



3DEXPERIENCE

Realistic Simulation with Abaqus for CATIA V5

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Agenda

1

SIMULIA & Realistic Simulation

2

Design Integrated Analysis

3

CATIA FEA

4

Abaqus for CATIA V5

5

SIMULIA V6

DS Brands

DS ENOVIA

Global Collaborative Innovation

DS 3DSW™

Social Innovation

Social Innovation

DS CATIA

Virtual Products

3D Modeling

3D

iⁱ

Search

DS EXALEAD

Information Intelligence

DS SOLIDWORKS

3D Design

Content and Simulation

DS DELMIA

Digital Manufacturing & Production

DS SIMULIA

Realistic Simulation

DS 3DVIA

3D Lifelike Experience

DS SIMULIA

DS DASSAULT SYSTEMES

IF WE ask the right questions
we can change the world.

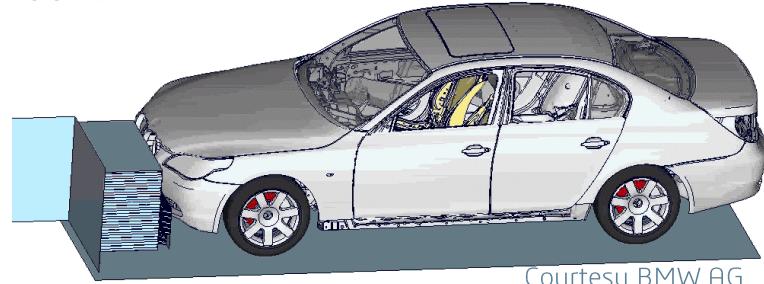
SIMULIA Vision & Mission

- ▶ SIMULIA is the Dassault Systèmes brand for Realistic Simulation
- ▶ Vision:
 - ▷ *“Make simulation an integral business practice”*
- ▶ Mission:
 - ▷ *“Be the leading provider of simulation solutions for engineering and scientific simulation”*



Realistic Simulation is...

- ▶ ... the use of sophisticated finite element analysis and multi-physics analysis to know how products will perform **before** they are built.
 - ▷ **Evaluate** design alternatives
 - ▷ **Reduce** physical prototypes
 - ▷ **Increase** confidence in product performance
 - ▷ **Accelerate** design decisions
 - ▷ **Gain** knowledge of real-world behavior



Courtesy BMW AG

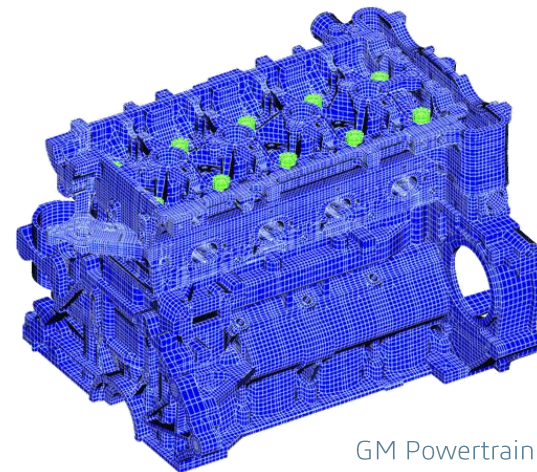


The Real World

- ▶ The real world is nonlinear
 - ▷ The frequency spectrum of a heated (pre-loaded) engine is relevant
 - ▷ Bolts are pre-tensioned
 - ▷ Misuse and failure situations are highly dynamic
 - ▷ Contact always includes friction
- ▶ Since the real world is nonlinear, the virtual world need to be nonlinear, too
- ▶ But
 - ▷ The analyst world is often still linear, especially the design-integrated world



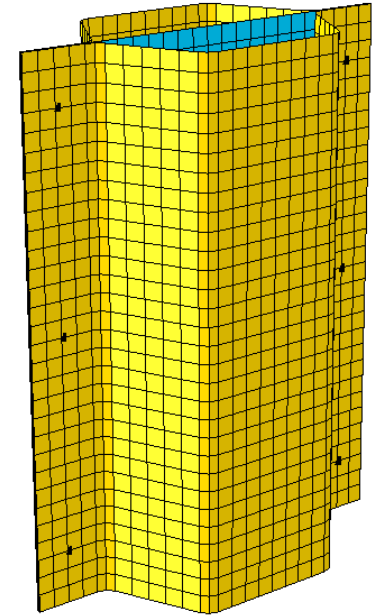
GM Powertrain



GM Powertrain

Sources for Nonlinearities

- ▶ Material Behavior
 - ▷ Nonlinear elasticity, plasticity
 - ▷ Damage / failure
 - ▷ Hardening / creep
- ▶ Contact
 - ▷ Close / open
 - ▷ Self-contact
 - ▷ Friction, stick / slip
 - ▷ Large sliding
- ▶ Geometry
 - ▷ Large rotations
 - ▷ Large deformations
 - ▷ Instabilities, e.g. buckling



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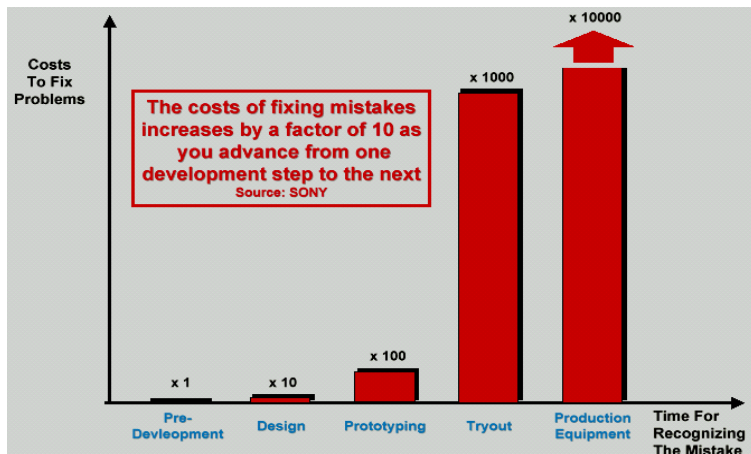
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Abaqus for CATIA V5

5

SIMULIA V6

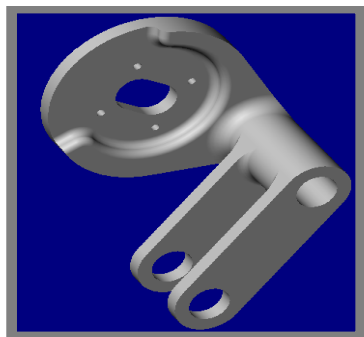
Why is Design Integrated Analysis Important?



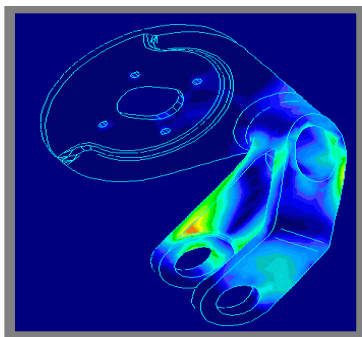
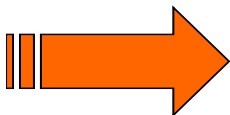
- \$100 mistake early in the design process could cost you \$1M to fix once the product is in the customers hands
- Simulation during the design phase can identify potential problems and give guidance to product improvements during the design phase

Why is Design Integrated Analysis Important?

