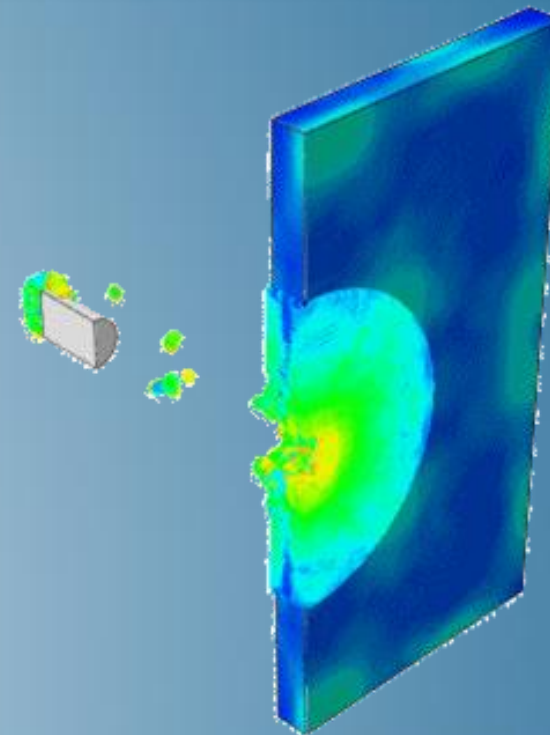


Modeling Extreme Deformation and Fluid Flow with Abaqus

Abaqus 2017



3DEXPERIENCE®



About this Course

Course objectives

Upon completion of this course you will be able to:

- ▶ Create Eulerian meshes and define the initial material location within an Eulerian mesh
- ▶ Specify initial conditions, boundary conditions and loads to materials in the Eulerian domain
- ▶ Use general contact to model Eulerian-Lagrangian interactions
- ▶ Create SPH meshes
- ▶ Automatically convert conventional continuum elements to SPH particles
- ▶ Define initial conditions, boundary conditions, and loads on SPH particles
- ▶ Define contact interactions between SPH particles and element-based or analytical surfaces
- ▶ Understand the differences between the CEL and SPH approaches

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus



2 days

Day 1

- ▶ Lecture 1 Introduction
- ▶ Lecture 2 Overview of CEL (Coupled Eulerian-Lagrangian) Analysis
- ▶ Lecture 3 Creating a CEL Model
- ▶ Workshop 1 Deformation of an Elastic Dam under Time-dependent Water Pressure
- ▶ Lecture 4 Abaqus/CAE Volume Fraction Tool
- ▶ Lecture 5 CEL Modeling Techniques
- ▶ Workshop 2 Bird Strike Impact on Double-walled Aircraft Fuselage

Day 2

- ▶ Lecture 6 CEL for Fluid Applications
- ▶ Lecture 7 Overview of SPH (Smoothed Particle Hydrodynamics)
- ▶ Lecture 8 SPH Modeling Techniques
- ▶ Workshop 3 Bird Strike on an Airplane Engine Blade
- ▶ Lecture 9 Comparison of CEL and SPH

