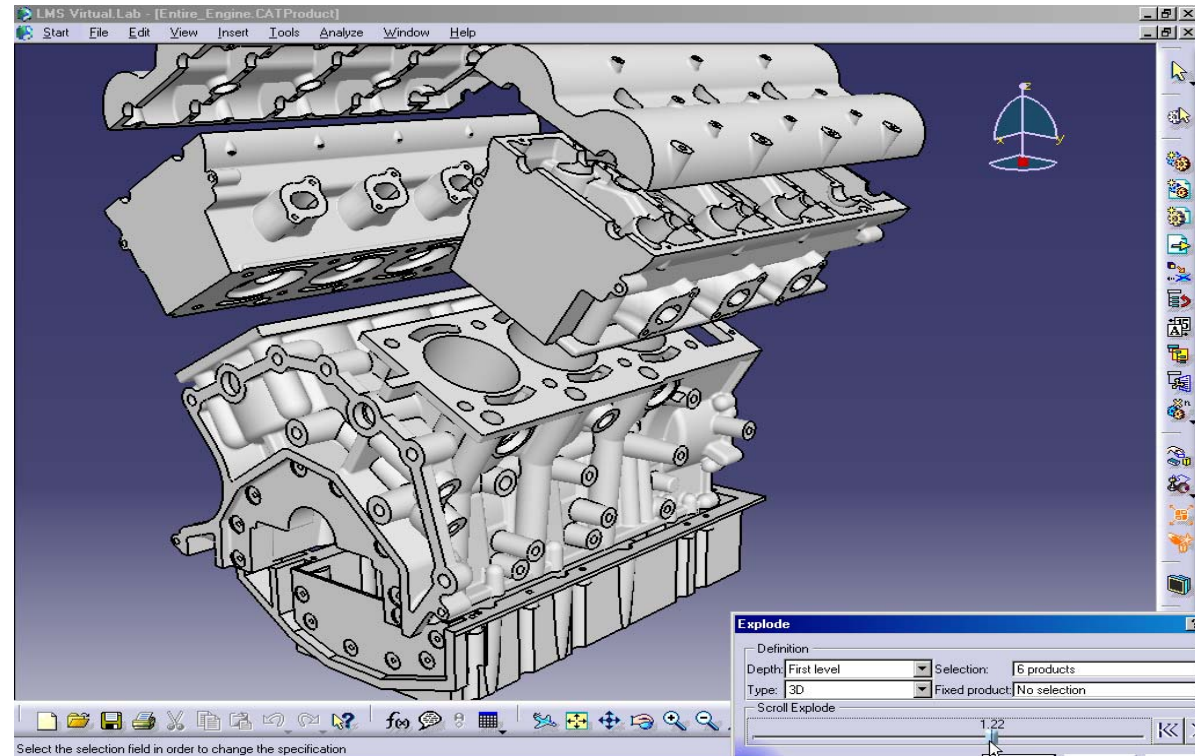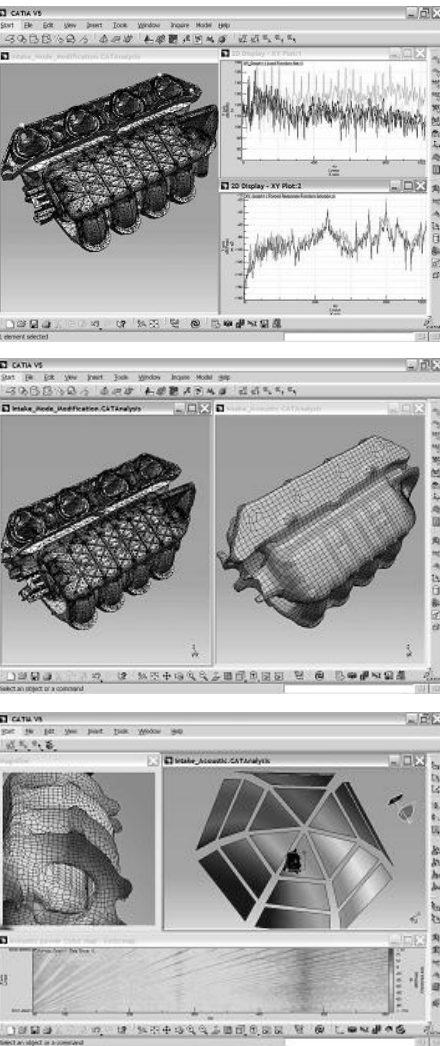- ▶ Seamless integration between CAD and CAE environments