A 40% material reduction can equal a 40% part cost reduction in large production



*Original
Design*



*Design Analyzed to Reduce Weight and
reach safety conditions*



*Optimized
Design*

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SIMULIA V6

CATIA Analysis: Key Benefits

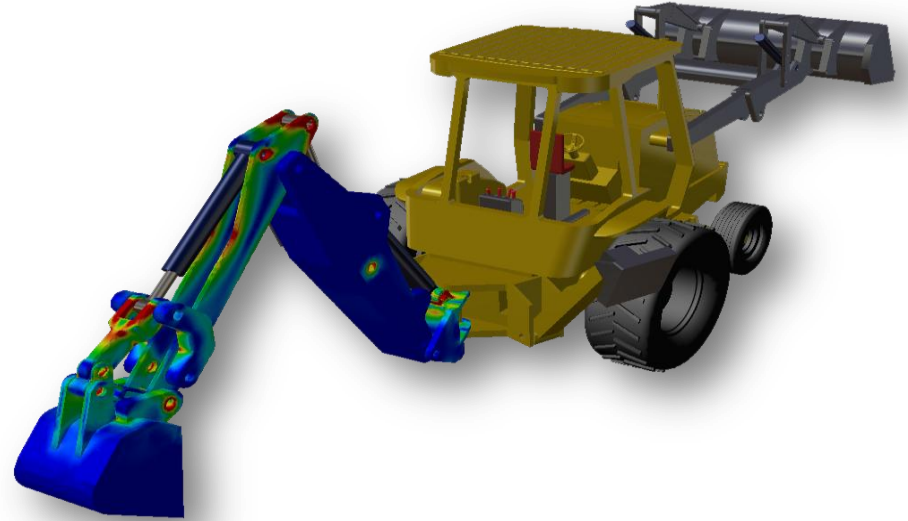
- **Direct integration with CATIA**
 - CATIA Analysis is a natural extension to the CATIA design workbenches.
- **Fast design-analysis loop**
 - All analysis specifications are performed directly on the CAD geometry.



Generative Analysis

CATIA Analysis lets a designer be a designer.

- ▷ Focus on the geometry, the analysis will update with changes
- ▷ Easily understand whether design changes improve the performance
- ▷ Properly size the design, add material only where it is needed.



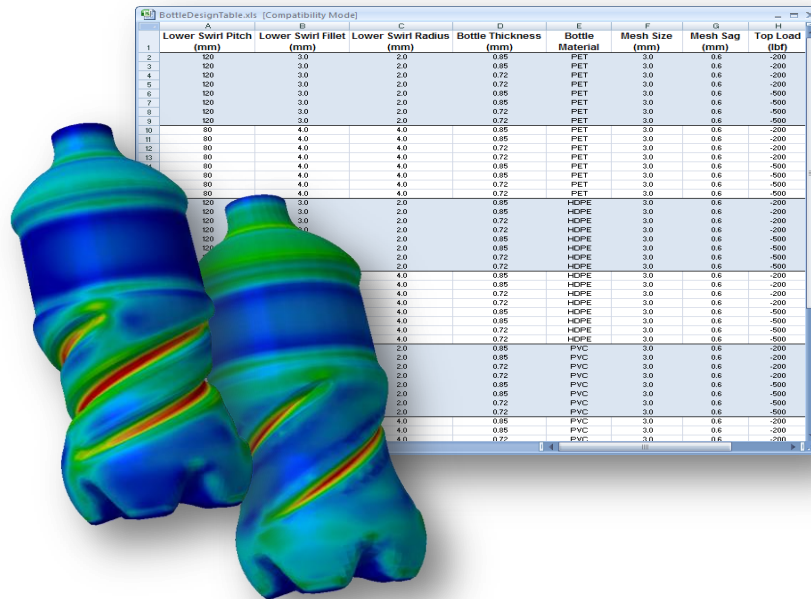
The Power of Parameters

Easily compare design alternatives using parameters and design tables

- Geometric parameters
- Materials
- Mesh parameters
- Loads

Knowledge-based optimization

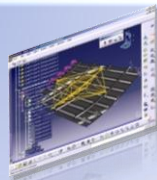
- Built upon the knowledge-based architecture
- CATIA Analysis lets designers take advantage of automation through the use of templates.



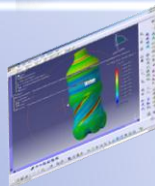
CATIA V5 Environment

Technology
Sophistication

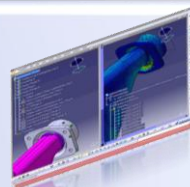
CATIA V5



Abaqus for
CATIA V5
Advanced
Simulation

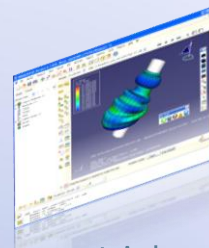


ATH/ANL
Nonlinear &
Thermal
Simulation



CATIA V5 Analysis
Design Simulation for CATIA Users

Abaqus
*Industry Standard for
Advanced Simulation*



Isight
*Design Exploration
& Optimization*



Designer

"Hybrid"

CAE Specialist

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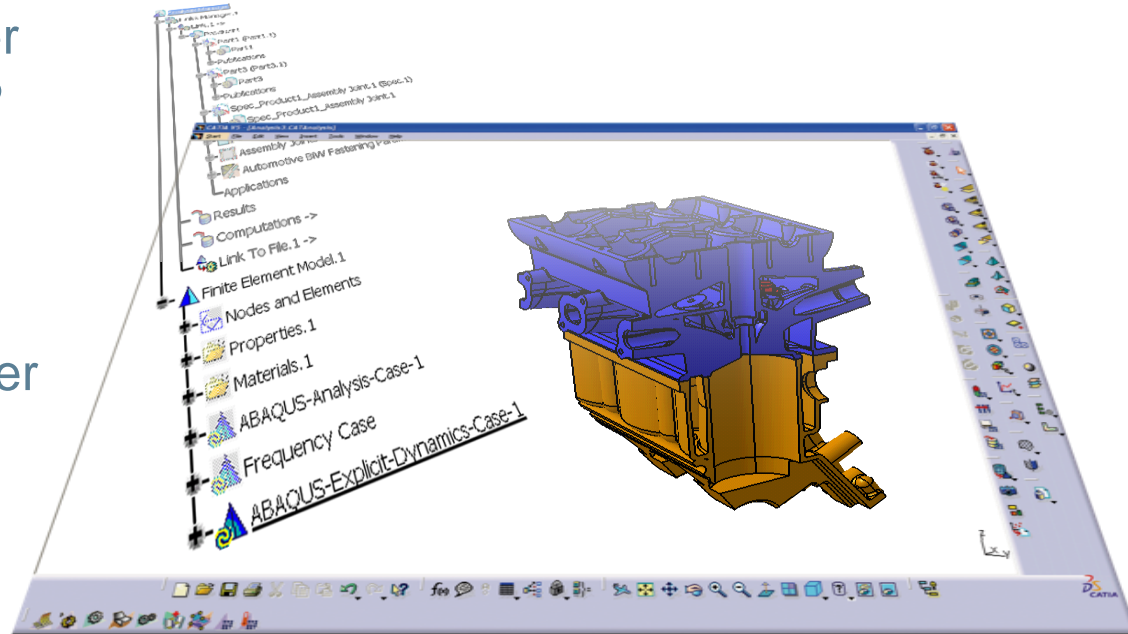
Abaqus for CATIA V5

