Modeling Extreme Deformation and Fluid Flow with Abaqus
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 an element-based or analytical surfaces
- Understand the differences between the CEL, SPH, and CFD approaches

Targeted audience
Simulation Analysts

Prerequisites
This course is recommended for engineers with experience using Abaqus
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: Overview of Abaqus/CFD
- Workshop 4: Unsteady flow across a circular cylinder
- Lecture 10: Comparison of CEL, CFD, and SPH
Additional Material

- Appendix 1: SPH Theory
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## Revision Status

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Lesson 1: Introduction

Lesson content:

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

1 hour
Lesson content:

- CEL Analysis Technique
- CEL Examples
- Detailed case study: Tire Hydroplaning/Aquaplaning
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
Lesson 4: Abaqus/CAE Volume Fraction Tool

Lesson content:

- Introduction
- Using the volume fraction tool
- Tips

30 minutes
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
- Comparison to Lagrangian analysis
- Limitations
- Workshop 2: Bird Strike Impact on Double-walled Aircraft Fuselage
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
Lesson 8: SPH Modeling Techniques

Lesson content:

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

- Abaqus/CFD
- Fluid-Structure Interaction (FSI)
- Native FSI using Abaqus
- Target Applications
- Execution Procedure
- Workshop 4: Unsteady Flow Across a Circular Cylinder
Lesson content:

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