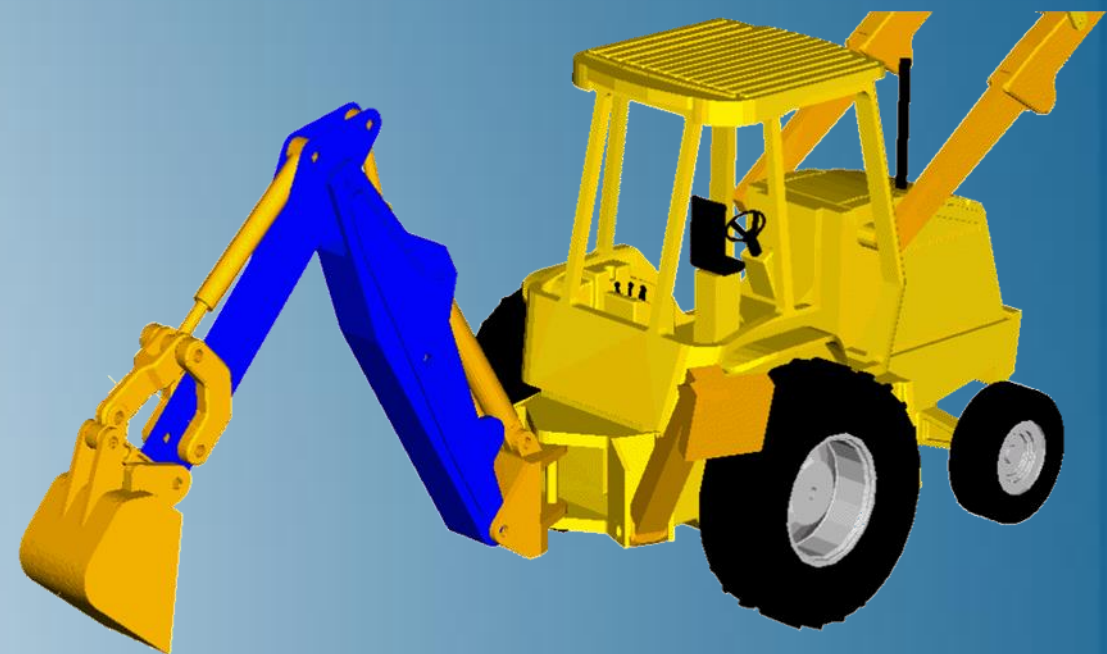# Connector Elements and Mechanism Analysis with Abaqus

Abaqus 2018

3DEXPERIENCE®

About this Course

Course objectives
The topics include:

- ▷ Comparison of connectors and MPCs
- ▷ Basic connector components
- ▷ Assembled kinematic connections
- ▷ Local relative displacements and rotations
- ▷ Defining stops and locks
- ▷ Defining connector friction
- ▷ Connector failure
- ▷ Actuating components of relative motion
- ▷ Sensors and actuators
- ▷ Output and postprocessing

Targeted audience
Simulation Analysts

Prerequisites
This course is recommended for engineers with experience using Abaqus

2 days

Day 1

▷ **Lecture 1**   Mechanisms and Multibodies in Abaqus

▷ **Lecture 2**   Connection Elements and Library (Part 1)

     ▢ Workshop 1   Hinge Connection

▷ **Lecture 3**   Connection Elements and Library (Part 2)

     ▢ Workshop 2a   Analysis of a UJOINT
     ▢ Workshop 2b   Four-Stroke Engine (Part 1)

▷ **Lecture 4**   Connector Builder

     ▢ Workshop 3a   Modeling Pliers
     ▢ Workshop 3b   Four-Stroke Engine (Part 2)

▷ **Lecture 5**   Overconstraints and Connectors

     ▢ Workshop 4   Overconstraints: Hinge Model

Day 2

▷ **Lecture 6**   Connector Behavior (Part 1)

     ▫ Workshop 5a   Connector Attributes – Hinge Model
     ▫ Workshop 5b   Connector Attributes – Four-Stroke Engine Model