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SIMULIA V6

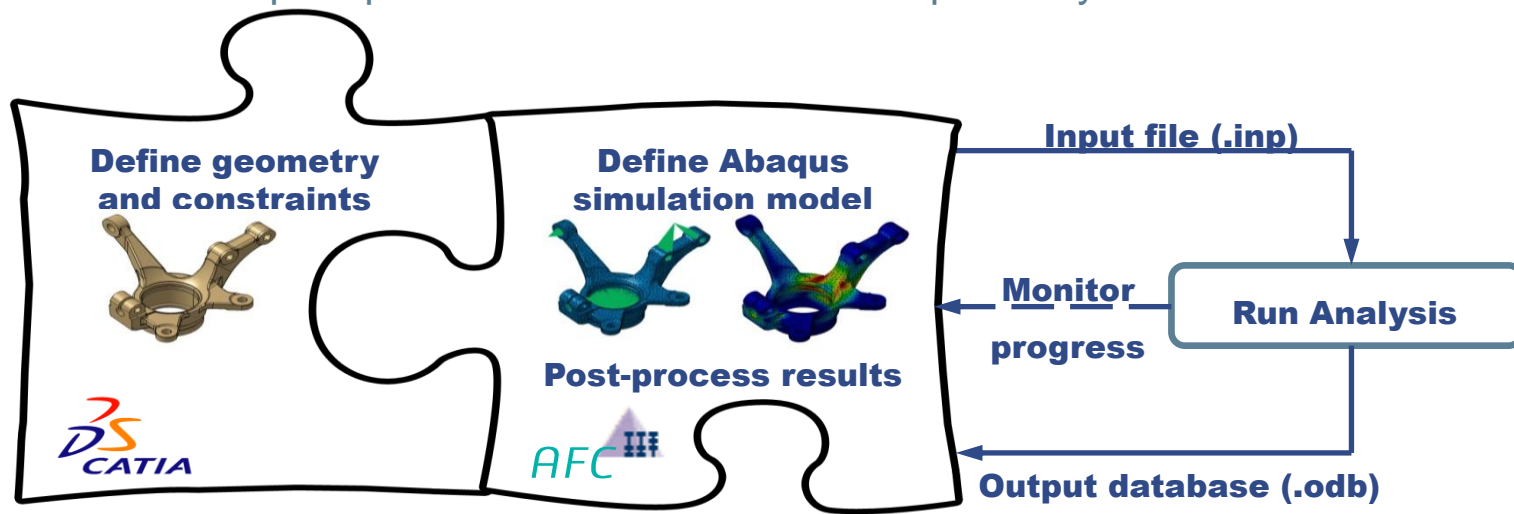
What is Abaqus for CATIA V5?

- ▶ End-to-end Abaqus modeler fully integrated in CATIA V5
 - ▷ Preprocessing
 - ▷ Job submission and monitoring
 - ▷ Postprocessing
- ▶ Take advantage of the power of Abaqus and CATIA V5
 - ▷ CATIA V5:
Intuitive modeling of complex assemblies
 - ▷ Abaqus:
Powerful analysis tools for linear and nonlinear FEA



What is Abaqus for CATIA V5?

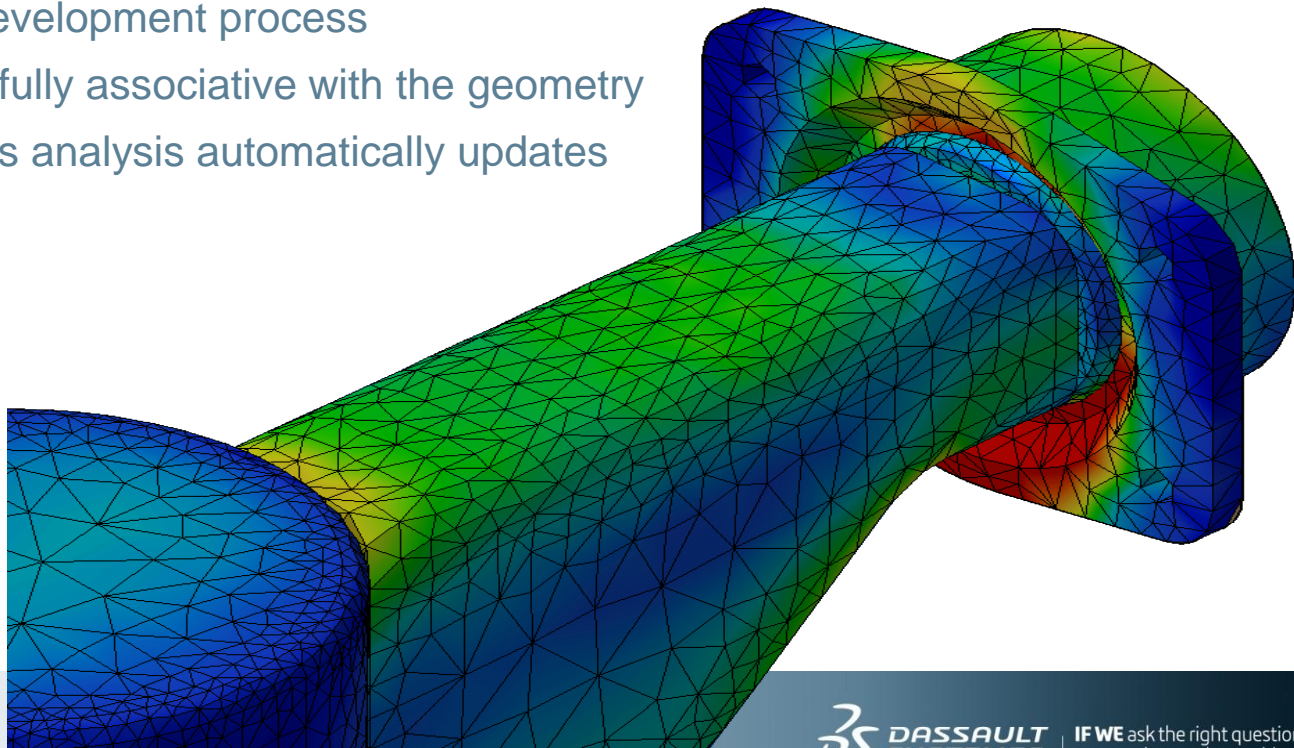
- ▶ AFC allows the user to:
 - ▷ Define an Abaqus model within CATIA V5
 - ▷ Submit and monitor an Abaqus job within CATIA V5
 - ▷ Read and post-process the results of an Abaqus analysis within CATIA V5