LMS Virtual.Lab **Acoustics**

External and internal acoustic simulation capabilities, fully integrated in CATIA V5

- Two possible options
  - → "Boundary Element Method" (BEM) for external simulations
    - **Example:** radiated sound field (far field) in free space emanating from external vibrating surfaces
  - → "Finite Element Method" (FEM) for internal simulations
    - **Example:** radiated sound field (standing field) in an enclosed volume surrounded by vibrating surfaces
- Maintains complete associativity with CATIA CAD geometry
- Visualization of sound pressure levels in a variety of formats

LMS Virtual.Lab
Acoustics


▸ Offers useful options like FE Mesh Coarsening that greatly decrease the time required to complete models
▸ Saves valuable protoype-build and test resources
▸ Seamless integration between CAD and CAE environments

LMS Virtual.Lab Optimization

Optimization of CAD and CAE parameters (including parameters exposed to Knowledgeware), fully integrated in CATIA V5

- Single and multi-parameter optimization with both discrete and continuous values
- Perform "virtual" design of experiments (DOE) and Monte Carlo simulations to determine design response to variability
- Explore design spaces by visualizing how parameter variations affect design performance
- All based on powerful algorithms developed by Noesis, a fully-owned LMS subsidiary
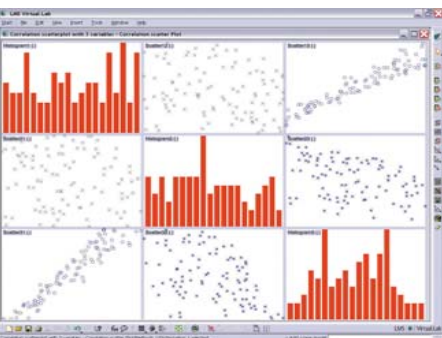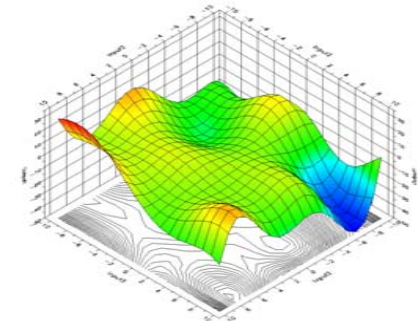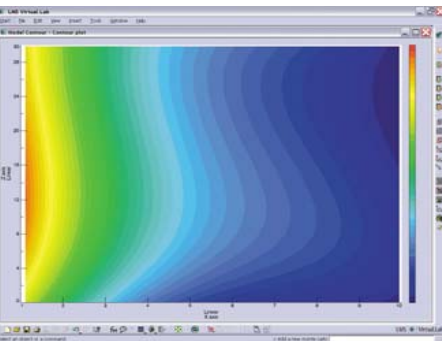
LMS Virtual.Lab
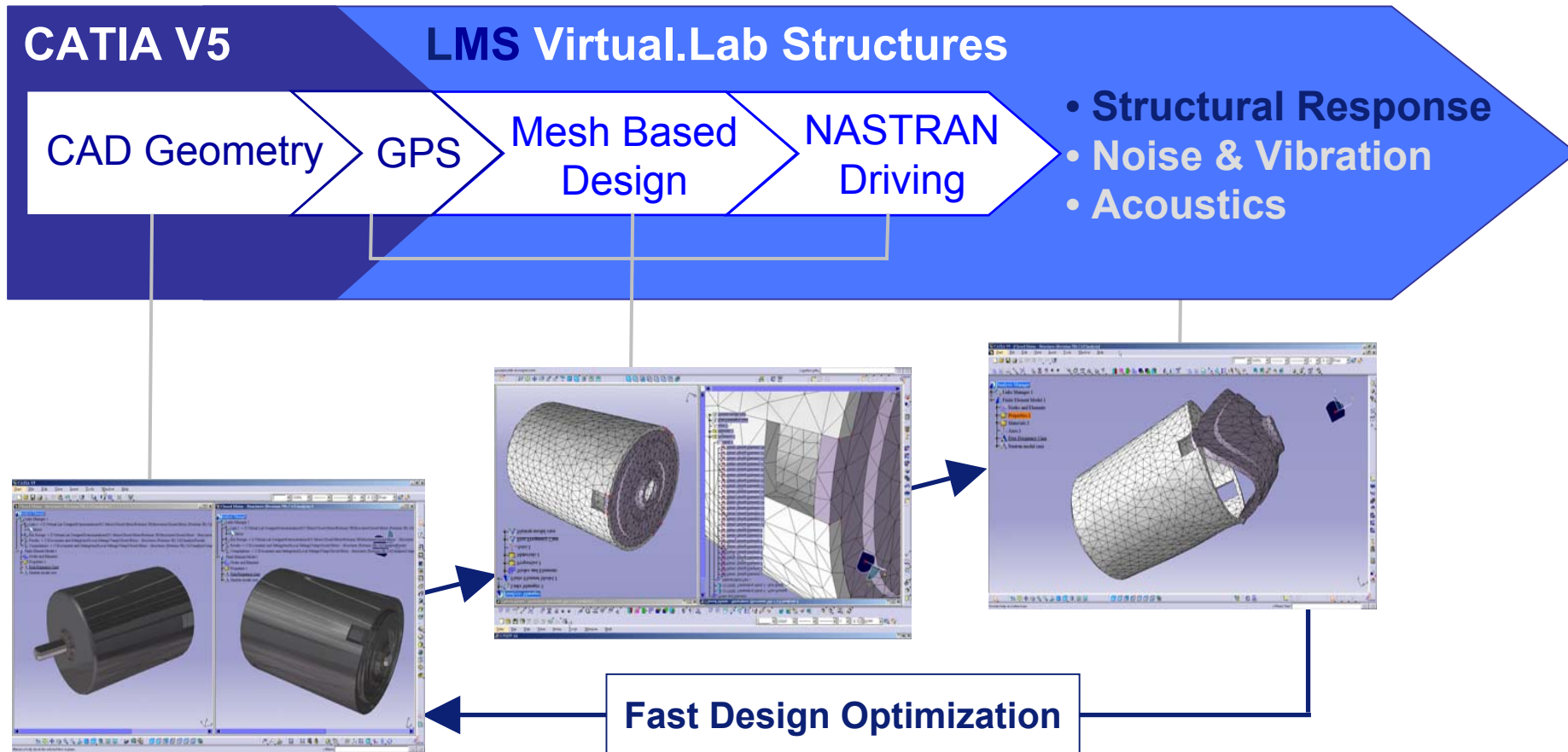## Optimization (Optimus/Noesis)
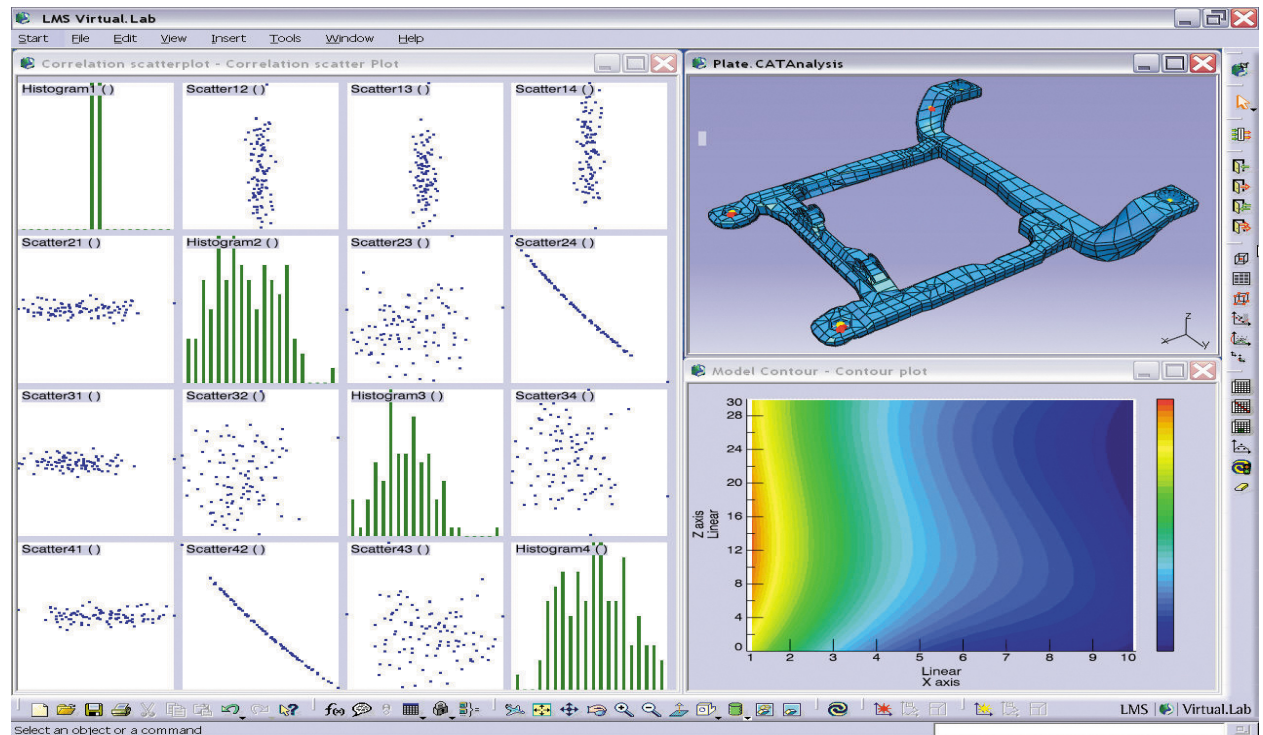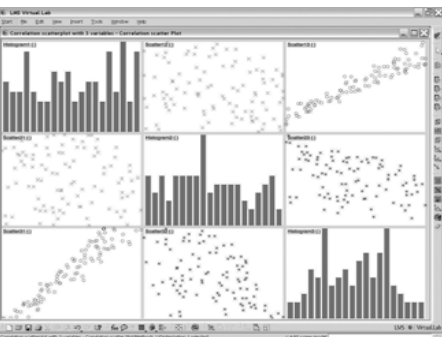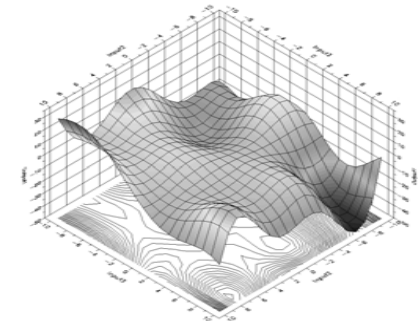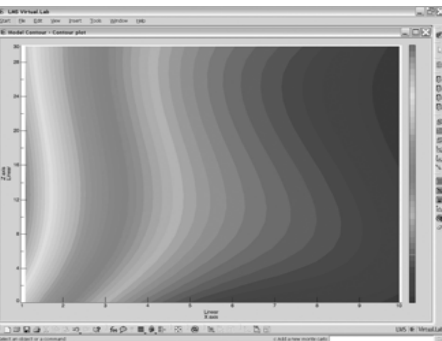
- ▸ Structural parameter optimzation of stress fields
- ▸ Analysis of variance (ANOVA) from Monte Carlo simulations
- ▸ Seamless integration among CAD/CAE optimization parameters