▷ **Lecture 7**   Connector Behavior (Part 2)

     ▫ Workshop 6a   Analysis of a Spot Weld
     ▫ Workshop 6b   Connector Friction

▷ **Lecture 8**   Rotational Connector Elements in Mechanism Analysis

     ▫ Workshop 7   Rotational Connector Elements

▷ **Lecture 9**   Connector Actuation and Output

     ▫ Workshop 8   Analysis of a Simple Four-Stroke Engine

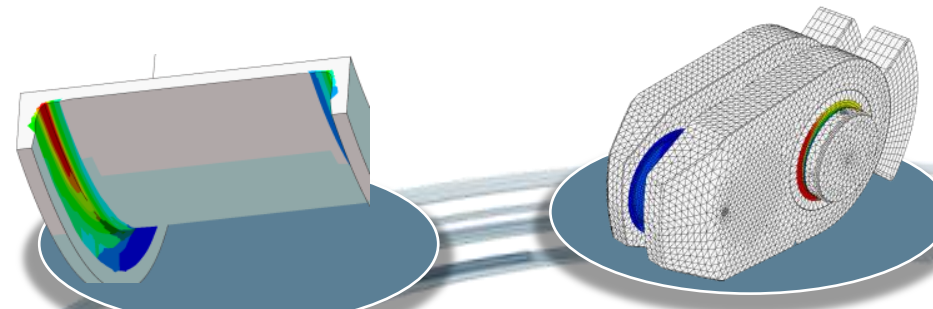# Additional Material

SIMULIA

▷ SIMULIA is the Dassault Systèmes brand for Realistic Simulation solutions

▷ Portfolio of established, best-in-class products
- Abaqus, Isight, Tosca, fe-safe, Simpack
- Most use a common extended licensing pool

Design Optimization: Tosca Structure

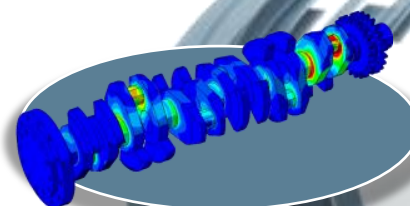Simulation-driven design refinement to improve performance

Durability Assessment: fe-safe
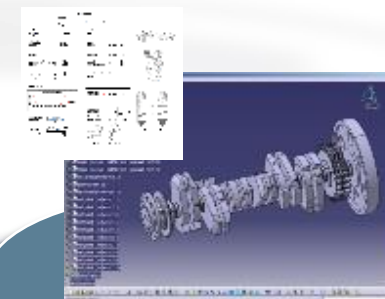
Accurate life estimation to achieve certification

FEA Stress Analysis: Abaqus

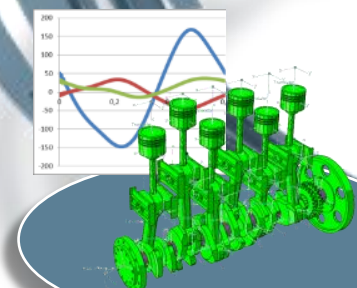Detailed stress analysis using extracted load history from MBS

CAD Geometry: CATIA

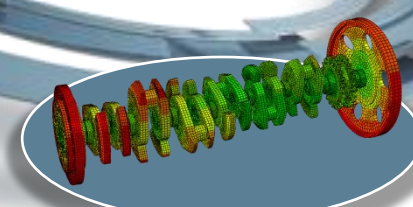Fully parameterized 3D geometry; FEA model generation via associative interface

Multibody Simulation: Simpack

System analysis to extract virtual load history of complete working cycle

Mesh Calibration: Isight

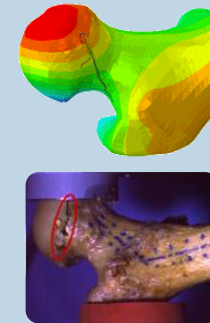Automated mesh calibration: sufficient mesh quality for accurate results