Additional Material

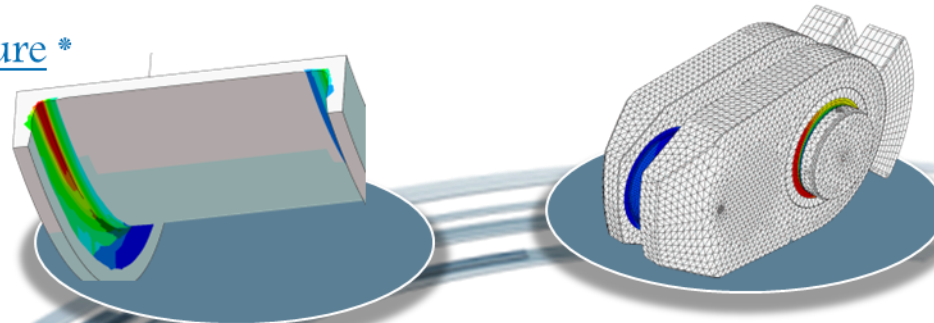
- ▶ Appendix 1 SPH Theory

SIMULIA

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

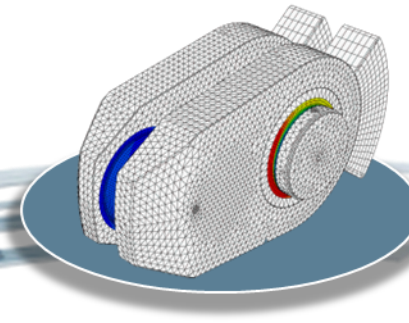
Design Optimization: Tosca Structure *

Simulation-driven design refinement to improve performance



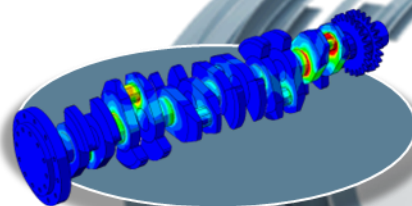
Durability Assessment: fe-safe *

Accurate life estimation to achieve certification



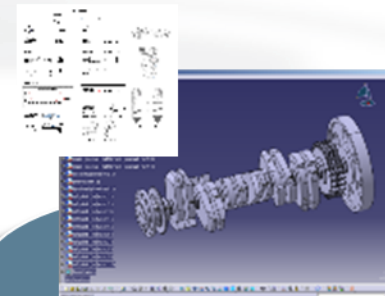
FEA Stress Analysis: Abaqus *

Detailed stress analysis using extracted load history from MBS



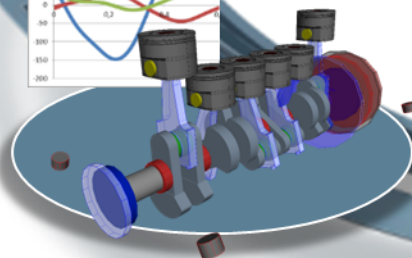
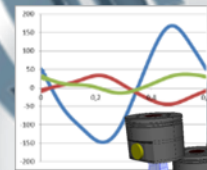
CAD Geometry: CATIA

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



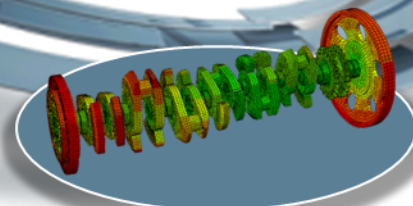
Multibody Simulation: Simpack

System analysis to extract virtual load history of complete working cycle



Mesh Calibration: Isight *

Automated mesh calibration; sufficient mesh quality for accurate results

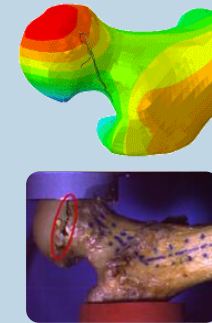


* Included in extended licensing pool

SIMULIA's Power of the Portfolio

Abaqus

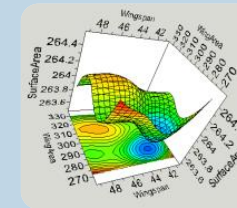
- Routine and Advanced Simulation
- Linear and Nonlinear, Static and Dynamic
- Thermal, Electrical, Acoustics
- Extended Physics through Co-simulation
- Model Preparation and Visualization



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

Isight

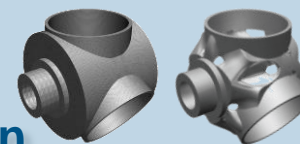
- Process Integration
- Design Optimization
- Parametric Optimization
- Six Sigma and Design of Experiments



**Material Calibration
Workflow Automation
Design Exploration**

Tosca

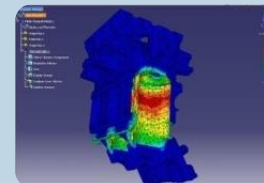
- Non-Parametric Optimization
- Structural and Fluid Flow Optimization
- Topology, Sizing, Shape, Bead Optimization



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

fe-safe

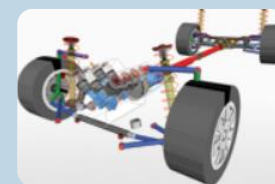
- Durability Simulation
- Low Cycle and High Cycle Fatigue
- Weld, High Temperature, Non-metallics



**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
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Flex Bodies, Advanced
Contact**

