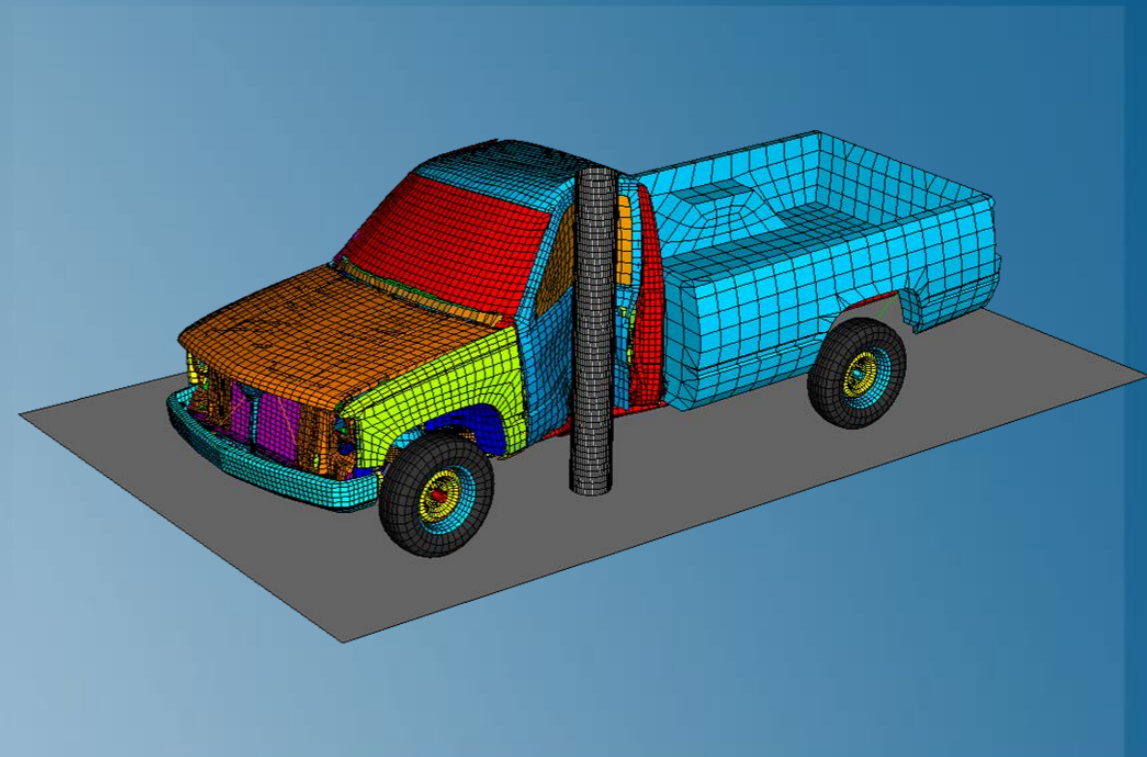


# Crashworthiness Analysis with Abaqus

Abaqus 2022



**3DEXPERIENCE**<sup>®</sup>

# About this Course

## Course objectives

This course covers:

- ▶ Abaqus fundamentals and input syntax
- ▶ General "automatic" contact modeling
- ▶ Element selection for crash simulation
- ▶ Constraints and connections modeling
- ▶ Material models used in crash simulation
- ▶ Multiple mechanism damage and failure modeling

## Targeted audience

New and experienced users of Abaqus who will perform structural crashworthiness or occupant safety simulations.

## Prerequisites

No previous knowledge of Abaqus is required, but knowledge of finite elements and engineering mechanics is necessary.



3 days

# Day 1

---

- ▶ Lesson 1 Introduction and Motivation
- ▶ Lesson 2 Setting up an Abaqus Model
- ▶ Lesson 3 Explicit Dynamics in Abaqus
- ▶ Lesson 4 Contact Modeling
  - Workshop 1 Impact of a Dodge Caravan Bumper against a Rigid Barrier

## Day 2

---

- ▶ Lesson 5            Element Technology
  
- ▶ Lesson 6            Constraints and Connections
  - Workshop 2      Crash Analysis of a Rail
  
  - Workshop 3      Door Pole-Intrusion Test
  
  - Workshop 4      Iltis All-Terrain Vehicle Curb Strike
  
- ▶ Lesson 7            Material Modeling

**Important note: Submit the global model for Workshop 7 prior to completing work on this day.**

## Day 3

---

- ▶ Lesson 8            Advanced Analysis Techniques
  - Workshop 5      Side Impact Analysis of a Pickup Truck using Submodeling Technique
  