SIMULIA's Power of the Portfolio

Abaqus
- **Routine and Advanced Simulation**
- **Linear and Nonlinear, Static and Dynamic**
- **Thermal, Electrical, Acoustics**
- **Extended Physics through Co-simulation**
- **Model Preparation and Visualization**

Realistic Human Simulation
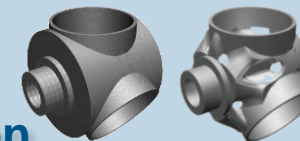**High Speed Crash & Impact**
Noise & Vibration

Isight
- **Process Integration**
- **Design Optimization**
- **Parametric Optimization**
- **Six Sigma and Design of Experiments**
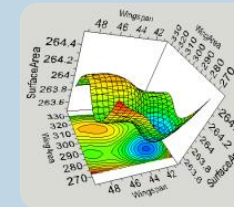
Material Calibration
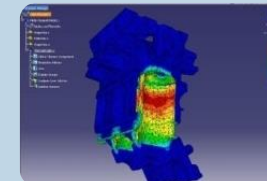**Workflow Automation**
Design Exploration

Tosca
- **Non-Parametric Optimization**
- **Structural and Fluid Flow Optimization**
- **Topology, Sizing, Shape, Bead Optimization**

Conceptual/Detailed Design
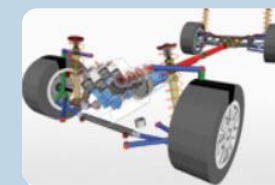**Weight, Stiffness, Stress**
Pressure Loss Reduction

fe-safe
- **Durability Simulation**
- **Low Cycle and High Cycle Fatigue**
- **Weld, High Temperature, Non-metallics**

Safety Factors
Creep-Fatigue Interaction
Weld Fatigue

Simpack
- **Multibody Dynamics Simulation**
- **Mechanical or Mechatronic Systems**

Flexible Bodies
Single Component Design
Complete System Analyses

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to log in or join!

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Revision Status

Lecture 1	**11/17**	**Updated for Abaqus 2018**	**Workshop 1**	**11/17**	**Updated for Abaqus 2018**
Lecture 2	**11/17**	**Updated for Abaqus 2018**	**Workshop 2a**	**11/17**	**Updated for Abaqus 2018**
Lecture 3	**11/17**	**Updated for Abaqus 2018**	**Workshop 2b**	**11/17**	**Updated for Abaqus 2018**
Lecture 4	**11/17**	**Updated for Abaqus 2018**	**Workshop 3a**	**11/17**	**Updated for Abaqus 2018**
Lecture 5	**11/17**	**Updated for Abaqus 2018**	**Workshop 3b**	**11/17**	**Updated for Abaqus 2018**
Lecture 6	**11/17**	**Updated for Abaqus 2018**	**Workshop 4**	**11/17**	**Updated for Abaqus 2018**
Lecture 7	**11/17**	**Updated for Abaqus 2018**	**Workshop 5a**	**11/17**	**Updated for Abaqus 2018**
Lecture 8	**11/17**	**Updated for Abaqus 2018**	**Workshop 5b**	**11/17**	**Updated for Abaqus 2018**
Lecture 9	**11/17**	**Updated for Abaqus 2018**	**Workshop 6a**	**11/17**	**Updated for Abaqus 2018**
Appendix 1	**11/17**	**Updated for Abaqus 2018**	**Workshop 6b**	**11/17**	**Updated for Abaqus 2018**
Appendix 2	**11/17**	**Updated for Abaqus 2018**	**Workshop 7**	**11/17**	**Updated for Abaqus 2018**
			Workshop 8	**11/17**	**Updated for Abaqus 2018**

Lesson 1: Mechanisms and Multibodies in Abaqus

Lesson content:

▷ Introduction

▷ Interaction Options in Abaqus

▷ Connector Element Basics

▷ Connector Applications and Capabilities

▷ Connectors vs. Multi-point Constraints

▷ Flexible and Rigid components in a Model

▷ Procedures

1 hour

Lesson 2: Connection Elements and Library (Part 1)

Lesson content:

- Introduction
- Defining Connector Elements
- Understanding Connector Sections
- Understanding Connection Types
- Understanding Connector Local Directions
- Connector Element Output
- Effects of Node Ordering and Rotation on Results
- Workshop Preliminaries
- Workshop 1: Hinge Connection (IA)
- Workshop 1: Hinge Connection (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

1.5 hours

Lesson 3: Connection Elements and Library (Part 2)

Lesson content:

▷ Rotational Degrees of Freedom at Nodes

▷ Surface-Based Coupling Constraints

▷ Mesh-Independent Fasteners

▷ Components of Relative Motion

▷ Connector Local Kinematics

▷ Summary of Orientations and Local Directions

▷ Workshop 2a: Analysis of a UJOINT (IA)

▷ Workshop 2a: Analysis of a UJOINT (KW)

▷ Workshop 2b: Four-Stroke Engine (Part 1) (IA)

▷ Workshop 2b: Four-Stroke Engine (Part 1) (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

2 hours

Lesson 4: Connector Builder

Lesson content:

▷ Introduction

▷ Connector Builder

▷ Coincident Point Builder

▷ Workshop 3a: Modeling Pliers (IA)

▷ Workshop 3a: Modeling Pliers (KW)

▷ Workshop 3b: Four-Stroke Engine (Part 2) (IA)

▷ Workshop 3b: Four-Stroke Engine (Part 2) (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

1.5 hours

Lesson 5: Overconstraints and Connectors

Lesson content:

▷ General Remarks

▷ Overconstraints Detected during Model Processing

▷ Overconstraints Detected during Analysis Execution

▷ Controlling the Overconstraint Checks

▷ Example: Multibody System

▷ Workshop 4: Overconstraints: Hinge Model (IA)

▷ Workshop 4: Overconstraints: Hinge Model (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

1.5 hours

Lesson 6: Connector Behavior (Part 1)

Lesson content:

▷ Introduction

▷ Defining Connector Behavior

▷ Connector Elasticity

▷ Reference Configuration for Constitutive Behavior

▷ Connector Damping

▷ Connector Stops

▷ Connector Locks

▷ Connector Failure

▷ Workshop 5a: Connector Attributes – Hinge Model (IA)

▷ Workshop 5a: Connector Attributes – Hinge Model (KW)

▷ Workshop 5b: Connector Attributes – Four-Stroke Engine Model (IA)

▷ Workshop 5b: Connector Attributes – Four-Stroke Engine Model (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

2 hours

Lesson 7: Connector Behavior (Part 2)

Lesson content:

▷ Connectors in Series/Parallel

▷ Connector Functions

▷ Connector Friction

▷ Connector Plasticity

▷ Connector Damage

▷ Connector Failure

▷ Workshop 6a: Analysis of a Spot Weld (IA)

▷ Workshop 6a: Analysis of a Spot Weld (KW)

▷ Workshop 6b: Connector Friction (IA)

▷ Workshop 6b: Connector Friction (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

2.5 hours

Lesson 8: Rotational Connectors

Lesson content:

▷ Cardan

▷ Euler

▷ Flexion-Torsion

▷ Projection Flexion-Torsion

▷ Rotation

▷ Workshop 7: Rotational Connector Elements (IA)

▷ Workshop 7: Rotational Connector Elements (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

1 hour

Lesson 9: Connector Actuation

Lesson content:

▷ Introduction

▷ Fixed Relative Motion

▷ Displacement-Controlled Actuation

▷ Force-Controlled Actuation

▷ Sensors and Actuators

▷ Workshop 8: Analysis of a Simple Four-Stroke Engine (IA)

▷ Workshop 8: Analysis of a Simple Four-Stroke Engine (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.

2 hours

Appendix 1: Some Advanced Connection Types

Appendix content:

- ▷ Overview
- ▷ SLIPRING
- ▷ FLOW-CONVERTER/RETRACTOR
- ▷ Example
- ▷ Limitations

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20 minutes

Appendix content:

▷ Connector Uniaxial Behavior

20 minutes