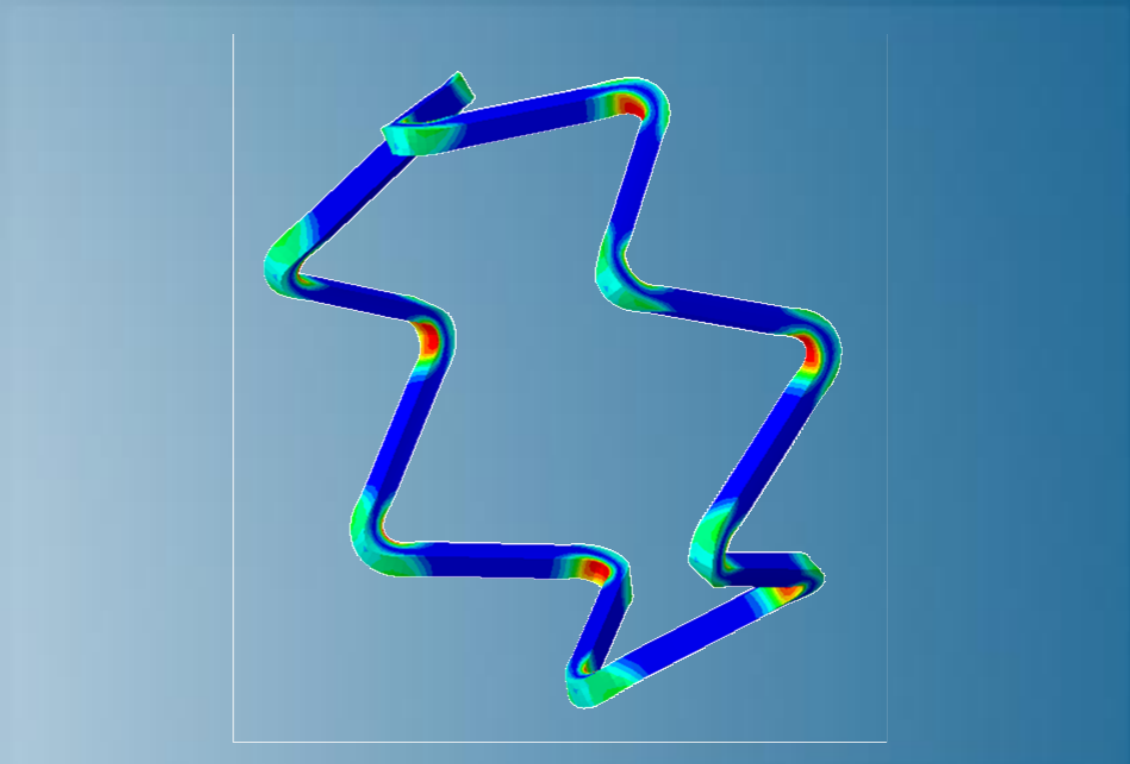


# Modeling Stents Using Abaqus

Abaqus 2019



**3DEXPERIENCE**<sup>®</sup>



# About this Course

## Course objectives

Upon completion of this course you will be able to:

- ▶ Create geometry for modeling stents and tools
- ▶ Choose the proper element type
- ▶ Choose material models: elastic-plastic (Stainless Steel), superelastic-plastic (Nitinol), hyperelastic (vessels)
- ▶ Perform stent analyses: Static, Implicit and Explicit Dynamics
- ▶ Define contact and constraints
- ▶ Postprocess stent analyses
- ▶ Perform fatigue evaluation

## Targeted audience

Simulation Analysts

## Prerequisites

This course is recommended for engineers with experience using Abaqus



2 days

# Day 1

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- ▶ Lecture 1 Introduction
- ▶ Lecture 2 Geometry and Meshing
- ▶ Lecture 3 Element Selection and Mesh Convergence
  - Workshop 1a Balloon-expanded Stent – Geometry and Meshing
  - Workshop 1b Self-expanding Stent – Geometry and Meshing
- ▶ Lecture 4 Material and Section Properties
  - Workshop 2a Balloon-expanded Stent – Materials and Sections
  - Workshop 2b Self-expanding Stent – Materials and Sections