- ▶ Lesson 9            Crash Output
  - Workshop 6      Curved Beam Analysis
  
- ▶ Lesson 10          Co-simulation
  - Workshop 7      Beam Impact Co-simulation

# Additional Material

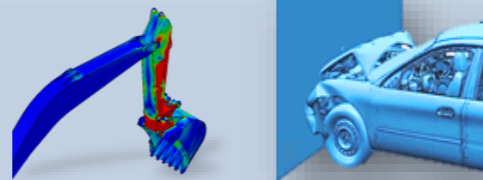
---

- ▶ Appendix 1            Contact Pairs
  
- ▶ Appendix 2            Seatbelts
  - Workshop 8        Seatbelt Safety System
  
- ▶ Appendix 3            Airbags
  - Workshop 9        Deployment of a Multi-Chambered Airbag
  
- ▶ Appendix 4            Tire Modeling and Analysis
  
- ▶ Appendix 5            Output Filtering
  - This appendix includes a detailed discussion of output filtering for general applications; however, the information is relevant for crash analysis.
  
- ▶ Appendix 6            Translators

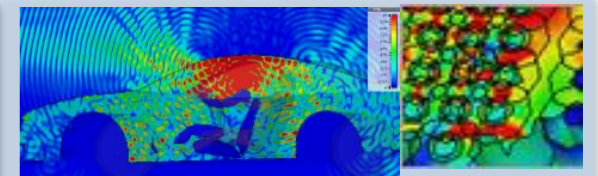
# SIMULIA

- ▶ SIMULIA is the Dassault Systèmes brand for realistic simulation solutions.
- ▶ Advanced simulation portfolio covering simulation disciplines such as structural mechanics, computational fluid dynamics and electromagnetic field simulation, for a true multiphysics simulation approach.

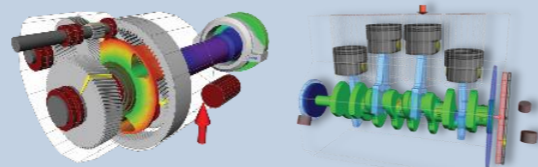
## Structures



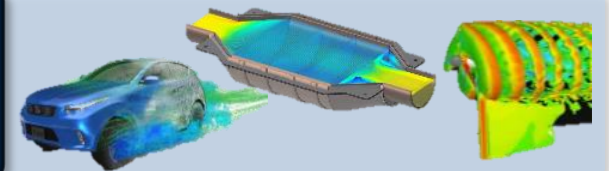
## Electromagnetics



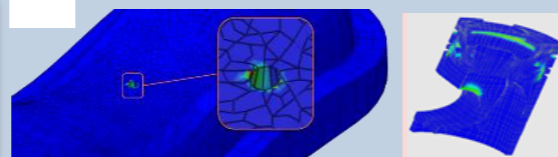
## Multibody



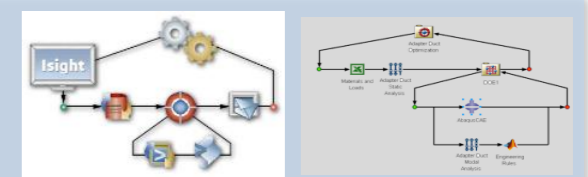
## Fluids



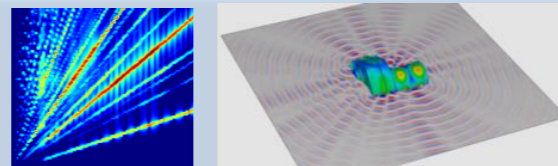
## Durability



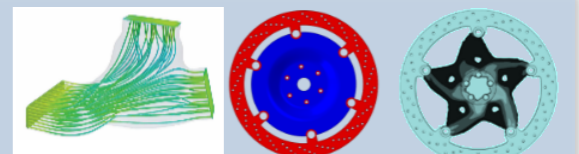
## Automation



## Vibro-acoustics



## Optimization



# Join the Community!

Go to [go.3ds.com/simc](http://go.3ds.com/simc) to log in or join!



## SIMULIA COMMUNITY

BECOME PART OF A GLOBAL USER COMMUNITY FOCUSED ON ADVANCING THE USE OF SIMULIA SIMULATION SOLUTIONS IN SCIENCE AND ENGINEERING

[LOGIN NOW](#)

### Join Us

Interested in the latest in simulation? Looking for advice and best practices? Want to discuss simulation with fellow users and Dassault Systèmes experts?

