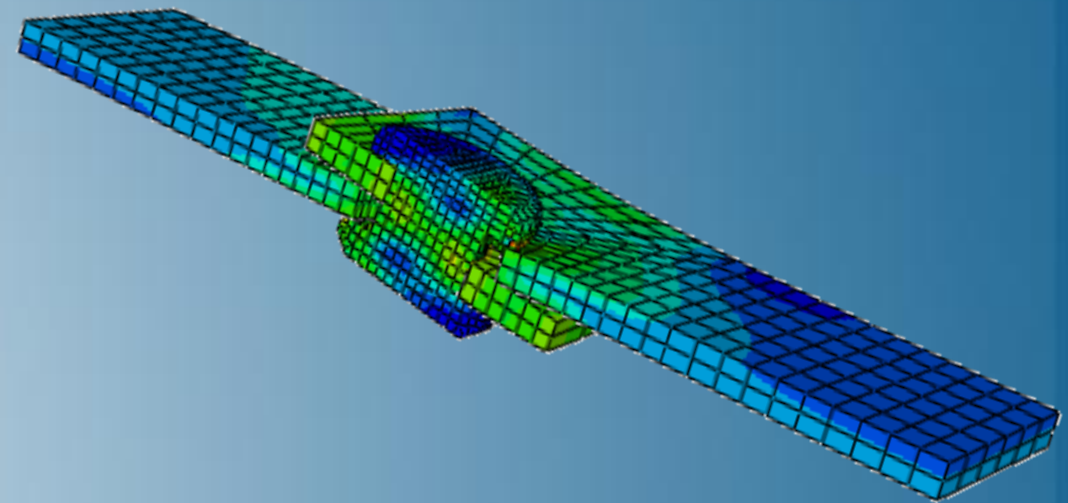


Modeling Contact with Abaqus/Standard

Abaqus 2018



3DEXPERIENCE®



About this Course

Course objectives

Upon completion of this course you will be able to:

- ▶ Define general contact and contact pairs
- ▶ Define appropriate surfaces (rigid or deformable)
- ▶ Model frictional contact
- ▶ Model large sliding between deformable bodies
- ▶ Resolve overclosures in interference fit problems

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus/Standard



2 days

Day 1

- ▶ Lecture 1 Introduction
- ▶ Lecture 2 Contact Workflow
 - Workshop 1 Compression of a Rubber Seal
- ▶ Lecture 3 Surface-based Contact
 - Workshop 2 Lap Joint Analysis
- ▶ Lecture 4 Contact Logic and Diagnostics Tools
 - Workshop 3 Bolted Flange Analysis

Day 2

- ▶ Lecture 5 Contact Properties
 - Workshop 4 Disk Forging Analysis

- ▶ Lecture 6 Interference Fits
 - Workshop 5 Interference Fit Analysis
 - Workshop 6 Syringe Analysis (optional)

- ▶ Lecture 7 Additional Features
 - Workshop 7 Pipe Reel Analysis

- ▶ Lecture 8 Modeling Tips
 - Workshop 8 Bolted Flange Analysis: Infinitesimal Sliding
 - Workshop 9 Snap Fit Analysis
 - Workshop 10 Analysis of a Radial Shaft Seal (optional)

Additional Material

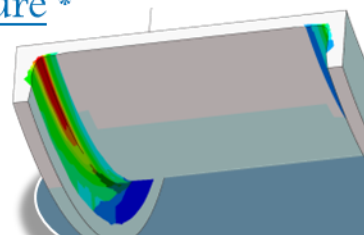
- ▶ Appendix 1 Node-to-Surface Formulation
- ▶ Appendix 2 Contact Elements
- ▶ Appendix 3 Dynamic Contact using Implicit Integration

SIMULIA

- ▶ SIMULIA is the Dassault Systèmes brand for Realistic Simulation solutions
- ▶ Portfolio of established, best-in-class products
 - Abaqus, Isight, Tosca, fe-safe, Simpack