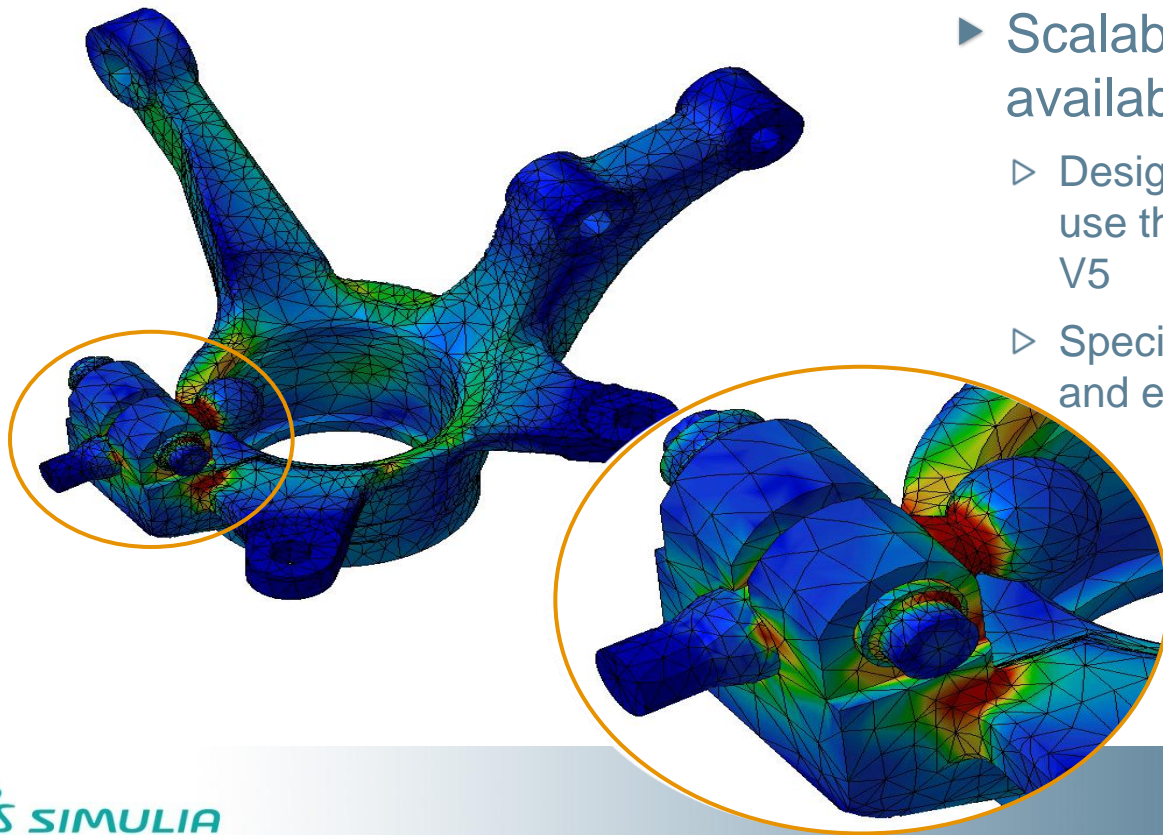
What is Abaqus for CATIA V5?

Seamless transfer between design and analysis

- ▷ Integrated in development process
- ▷ Abaqus model fully associative with the geometry
- ▷ Design changes analysis automatically updates



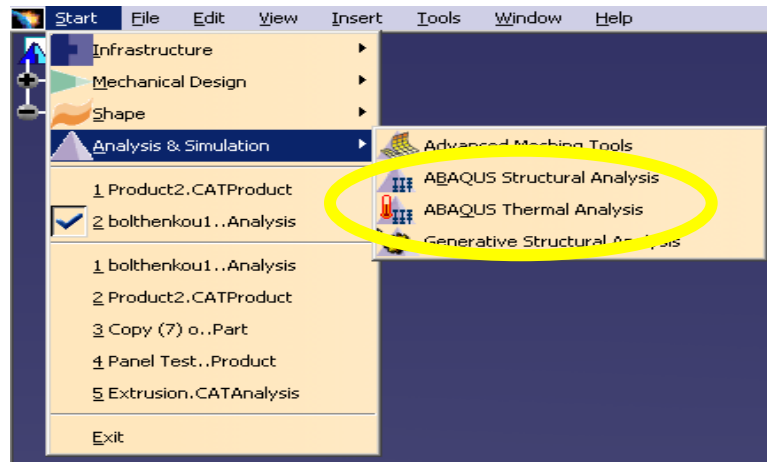
What is Abaqus for CATIA V5?

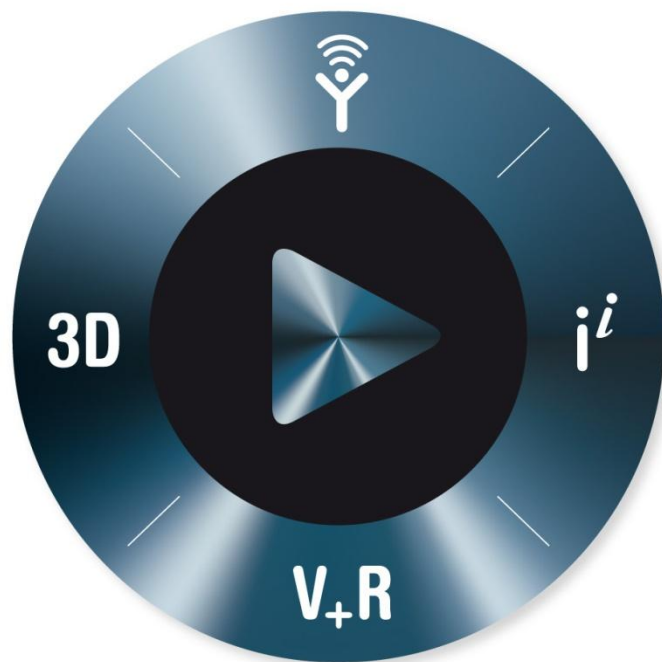


- ▶ Scalability of complexity available within CATIA V5
 - ▷ Design engineer and specialist can use the same FEA tools within CATIA V5
 - ▷ Specialists can use the same models and enhance for their own purposes

Familiar CATIA Framework

- ▶ Two ABAQUS workbenches
 - ▷ Structural analysis
 - ▷ Thermal analysis
- ▶ Reuse and enhancement of CATIA definitions
 - ▷ Assembly constraints
 - ▷ Material library
 - ▷ Specification tree: Same .CATAnalysis document
 - ▶ Bolt loading
 - ▶ CATIA virtual parts
 - ▶ Contact surfaces