The SIMULIA Community is the place to be.

Simply [log in](#) with your 3DS Passport username and password. If you use DSx Client Care for technical support, you can use these same credentials to access the community.

If you do not already have a 3DS Passport, you can [register now](#). An account is free and access is instant.



### Join the conversation

Start a discussion with other members of the SIMULIA Community. Talk through your burning simulation questions with peers, SIMULIA experts and SIMULIA Champions. Apply to be an author to create posts, share useful tips you've discovered for SIMULIA software and establish yourself as a thought-leader. The SIMULIA Community is home to both SIMULIA product users across the world, and to SIMULIA subject matter experts.

### Stay up to date on the latest news

Modern industry trends change rapidly, and SIMULIA is always developing its products to stay ahead. Follow the SIMULIA Community to be informed of new product releases and updates to the Knowledge Base, and to receive links to articles and blog posts about the latest industry trends.



### Browse e-learning resources

The SIMULIA Community brings together learning materials covering numerous applications for SIMULIA products. Read a whitepaper on the benefits of simulation in your work, discover tips and tricks for using SIMULIA software efficiently, or watch a demonstration of how to use simulation to achieve your goals.

# SIMULIA Training

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



## SIMULIA TRAINING

PROVIDING TRAINING SERVICES TO ENABLE OUR CUSTOMERS TO BE MORE PRODUCTIVE AND COMPETITIVE

FIND A BUSINESS PARTNER

### Simulation Training

SIMULIA and our education partners offer regularly scheduled public seminars as well as training courses at customer sites. An extensive range of courses are available, ranging from basic introductions to advanced courses that cover specific analysis topics and applications. The same courseware, and other content, is available for self-paced eLearning. On-site courses can be customized to focus on topics of particular interest to the customer, based on the customer's prior specification. To view the worldwide course schedule, register for a course, or to learn more about our eLearning options, visit the links below.

### SIMULIA DIRECT TRAINING



Instructor-lead training of both off-the-shelf materials and customized content based on your needs.

### MENTORING



Mentoring consists of short-term engagements to accelerate the efficiency and effectiveness of your processes

### EDUCATION PARTNER TRAINING



SIMULIA has a large eco-system of education partners with certified instructors who also

### SIMULIA ELEARNING RESOURCES



SIMULIA provides extensive eLearning solutions, published on various platforms, to enable:

## Legal Notices

---

The software described in this documentation is available only under license from Dassault Systèmes or its subsidiaries and may be used or reproduced only in accordance with the terms of such license.

This documentation and the software described in this documentation are subject to change without prior notice.

Dassault Systèmes and its subsidiaries shall not be responsible for the consequences of any errors or omissions that may appear in this documentation.

No part of this documentation may be reproduced or distributed in any form without prior written permission of Dassault Systèmes or its subsidiaries.

© Dassault Systèmes, 2021

Printed in the United States of America.

Abaqus, the 3DS logo, and SIMULIA are trademarks or registered trademarks of Dassault Systèmes or its subsidiaries in the US and/or other countries.

Other company, product, and service names may be trademarks or service marks of their respective owners. For additional information concerning trademarks, copyrights, and licenses, see the Legal Notices in the SIMULIA User Assistance.

# Revision Status

---

<b>Lesson 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 2</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 3</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 4</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 5</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 6</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 7</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 8</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 9</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Lesson 10</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 2</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 3</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 4</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 5</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Appendix 6</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>

<b>Workshop 1</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 2</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 3</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 4</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 5</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 7</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 8</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>
<b>Workshop 9</b>	<b>11/21</b>	<b>Updated for Abaqus 2022</b>

# Lesson 1: Introduction and Motivation

## *Lesson content:*

- ▶ Background
- ▶ Selected Crashworthiness Applications
- ▶ Abaqus Crashworthiness Functionality



1 hour

# Lesson 2: Setting up an Abaqus analysis

## *Lesson content:*

- ▶ Components of an Abaqus Model
- ▶ Details of an Abaqus Input File
- ▶ Abaqus Input Conventions
- ▶ Abaqus Output
- ▶ Loads and Boundary Conditions
- ▶ Initial Conditions
- ▶ Example: Tube Crush Model
- ▶ Results Visualization
- ▶ Documentation
- ▶ Parallel Execution