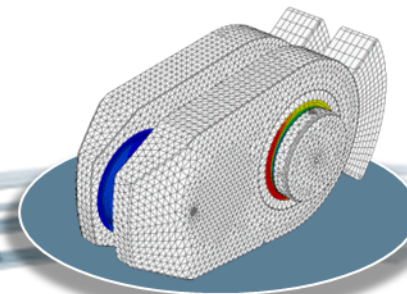
Design Optimization: Tosca Structure *

Simulation-driven design refinement to improve performance



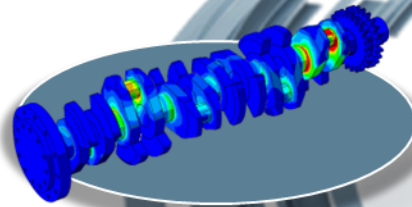
Durability Assessment: fe-safe *

Accurate life estimation to achieve certification



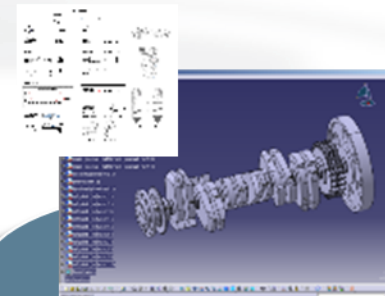
FEA Stress Analysis: Abaqus *

Detailed stress analysis using extracted load history from MBS



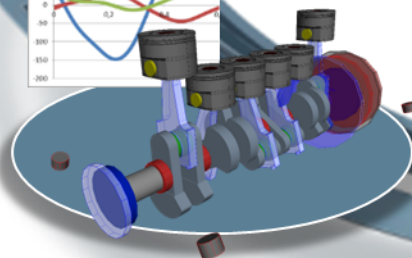
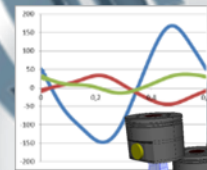
CAD Geometry: CATIA

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



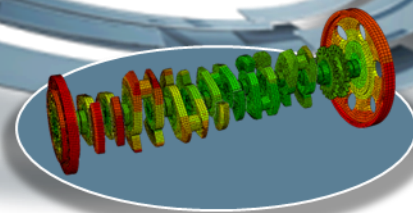
Multibody Simulation: Simpack

System analysis to extract virtual load history of complete working cycle



Mesh Calibration: Isight *

Automated mesh calibration; sufficient mesh quality for accurate results

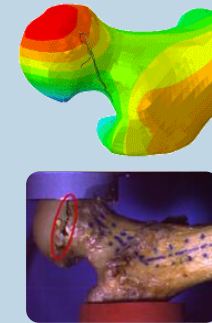


* Included in extended licensing pool

SIMULIA's Power of the Portfolio

Abaqus

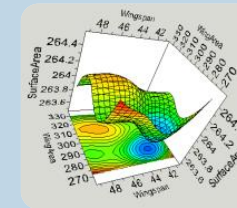
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



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

Isight

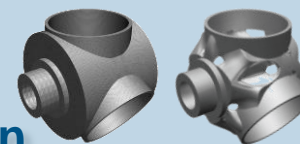
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



**Material Calibration
Workflow Automation
Design Exploration**

Tosca

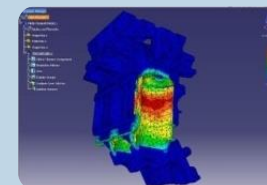
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

fe-safe

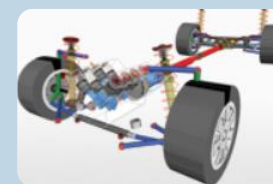
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



**Safety Factors
Creep-Fatigue Interaction
Weld Fatigue**

Simpack

- 3D Multibody Dynamics Simulation
- Mechanical or Mechatronic Systems
- Detailed Transient Simulation (Offline and Realtime)



**Complete System Analyses
(Quasi-)Static, Dynamics, NVH
Flex Bodies, Advanced
Contact**

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Revision Status

Lecture 1	11/17	Updated for Abaqus 2018
Lecture 2	11/17	Updated for Abaqus 2018
Lecture 3	11/17	Updated for Abaqus 2018
Lecture 4	11/17	Updated for Abaqus 2018
Lecture 5	11/17	Updated for Abaqus 2018
Lecture 6	11/17	Updated for Abaqus 2018
Lecture 7	11/17	Updated for Abaqus 2018
Lecture 8	11/17	Updated for Abaqus 2018
Appendix 1	11/17	Updated for Abaqus 2018
Appendix 2	11/17	Updated for Abaqus 2018
Appendix 3	11/17	Updated for Abaqus 2018

Workshop 1	11/17	Updated for Abaqus 2018
Workshop 2	11/17	Updated for Abaqus 2018
Workshop 3	11/17	Updated for Abaqus 2018
Workshop 4	11/17	Updated for Abaqus 2018
Workshop 5	11/17	Updated for Abaqus 2018
Workshop 6	11/17	Updated for Abaqus 2018
Workshop 7	11/17	Updated for Abaqus 2018
Workshop 8	11/17	Updated for Abaqus 2018
Workshop 9	11/17	Updated for Abaqus 2018
Workshop 10	11/17	Updated for Abaqus 2018