LMS Virtual.Lab Structures
Typical Design Process in CATIA V5

Seamless CAD/CAE Integration in CATIA V5 Without Data Transfers

CATIA V5 — **LMS Virtual.Lab Structures**

CAD Geometry → GPS → Mesh Based Design → NASTRAN Driving →

- **Structural Response**
- **Noise & Vibration**
- **Acoustics**

Fast Design Optimization

Why CAE?
Design-Right/First-Time

Seamless CAD/CAE Integration in CATIA V5 Without Data Transfers

CATIA V5 **LMS Virtual.Lab Motion**

CAD Geometry → Rigid-Body Dynamics → GPS+ ELFINI → Flexible Bodies → • **Fatigue** • **Acoustics**

Fast Design Optimization
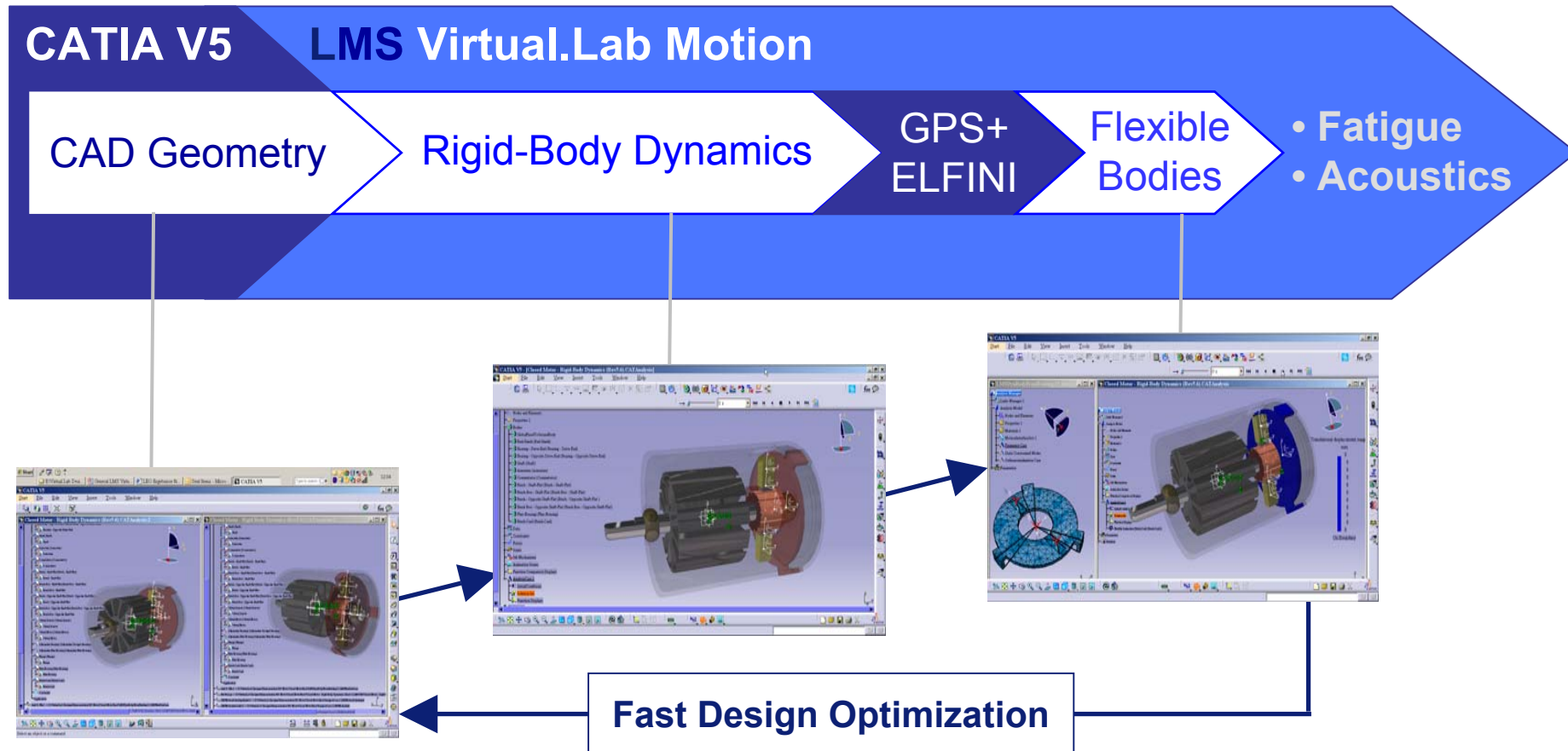
CATIA V5 and LMS Virtual.Lab
What is the Value of Using Integrated CAE Tools?