2 hours

# Lesson 3: Explicit Dynamics in Abaqus

## *Lesson content:*

- ▶ What is Explicit Dynamics?
- ▶ Overview of Abaqus/Explicit
- ▶ Stable Time Increment
- ▶ Mass Scaling



1 hour

# Lesson 4: Contact Modeling

## *Lesson content:*

- ▶ Contact in Abaqus/Explicit
- ▶ Overview of General Contact
- ▶ Basic Features of General Contact
- ▶ Keyword Interface
- ▶ Additional Features of General Contact
- ▶ General Contact Output
- ▶ Tips for Diagnosing Contact Errors
- ▶ Additional Information
- ▶ Workshop Preliminaries
- ▶ Workshop 1: Impact of a Dodge Caravan Bumper against a Rigid Barrier



2 hours

# Lesson 5: Element Technology

## *Lesson content:*

- ▶ Introduction
- ▶ Designing the Crash Mesh
- ▶ Solid Elements
- ▶ Shell Elements
- ▶ Membrane Elements
- ▶ Beam and Truss Elements
- ▶ Special-Purpose Elements
- ▶ Section Controls to Modify Element Formulation



1.5 hours

# Lesson 6: Constraints and Connections

## *Lesson content:*

- ▶ Introduction
- ▶ Multi-Point Constraints
- ▶ Rigid Bodies
- ▶ Surface-Based Coupling Constraints
- ▶ Connector Elements
- ▶ Surface-Based Tie Constraints
- ▶ Offset Tied Interfaces
- ▶ Mesh-Independent Fasteners
- ▶ Cohesive Connections
- ▶ Tips for Diagnosing Constraint and Connection Errors
- ▶ Workshop 2: Crash Analysis of a Rail
- ▶ Workshop 3: Door Pole-Intrusion Test
- ▶ Workshop 4: Iltis All-Terrain Vehicle Curb Strike



3 hours

# Lesson 7: Material Modeling

## *Lesson content:*

- ▶ Introduction
- ▶ Material Data Definition
- ▶ Metal Plasticity
- ▶ Progressive Damage and Failure
- ▶ Hyperelastic Solid Rubbers
- ▶ Hyperfoam
- ▶ Low Density Foam
- ▶ Crushable Foams
- ▶ Other Material Properties and Models
- ▶ Encrypting Material Data



2 hours

# Lesson 8: Advanced Analysis Techniques

## *Lesson content:*

- ▶ Static Initialization and Import
- ▶ Selective Subcycling
- ▶ Submodeling
- ▶ Incorporating Manufacturing Effects
- ▶ Quasi-Static Analysis
- ▶ Restart
- ▶ Workshop 5: Side Impact Analysis of a Pickup Truck using the Submodeling Technique



2 hours

# Lesson 9: Output

## *Lesson content:*

- ▶ Output
- ▶ Workshop 6: Curved Beam Analysis



2 hours

# Lesson 10: Co-simulation

## *Lesson content:*

- ▶ Introduction
- ▶ Examples
- ▶ Co-simulation Modeling
- ▶ Postprocessing
- ▶ Substructuring
- ▶ Workshop 7: Beam Impact Co-simulation



2 hours

# Appendix 1: Contact Pairs

## *Appendix content:*

- ▶ Contact Pairs



0.5 hour

# Appendix 2: Seatbelts

## *Appendix content:*

- ▶ Seatbelts
- ▶ Workshop 8: Seatbelt Safety System



2.5 hours

# Appendix 3: Airbags

## *Appendix content:*

- ▶ Airbags Overview
- ▶ Uniform Pressure Method
- ▶ Lumped Kinetic Molecular Method
- ▶ Coupled Eulerian-Lagrangian Method
- ▶ Workshop 9: Deployment of a Multi-Chambered Airbag



2.5 hours

# Appendix 4: Tire Modeling and Analysis

## *Appendix content:*

- ▶ Tire Modeling and Analysis



0.5 hour

# Appendix 5: Output Filtering

## *Appendix content:*

- ▶ Introduction
- ▶ What is aliasing?
- ▶ Preventing aliasing
- ▶ On-demand output
- ▶ Abaqus/Viewer postprocessing filters
- ▶ Filter options
- ▶ Filter distortions
- ▶ References



1 hour

# Appendix 6: Translators

## *Appendix content:*

- ▶ Translator from PAM-CRASH to Abaqus
- ▶ Translator from RADIOSS to Abaqus
- ▶ Translator from LS-DYNA to Abaqus



45 minutes