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Revision Status

Lecture 1	3/17	Minor edits
Lecture 2	11/16	Updated for Abaqus 2017
Lecture 3	11/16	Updated for Abaqus 2017
Lecture 4	11/16	Updated for Abaqus 2017
Lecture 5	11/16	Updated for Abaqus 2017
Lecture 6	11/16	Updated for Abaqus 2017
Lecture 7	11/16	Updated for Abaqus 2017
Lecture 8	11/16	Updated for Abaqus 2017
Lecture 9	11/16	Updated for Abaqus 2017
Appendix 1	11/16	Updated for Abaqus 2017
Workshop 1	11/16	Updated for Abaqus 2017
Workshop 2	11/16	Updated for Abaqus 2017
Workshop 3	11/16	Updated for Abaqus 2017

Lesson 1: Introduction

Lesson content:

- ▶ Multiphysics / Multiscale Simulation
- ▶ SIMULIA Multiphysics
- ▶ Abaqus Multiphysics
- ▶ Coupled Eulerian-Lagrangian (CEL) approach
- ▶ Smoothed Particle Hydrodynamics (SPH) approach



1 hour

Lesson 2: Overview of CEL (Coupled Eulerian-Lagrangian) Analysis

Lesson content:

- ▶ CEL Analysis Technique
- ▶ CEL Examples
- ▶ Detailed case study: Tire Hydroplaning/Aquaplaning



45 minutes

Lesson 3: Creating a CEL Model

Lesson content:

- ▶ Case Study Introduction: Front-load washing machine
- ▶ Defining the Eulerian Domain
- ▶ Eulerian-Lagrangian Coupling
- ▶ Postprocessing—Basic tips
- ▶ Postprocessing—Additional suggestions
- ▶ Summary
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Deformation of an Elastic Dam under Time-dependent Water Pressure



2 hours

Lesson 4: Abaqus/CAE Volume Fraction Tool

Lesson content:

- ▶ Introduction
- ▶ Using the volume fraction tool
- ▶ Tips



30 minutes

Lesson 5: Coupled Eulerian-Lagrangian Modeling Techniques

Lesson content:

- ▶ Element types and procedures
- ▶ Initial conditions, boundary conditions, and loads
- ▶ Eulerian mesh motion
- ▶ Contact
- ▶ Mesh density
- ▶ Adaptive mesh refinement
- ▶ Materials and material instances
- ▶ Output and postprocessing
- ▶ Tracer particles
- ▶ Comparison to Lagrangian analysis
- ▶ Limitations
- ▶ Workshop 2: Bird Strike Impact on Double-walled Aircraft Fuselage



2.5 hours

Lesson 6: CEL for Fluid Applications

Lesson content:

- ▶ EOS Materials
- ▶ CEL and Flow Problems
- ▶ Flow Benchmarks
- ▶ Hourglass Control
- ▶ Boundary Reflections
- ▶ Tips
- ▶ Troubleshooting Checklist



2 hours

Lesson 7: Overview of SPH (Smoothed Particle Hydrodynamics)

Lesson content:

- ▶ Introduction
- ▶ Examples
 - ▣ Water-wave impact
 - ▣ Priming a Pump
 - ▣ Bottle Drop
 - ▣ Garden Hose
 - ▣ Taylor Test
 - ▣ Projectile Impact on a Plate
 - ▣ Hail Impact
- ▶ SPH Basics
- ▶ SPH Interpolation



1 hour

Lesson 8: SPH Modeling Techniques

Lesson content:

- ▶ Overview
- ▶ Particle elements
- ▶ Model definition
- ▶ Optional controls
- ▶ Converting finite elements to SPH particles
- ▶ Limitations
- ▶ Workshop 3: Bird Strike on an Airplane Engine Blade



2 hours

Lesson 9: Comparison of CEL and SPH

Lesson content:

- ▶ Abbreviations
- ▶ Material considerations
- ▶ Contact considerations
- ▶ Geometry and mesh considerations
- ▶ Analysis type considerations
- ▶ Computational considerations
- ▶ Summary tables
 - Functionality-based comparison
 - Application-based comparison



45 minutes

Appendix 1: SPH Theory

Appendix content:

- ▶ Introduction
- ▶ Basic Properties of Kernels
- ▶ Particle Approximation
- ▶ SPH Interpolation
- ▶ Lucy's Weight Function
- ▶ Characteristic Properties of SPH
- ▶ SPH Applications
- ▶ References



45 minutes