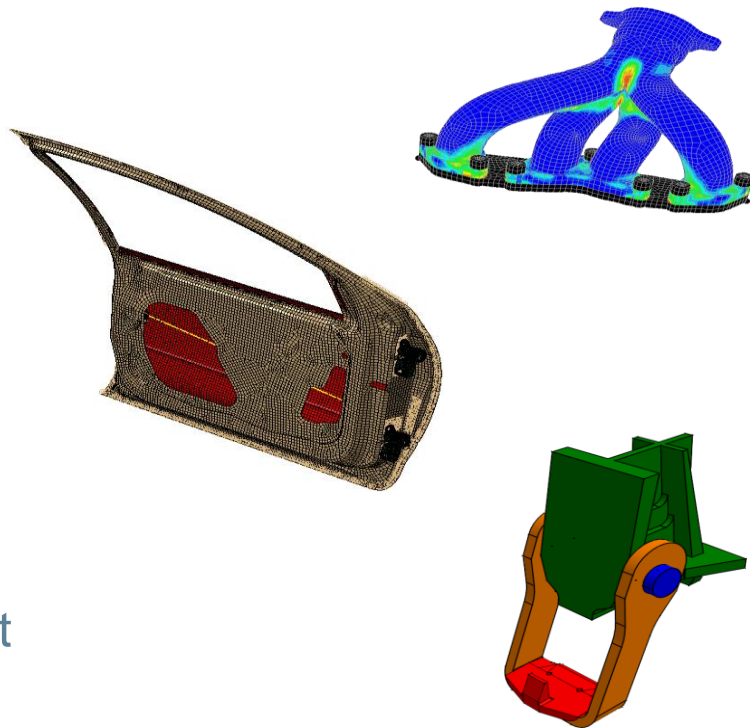
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Abaqus for CATIA V5

Functionality Overview

Functionality Overview

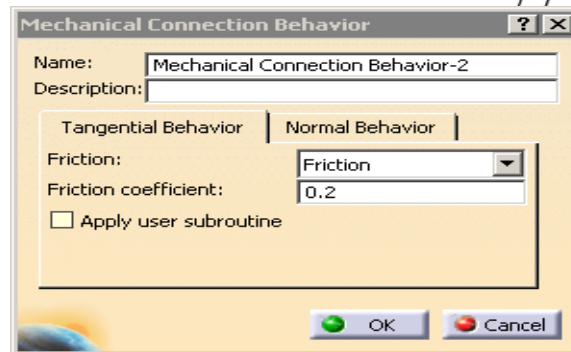
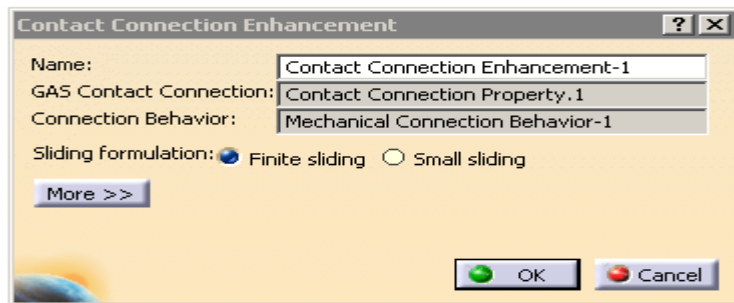
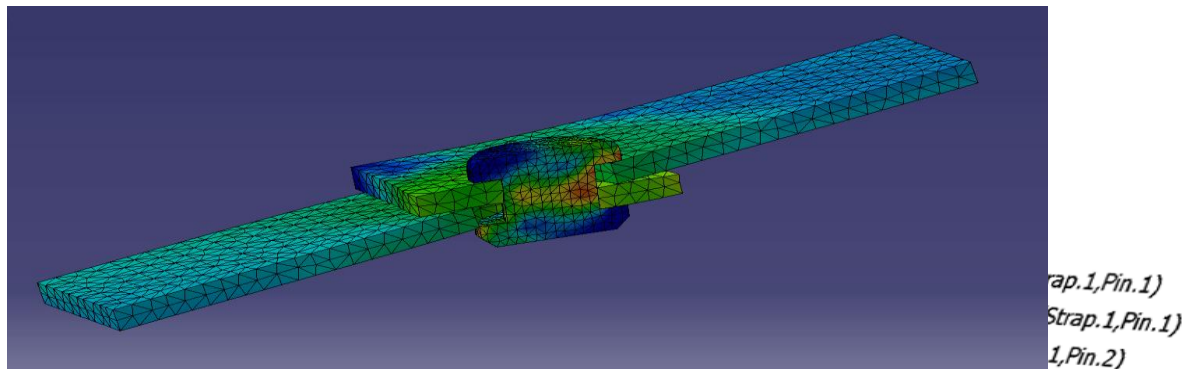
- ▶ AFC extends analysis capabilities when linear analysis tools are not enough
 - ▷ Nonlinear material properties
 - ▷ Large deformation analysis
 - ▷ Finite sliding and intermittent contact
 - ▷ Explicit Dynamics
- ▶ AFC extends analysis capabilities to include non-structural capabilities
 - ▷ Heat transfer analysis
 - ▷ Sequential thermal-stress analysis
- ▶ AFC extends the CATIA V5 environment to a broader range of real-world applications



Nonlinear Analysis Highlights

► Contact

- Finite sliding
- Friction



Strap.1,Pin.1)
Strap.1,Pin.1)
1,Pin.2)
Coincidence.6 (Strap.1,Pin.2)
Surface contact.7 (Strap.1,Pin.2)
Offset.9 (Strap.1,Foot.1)
Offset.10 (Strap.1,Foot.1)
Surface contact.11 (Strap.1,Foot.1)
Coincidence.16 (base.1,Pin.1)
Contact.17 (base.1,Strap.1)
Connection Manager
Connections.1
Analysis Connection.1
Analysis Connection.1
General Analysis Connection.2

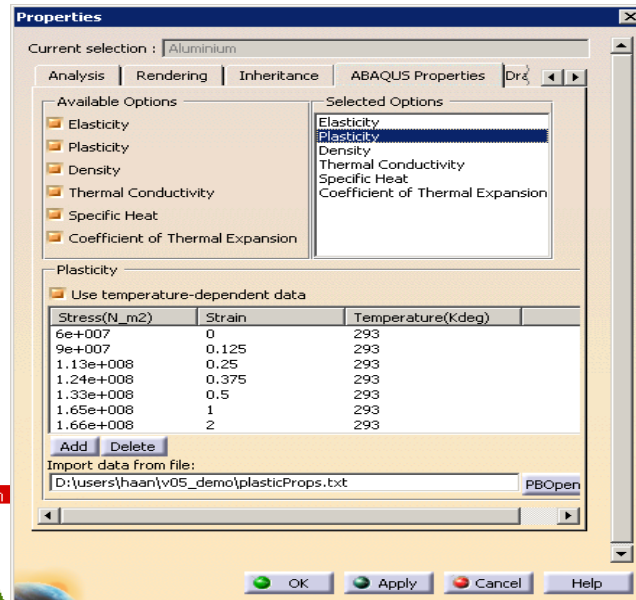
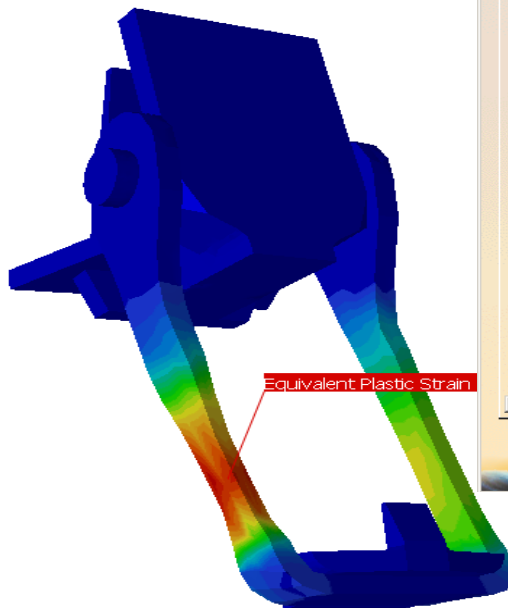
Nonlinear Analysis Highlights