1 **Seamless and Integrated CAD/CAE Environment**

3 **Optimized Protoype Design**

CATIA V5 **LMS Virtual.Lab Designer**

Sample Build

CAD-Geometry **CAE Simulation and Analysis**

Tests

2 **Fast and Easy Design Iterations** "What Happens, if I Change…?" Scenarios

4 **Minimization of the Risk that Failures Occur During Expensive Protype Testing**

Why CAE?
Design-Right/First-Time

Development Project
Development and Project Engineers
- CAD Resources

Project Funds

"Results"

How much project money and time is continually wasted here?

Internal Service Group
Specialists
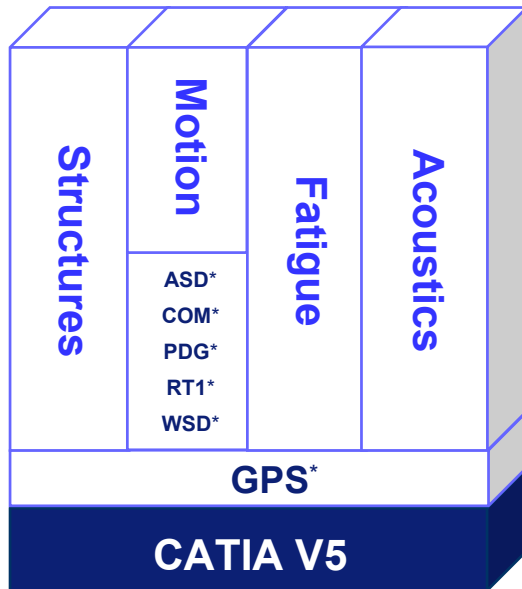- CAE Resources

Why CAE?
Design-Right/First-Time

Virtual.Lab Designer and Virtual.Lab
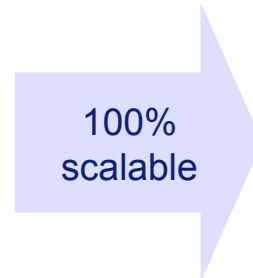## CATIA Prerequisites and Functionality Upgrades