## Day 2

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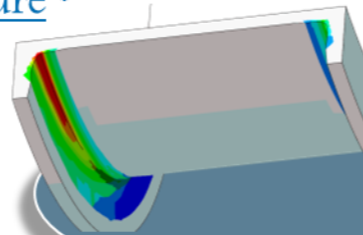
- ▶ Lecture 5            Analysis Procedures
  
- ▶ Lecture 6            Loads, Contact and Constraints
  - Workshop 3a    Balloon-expanded Stent – Analysis Setup
  - Workshop 3b    Self-expanding Stent – Analysis Setup
  
- ▶ Lecture 7            Postprocessing Stent Analyses
  - Workshop 4a    Balloon-expanded Stent – Postprocessing
  - Workshop 4b    Self-expanding Stent – Postprocessing

# SIMULIA

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

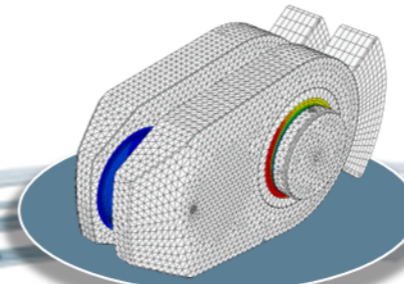
## Design Optimization: Tosca Structure \*

Simulation-driven design refinement to improve performance



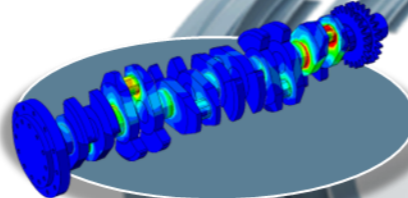
## Durability Assessment: fe-safe \*

Accurate life estimation to achieve certification



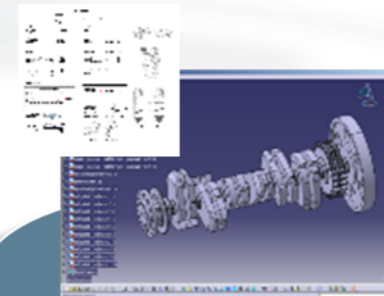
## FEA Stress Analysis: Abaqus \*

Detailed stress analysis using extracted load history from MBS



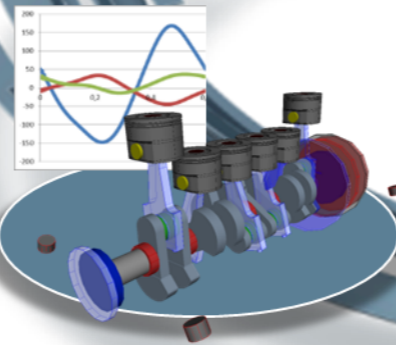
## CAD Geometry: CATIA

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



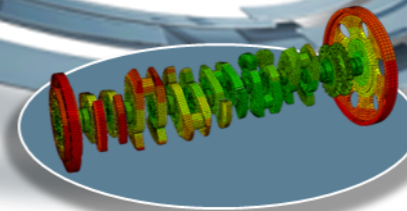
## Multibody Simulation: Simpack

System analysis to extract virtual load history of complete working cycle



## Mesh Calibration: Isight \*

Automated mesh calibration; sufficient mesh quality for accurate results

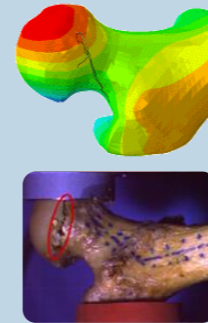


\* Included in extended licensing pool

# SIMULIA's Power of the Portfolio

## Abaqus

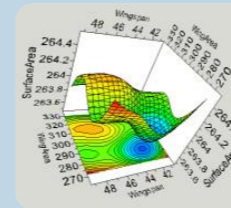
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



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

## Isight

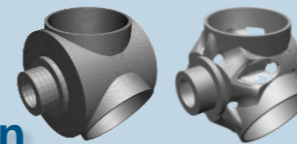
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



**Material Calibration  
Workflow Automation  
Design Exploration**

## Tosca

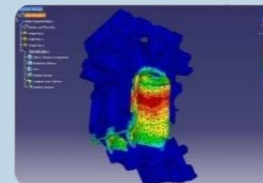
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

## fe-safe

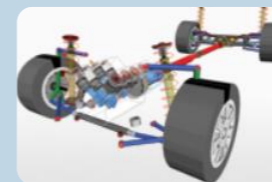
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



**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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Connect with peers to share knowledge and get technical insights

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to log in or join!