► Contact

- ▷ Finite sliding
- ▷ Friction

► Materials

- ▷ Plasticity, Hyperelasticity
- ▷ Temperature dependence



Nonlinear Analysis Highlights

► Contact

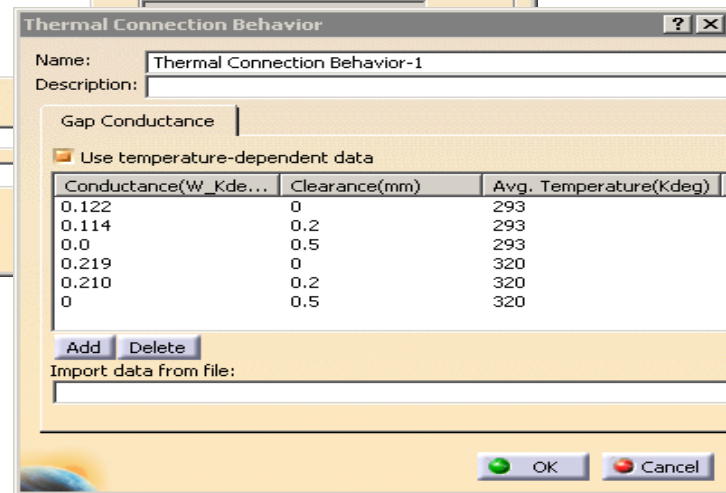
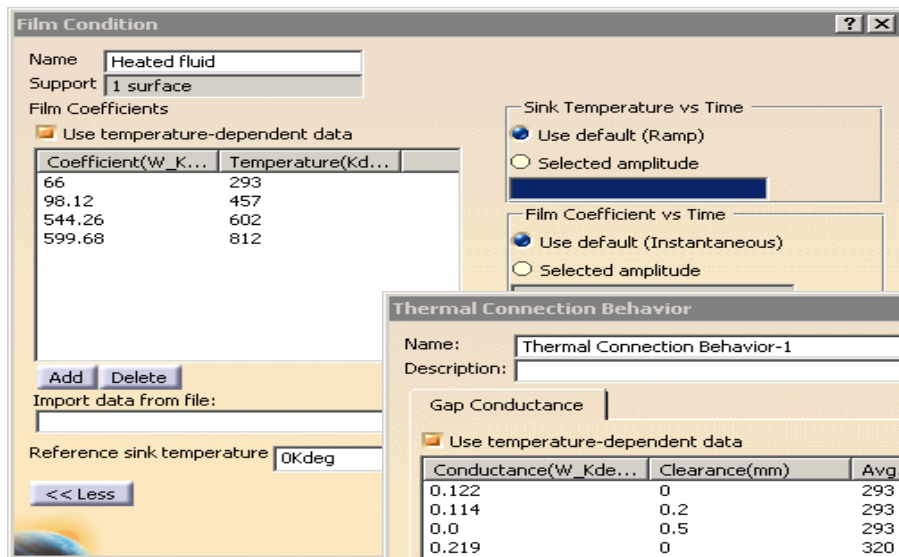
- ▷ Finite sliding
- ▷ Friction

► Materials

- ▷ Plasticity, Hyperelasticity
- ▷ Temperature dependence

► Transient heat transfer

- ▷ Surface film conditions
- ▷ Gap thermal conductance



Nonlinear Analysis Highlights

- ▶ **Contact**
 - ▷ Finite sliding
 - ▷ Friction
- ▶ **Materials**
 - ▷ Plasticity, Hyperelasticity
 - ▷ Temperature dependence
- ▶ **Transient heat transfer**
 - ▷ Gap thermal conductance
 - ▷ Surface film conditions
- ▶ **Loads and boundary conditions**
 - ▷ Time domain amplitude support



Tabular Amplitudes

Name:

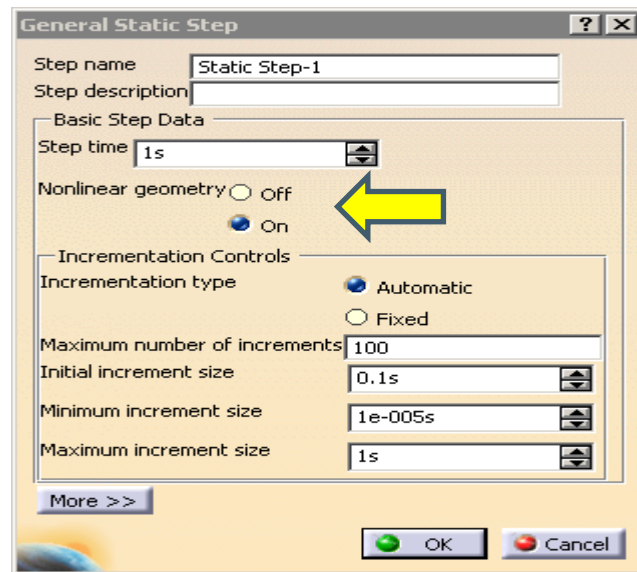
Time Span:

Time(s)	Amplitude
0	0
0.002	0.3
0.128	0.7
0.235	1.6
0.347	1.2
0.435	0.6
0.523	0.1
0.612	0.6
0.657	0.8
0.982	1.4

Import data from file:

