

Topology and Shape Optimization in Abaqus



About this Course

Course objectives

Upon completion of this course you will be able to:

- Use topology and shape optimization techniques in Abaqus to your designs and produce lightweight, strong and durable components
- Reduce iterations of designs
- Use the ATOM interface in Abaqus/CAE for setup, execution, monitoring and postprocessing of topology and shape optimization problems
- Use ATOM's structural optimization capability for highly nonlinear problems

Targeted audience

Finite element analysts or product designers with some background in finite element analysis

Prerequisites

Some familiarity with Abaqus/CAE is useful but not required.



1 day

Day 1

- ▶ Lecture 1 Introduction
- ▶ Lecture 2 Condition-based Topology Optimization
- ▶ Workshop 1 Condition-based Topology Optimization of a Gear

- ▶ Lecture 3 Geometric Restrictions and Filtering
- ▶ Workshop 2a Stamping Geometric Restrictions
- ▶ Workshop 2b Demold Control Using the Central Plane Technique
- ▶ Workshop 2c Symmetry Geometric Restrictions

- ▶ Lecture 4 Sensitivity-based Topology Optimization
- ▶ Workshop 3 Sensitivity-based Topology Optimization of a Gear

- ▶ Lecture 5 Shape Optimization
- ▶ Workshop 4 Shape Optimization of a Plate with a Hole

- ▶ Lecture 6 Nonlinear Effects in Topology Optimization

Additional Material

- ▶ Appendix 1 Geometric Restrictions in Shape Optimization

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Revision Status

Lecture 1	10/13	Updated for 6.13
Lecture 2	10/13	Updated for 6.13
Lecture 3	10/13	Updated for 6.13
Lecture 4	10/13	Updated for 6.13
Lecture 5	10/13	Updated for 6.13
Lecture 6	10/13	Updated for 6.13
Appendix 1	10/13	Updated for 6.13
Workshop 1	10/13	Updated for 6.13
Workshop 2a	10/13	Updated for 6.13
Workshop 2b	10/13	Updated for 6.13
Workshop 2c	10/13	Updated for 6.13
Workshop 3	10/13	Updated for 6.13
Workshop 4	10/13	Updated for 6.13

Lesson 1: Introduction

Lesson content:

- ▶ Overview
- ▶ Structural optimization
 - Sizing
 - Shape
 - Topology
- ▶ Abaqus Topology Optimization Module (ATOM)
- ▶ ATOM and Isight

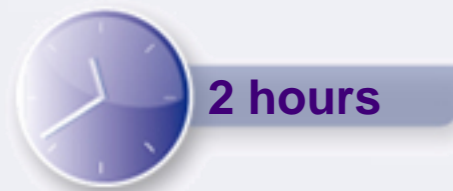


10 minutes

Lesson 2: Condition-based Topology Optimization

Lesson content:

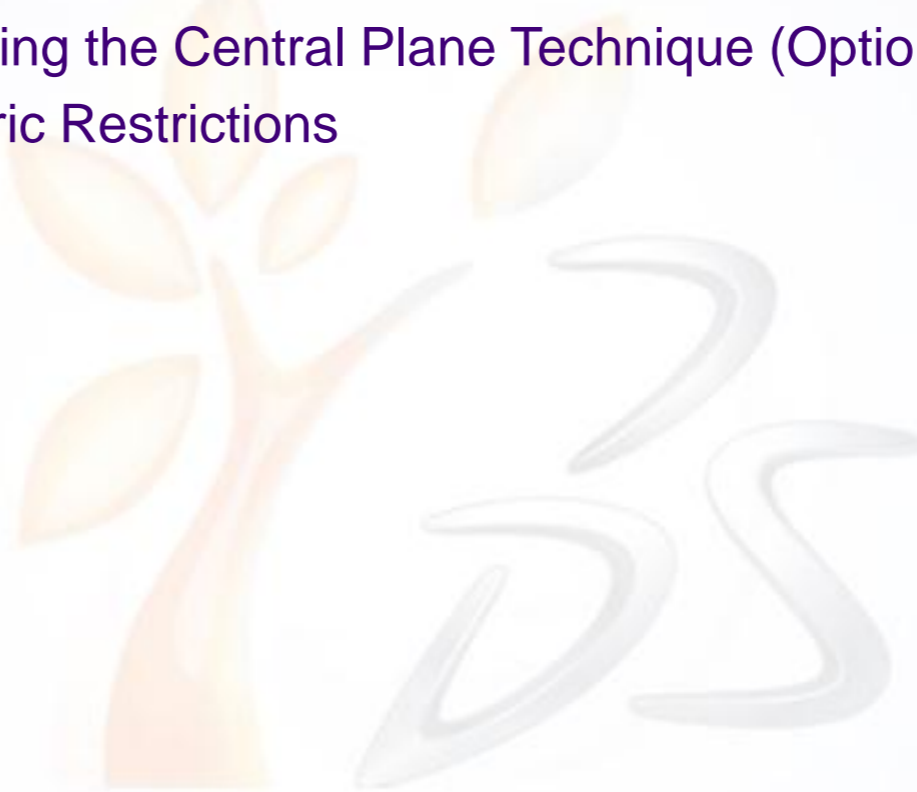
- ▶ Algorithms for Topology Optimization
- ▶ Condition-based Topology Optimization
- ▶ Basic Terminology
- ▶ ATOM Workflow
- ▶ Abaqus Model
- ▶ Optimization Tasks
- ▶ Design Responses
- ▶ Objective Functions
- ▶ Constraints
- ▶ Geometric Restrictions
- ▶ Setup
- ▶ Execution and Monitoring
- ▶ Results
- ▶ Extraction
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Condition-based Topology Optimization of a Gear



Lesson 3: Geometric Restrictions and Filtering

Lesson content:

- ▶ Geometric Restrictions
- ▶ Filtering
- ▶ Workshop 2a: Stamping Geometric Restrictions
- ▶ Workshop 2b: Demold Control Using the Central Plane Technique (Optional)
- ▶ Workshop 2c: Symmetry Geometric Restrictions



Lesson 4: Sensitivity-based Topology Optimization

Lesson content:

- ▶ Algorithms for Topology Optimizations
- ▶ General Topology Optimization
- ▶ Optimization Tasks
- ▶ Design Responses
- ▶ Objective Functions
- ▶ Constraints
- ▶ Condition-based vs. Sensitivity-based Optimization
- ▶ Postprocessing
- ▶ Workshop 3: Sensitivity-based Topology Optimization of a Gear



1.5 hours

Lesson 5: Shape Optimization

Lesson content:

- ▶ Basic Terminology
- ▶ Shape Optimization
- ▶ Abaqus Model
- ▶ Optimization Tasks
- ▶ Design Responses
- ▶ Objectives and Constraints
- ▶ Geometric Restrictions
- ▶ Stop Conditions
- ▶ Postprocessing
- ▶ Workshop 4: Shape Optimization of a Plate with a Hole



1 hour

Lesson 6: Nonlinear Effects in Topology Optimization

Lesson content:

- ▶ Example: Beam Structure
- ▶ Topology Optimization of a Beam Structure: Linear geometry
- ▶ Topology Optimization of a Beam Structure: Nonlinear geometry
- ▶ Example: Gear Shaft Assembly
- ▶ Gear Shaft Assembly: Results
- ▶ Conclusions



30 minutes

Appendix 1: Geometric Restrictions in Shape Optimization

Lesson content:

- ▶ Demold Control
- ▶ Turn Control
- ▶ Drill Control
- ▶ Planar Symmetry
- ▶ Stamp Control
- ▶ Growth
- ▶ Design Direction
- ▶ Penetration Check
- ▶ Slide Region



45 minutes