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 | The 3DEXPERIENCE Company

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<http://www.3ds.com/products-services/simulia/services/training-courses/>

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- > By Location
- > By Course

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# Revision Status

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Lecture 1	11/18	Updated for Abaqus 2019
Lecture 2	11/18	Updated for Abaqus 2019
Lecture 3	11/18	Updated for Abaqus 2019
Lecture 4	11/18	Updated for Abaqus 2019
Lecture 5	11/18	Updated for Abaqus 2019
Lecture 6	11/18	Updated for Abaqus 2019
Lecture 7	11/18	Updated for Abaqus 2019
Workshop 1a	11/18	Updated for Abaqus 2019
Workshop 1b	11/18	Updated for Abaqus 2019
Workshop 2a	11/18	Updated for Abaqus 2019
Workshop 2b	11/18	Updated for Abaqus 2019
Workshop 3a	11/18	Updated for Abaqus 2019
Workshop 3b	11/18	Updated for Abaqus 2019
Workshop 4a	11/18	Updated for Abaqus 2019
Workshop 4b	11/18	Updated for Abaqus 2019

# Lesson 1: Introduction

## *Lesson content:*

- ▶ Stent Basics
- ▶ Stent Modeling
- ▶ Modeling Stents using Abaqus



30 minutes

# Lesson 2: Geometry and Meshing

## *Lesson content:*

- ▶ Introduction
- ▶ Creating Stents
  - Example: Create Laser Cut Stents
  - Example: Create Braided Wire Stents
- ▶ Creating Expansion and Crimping Tools
- ▶ Stent Residing Vessels
  - Import STL file
- ▶ Import Orphan Meshes
- ▶ Unwrap a Deformed Stent into Flat Geometry



45 minutes

# Lesson 3: Element Selection and Mesh Convergence

## *Lesson content:*

- ▶ Introduction
- ▶ Solid Elements
- ▶ Beam Elements
- ▶ Surface and Membrane Elements
- ▶ Mesh Convergence
- ▶ Workshop Preliminaries
- ▶ Workshop 1a: Balloon-expanded Stent – Geometry and Meshing
- ▶ Workshop 1b: Self-expanding Stent – Geometry and Meshing



1.5 hours

# Lesson 4: Material and Section Properties

## *Lesson content:*

- ▶ Introduction
- ▶ Linear Elastic-plastic Material
- ▶ Nitinol
- ▶ Hyperelastic Material
- ▶ References
- ▶ Workshop 2a: Balloon-expanded Stent – Materials and Sections
- ▶ Workshop 2b: Self-expanding Stent – Materials and Sections



1.5 hours

# Lesson 5: Analysis Procedures

## *Lesson content:*

- ▶ Introduction
- ▶ Static Analysis
- ▶ Implicit Dynamics
- ▶ Natural Frequency Extraction
- ▶ Explicit Dynamics
- ▶ Quasi-static Analysis Using Dynamic Procedures
- ▶ Annealing
- ▶ Importing and Transferring Results



1.5 hours

# Lesson 6: Loads, Contact, and Constraints

## *Lesson content:*

- ▶ Introduction
- ▶ Loads and Boundary Conditions
- ▶ Contact
  - General Contact
  - Contact Pairs
  - Local Surface Behavior
  - Contact Enforcement Methods
  - Contact Stabilization
- ▶ Constraints
- ▶ Cyclic Symmetry
- ▶ Workshop 3a: Balloon-expanded Stent – Analysis Setup
- ▶ Workshop 3b: Self-expanding Stent – Analysis Setup



2.5 hours

# Lesson 7: Results Postprocessing

## *Lesson content:*

- ▶ Introduction
- ▶ Results Visualization
- ▶ Fatigue Evaluation
- ▶ Workshop 4a: Balloon-expanded Stent – Postprocessing
- ▶ Workshop 4b: Self-expanding Stent – Postprocessing



1.5 hours