Nonlinear Analysis Highlights

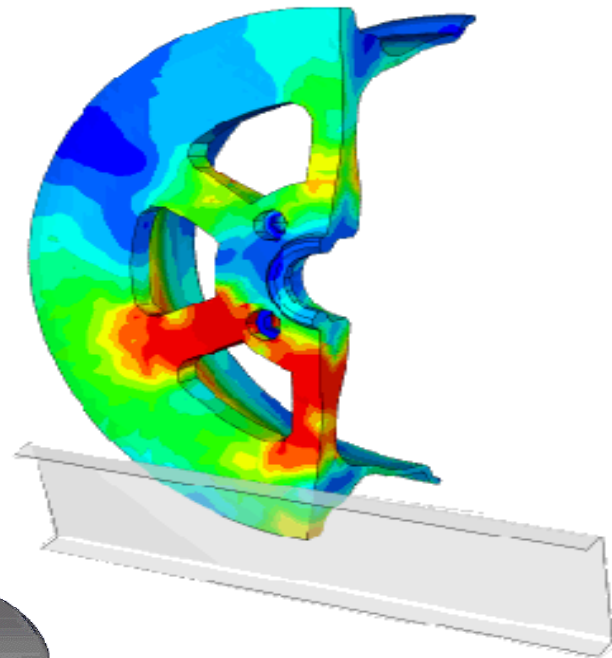
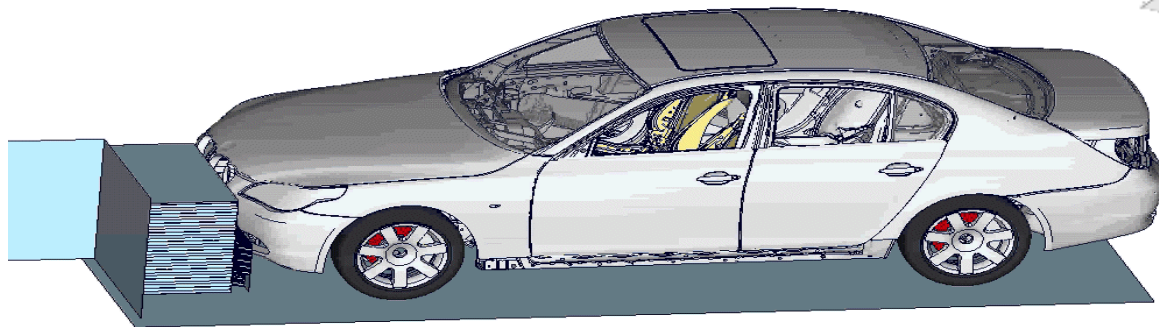
- ▶ **Contact**
 - ▷ Finite sliding
 - ▷ Friction
- ▶ **Materials**
 - ▷ Plasticity, Hyperelasticity
 - ▷ Temperature dependence
- ▶ **Transient heat transfer**
 - ▷ Gap thermal conductance
 - ▷ Surface film conditions
- ▶ **Loads and boundary conditions**
 - ▷ Time domain amplitude support
- ▶ **Geometric nonlinearity**
 - ▷ Large rotations
 - ▷ Stress stiffening



Explicit dynamics

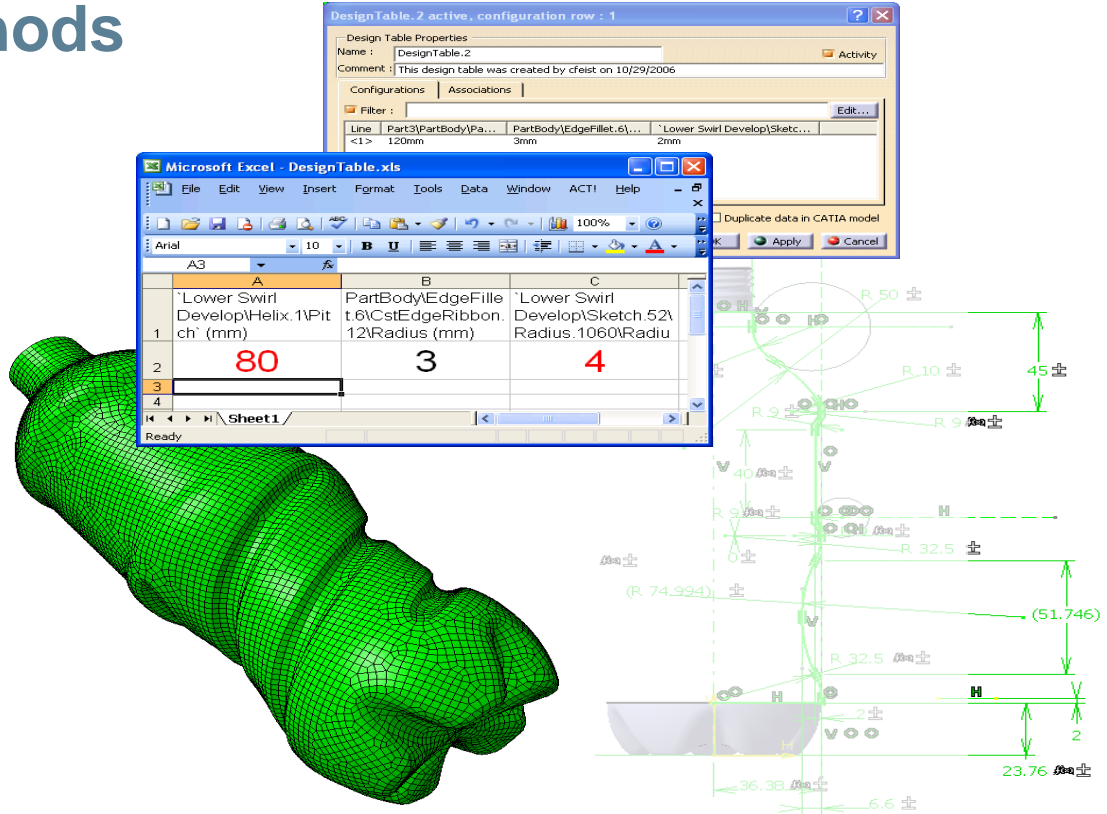
Abaqus/Explicit in AFC

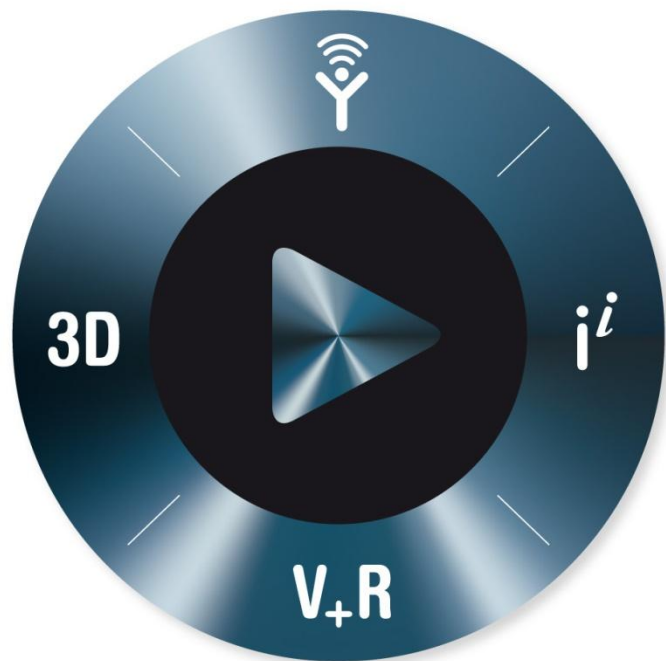
- ▶ High speed dynamics
- ▶ Quasi-static analysis



Reused CATIA Methods

- ▶ Meshing
- ▶ Publications
- ▶ Templates
- ▶ Knowledgeware
 - ▷ Design Tables
- ▶ Postprocessing





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Abaqus for CATIA V5

Summary

Abaqus for CATIA V5 - Summary

- ▶ Integrated nonlinear FEA for CATIA V5
- ▶ Easy access from within the environment of CATIA V5
- ▶ Combines Abaqus functionality and CATIA V5 PLM
- ▶ Used by non-FEA specialists
 - ▷ Application focused user interface
 - ▷ Robust workflows
 - ▷ Complete solution, not just an input-file writer
- ▶ And also:
Advanced input-file writer for Abaqus experts !!