Scalable from LMS Virtual.Lab Designer → LMS Virtual.Lab

- **No** data and/or file transfers between CAD and CAE environments
- **Virtual.Lab Designer and Virtual.Lab** are completely based on CATIA's user-interface architecture und maintain full associativity with CATIA CAD geometry
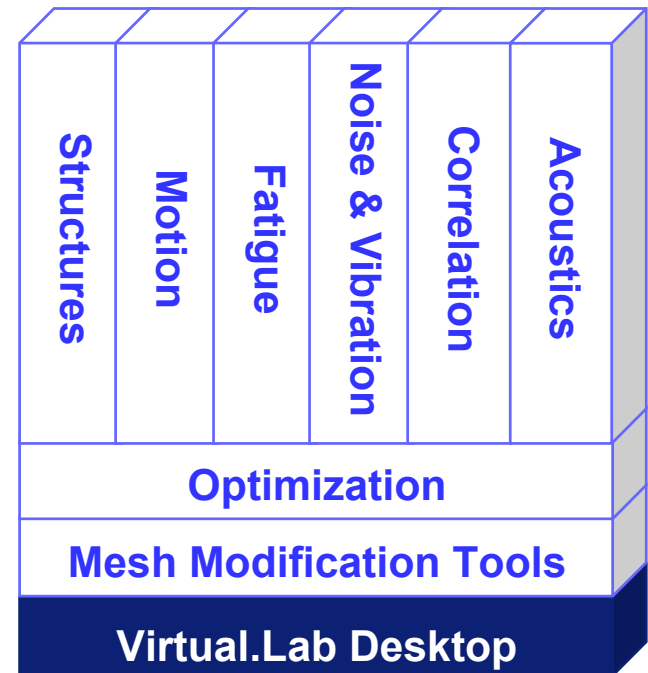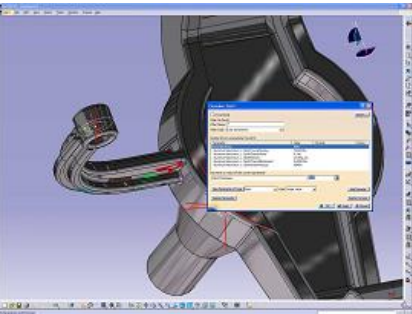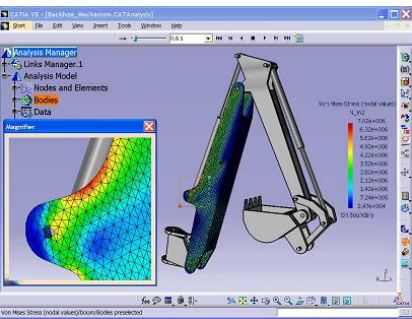
LMS Virtual.Lab Designer

Structures	Motion	Fatigue	Acoustics
	ASD* COM* PDG* RT1* WSD*		

GPS*

CATIA V5

*minimum CATIA V5 requirements

100% scalable

LMS Virtual.Lab

Structures	Motion	Fatigue	Noise & Vibration	Correlation	Acoustics

Optimization

Mesh Modification Tools

Virtual.Lab Desktop

Why CAE?
Design-Right/First-Time

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LMS Virtual.Lab
Summary
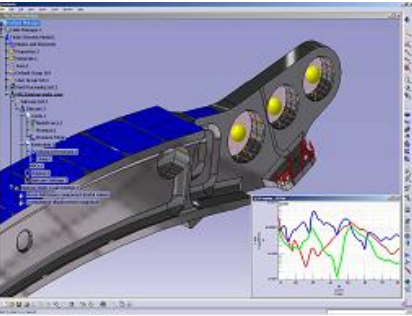
- Based on and fully integrated in CATIA V5

- Add-On or Stand-Alone versions with CATIA V5

- Complements and completes the already existing CAE functionality of V5 PLM

- Offers CATIA V5 users and development engineers direct access to:
  - Static and dynamic structural response with 3rd-party solvers
  - Rigid-body dynamics and dynamic stress (flexible bodies)
  - Strength and fatigue analysis
  - Vibration analysis (frequency-domain)
  - Acoustic simulation (frequency-domain)
  - Optimization

  …all in one CATIA V5 environment!

- Completely scalable and modular product palette

Tack så mycket
Thank You

Why CAE?
Design-Right/First-Time