Lesson 1: Introduction

Lesson content:

- ▶ General Considerations
- ▶ Surface-based Contact
- ▶ Contact Examples
- ▶ Ingredients of a Contact Model



30 minutes

Lesson 2: Contact Workflow

Lesson content:

- ▶ Defining General Contact
- ▶ Defining Contact Pairs
- ▶ Defining Surfaces for Contact Pairs
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Compression of a Rubber Seal (IA)
- ▶ Workshop 1: Compression of a Rubber Seal (KW)



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



1.5 hours

Lesson 3: Surface-based Contact

Lesson content:

- ▶ Contact Formulations
- ▶ Contact Discretization
- ▶ Contact Enforcement Methods
- ▶ Relative Sliding Between Bodies
- ▶ Contact Output
- ▶ Summary
- ▶ Workshop 2: Lap Joint Analysis (IA)
- ▶ Workshop 2: Lap Joint Analysis (KW)



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



2 hours

Lesson 4: Contact Logic and Diagnostics Tools

Lesson content:

- ▶ Newton Method
- ▶ The Contact Algorithm
- ▶ Contact Diagnostics: Visual
- ▶ Contact Diagnostics: Text
- ▶ Workshop 3: Bolted Flange Analysis (IA)
- ▶ Workshop 3: Bolted Flange Analysis (KW)



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



2 hours

Lesson 5: Contact Properties

Lesson content:

- ▶ Pressure-Overclosure Models
- ▶ Friction Models
- ▶ Friction Enforcement
- ▶ Workshop 4: Disk Forging Analysis (IA)
- ▶ Workshop 4: Disk Forging Analysis (KW)



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



2 hours

Lesson 6: Interference Fits

Lesson content:

- ▶ Initial Overclosure
- ▶ Strain-free Adjustments
- ▶ Interference Fit Problems
- ▶ Interference Fit Techniques for General Contact
- ▶ Interference Fit Techniques for Contact Pairs
- ▶ Interference Fit Example
- ▶ Precise Specification of Clearances
- ▶ Geometric Smoothing for Curved Surfaces
- ▶ Workshop 5: Interference Fit Analysis (IA)
- ▶ Workshop 5: Interference Fit Analysis (KW)
- ▶ Workshop 6: Syringe Analysis (IA)
- ▶ Workshop 6: Syringe Analysis (KW)



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



3 hours

Lesson 7: Additional Features

Lesson content:

- ▶ Beam Contact
- ▶ Tie Constraints
- ▶ Rigid Bodies and Contact
- ▶ Analytical Rigid Surfaces
- ▶ Pre-Tensioning of Cross-Sections
- ▶ Pressure Penetration
- ▶ Contact in Linear Perturbation Procedures
- ▶ Workshop 7: Pipe Reel Analysis (IA)
- ▶ Workshop 7: Pipe Reel Analysis (KW)



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



2 hours

Lesson 8: Modeling Tips

Lesson content:

- ▶ Initial Rigid Body Motion
- ▶ Overconstraint
- ▶ Contact with Quadratic Elements
- ▶ Unsymmetric Matrices in Finite-Sliding Problems
- ▶ Dynamic Instabilities
- ▶ Modeling Corners and Edges
- ▶ Workshop 8: Bolted Flange Analysis: Infinitesimal Sliding (IA)
- ▶ Workshop 8: Bolted Flange Analysis: Infinitesimal Sliding (KW)
- ▶ Workshop 9: Snap Fit Analysis (IA)
- ▶ Workshop 9: Snap Fit Analysis (KW)
- ▶ Workshop 10: Analysis of a Radial Shaft Seal (IA)
- ▶ Workshop 10: Analysis of a Radial Shaft Seal (KW)



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



2 hours

Appendix 1: Node-to-Surface Formulation

Appendix content:

- ▶ Discretization
- ▶ Finite Sliding: Surface Considerations
- ▶ Small Sliding Characteristics
- ▶ Small Sliding: Local Contact Plane
- ▶ Small Sliding: Surface Considerations



1.5 hours

Appendix 2: Contact Elements

Appendix content:

- ▶ Surface-Based vs. Contact Element Approach
- ▶ Contact Elements
- ▶ Contact Element Output
- ▶ Contact Element Visualization



1 hour

Appendix 3: Dynamic Contact using Implicit Integration

Appendix content:

- ▶ Time Integration Issues
- ▶ Implicit Dynamics
- ▶ Damping
- ▶ Impact Problems



1 hour