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SIMULIA V6

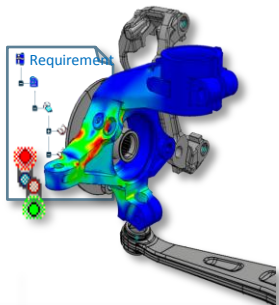
V6 Architecture



4 Pillars of Realistic Simulation

Integration

Simulation integral within business processes



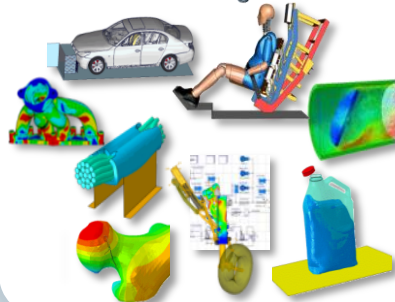
Managed

Associative

Collaborative

Technology

Leading Innovative simulation technologies



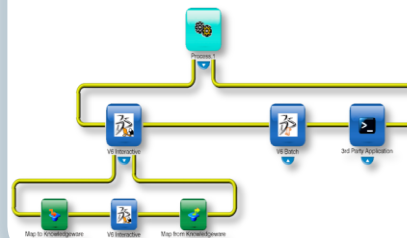
Multiphysics

Performance

Quality

Workflow

Deploy best practices with full traceability



Integrate & Manage

Automate

Optimize

Open Ecosystem

Expand and enrich simulation solutions on the Version6 platform



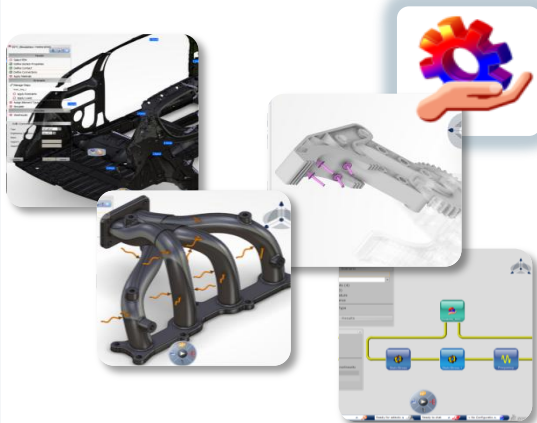
Integral

Interoperable

Extend

SIMULIA Version 6

Scalable portfolio configurable
for all types of users

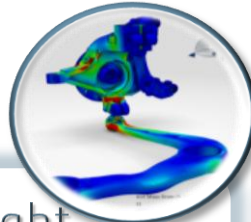


DesignSight

Guided simulation workflows for designers

Enable simulation driven design through an intuitive interface that guides users through the simulation process without requiring extensive simulation experience

Static Stress Methods Thermal Methods
Frequency Methods



ExSight

Multiphysics simulation environment for specialists

Comprehensive suite of applications to simulate products virtually through realistic multi-physics conditions

Best-in-Class Modeling Results visualization
Multi-physics Scenarios



Simulation IP Management

Improve simulation data and process quality

Manage and secure simulation IP throughout its lifecycle with full traceability

Process Capture Optimization Collaborate & Share
Automation Execution



DesignSight | Overview

Guided workflows

- Statics methods
- Frequency methods
- Thermal methods



Natural extension of design experience

- Integrated with design to virtually explore design alternatives.
- Automatic management of simulations

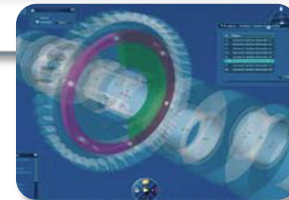


Ease of use - requires little knowledge of FEA methods

- Advanced analysis technology handled automatically with continuous interactive assistance provided to aide the user through simulation setup

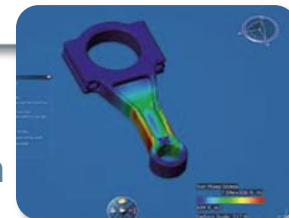
Leverages proven Abaqus technology

- Model and simulate the realistic behavior of products while fostering collaboration between designers and specialists



High performance technology

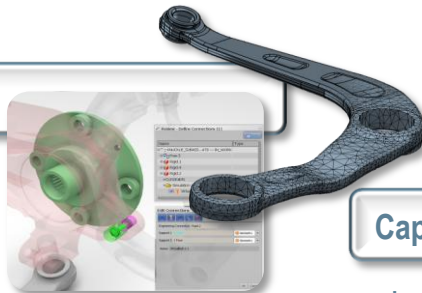
- Leverage HPC resources for rapid turnaround of large models. Results visualization leverages the latest in high performance visualization



ExSight | Overview

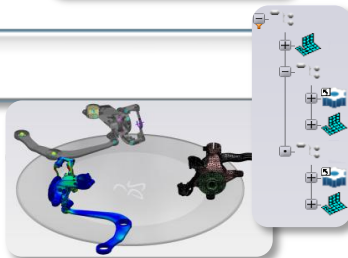
Seamless Integration with CATIA V6

Rapidly iterate design modifications with associative simulation features



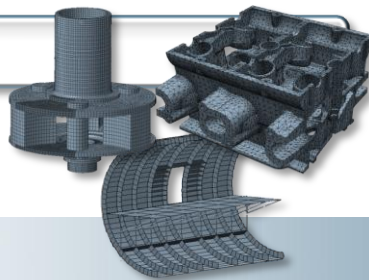
Built-in management of simulation IP

Manage and organize simulation data throughout its lifecycle with full traceability



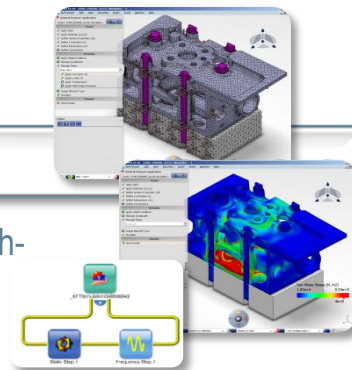
Comprehensive meshing toolset

Flexible toolset for 1D, surface and volume meshing



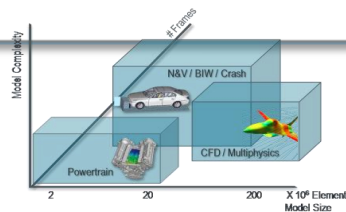
Capabilities for experts

Leverage Abaqus technology for high-end multiphysics simulation



High performance for large models

High performance visualization environment for results display





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Matthias Ernst
Dassault Systèmes Deutschland GmbH

