Course objectives
Upon completion of this course you will be able to:

- Understand all necessary elements for railway modeling
- Set up railway vehicles according to common concepts
- Set up, run and analyze typical applications for railway models

Targeted Audience
- Simulation analysts and design engineers in the railway industry
- Multibody simulation experts with no previous experience of railway simulation in Simpack

Prerequisites
- Before undertaking this course, you should have completed the Introduction to Simpack training course
- Some familiarity with fundamental railway theory
Day 1

- Lesson 1  Basic Elements
  - Workshop 1  Single Wheelset
- Lesson 2  Plots and Outputs
- Lesson 3  Track Settings
  - Workshop 2  Track Definition
- Lesson 4  Suspension Modeling
  - Workshop 3  Full Vehicle
- Lesson 5  Finalize Model Setup
  - Workshop 4  Preloads and Solver
Day 2

- Lesson 6  Quasilinearization
  - Workshop 5  Calculate Eigenvalues

- Lesson 7  Critical Speed
  - Workshop 6  Root Loci (Linear Critical Speed)
  - Workshop 7  Nonlinear Critical Speed

- Lesson 8  Typical Applications
  - Workshop 8  Derailment
  - Workshop 9  Comfort Analysis
  - Workshop 10  Roll Coefficient

- Lesson 9  Additional Rail Topics  (optional)
  - Workshop 11  Independent Wheels  (optional)
  - Workshop 12  Roller Rig  (optional)
  - Workshop 13  Elastic Track Foundation  (optional)
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

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<tr>
<th>Software</th>
<th>Features</th>
<th>Applications</th>
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<tr>
<td><strong>Abaqus</strong></td>
<td>• Routine and Advanced Simulation&lt;br&gt;• Linear and Nonlinear, Static and Dynamic&lt;br&gt;• Thermal, Electrical, Acoustics&lt;br&gt;• Extended Physics through Co-simulation&lt;br&gt;• Model Preparation and Visualization</td>
<td>Realistic Human Simulation&lt;br&gt;High Speed Crash &amp; Impact&lt;br&gt;Noise &amp; Vibration</td>
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<td><strong>Isight</strong></td>
<td>• Process Integration&lt;br&gt;• Design Optimization&lt;br&gt;• Parametric Optimization&lt;br&gt;• Six Sigma and Design of Experiments</td>
<td>Material Calibration&lt;br&gt;Workflow Automation&lt;br&gt;Design Exploration</td>
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<td><strong>Tosca</strong></td>
<td>• Non-Parametric Optimization&lt;br&gt;• Structural and Fluid Flow Optimization&lt;br&gt;• Topology, Sizing, Shape, Bead Optimization</td>
<td>Conceptual/Detailed Design&lt;br&gt;Weight, Stiffness, Stress&lt;br&gt;Pressure Loss Reduction</td>
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<td><strong>fe-safe</strong></td>
<td>• Durability Simulation&lt;br&gt;• Low Cycle and High Cycle Fatigue&lt;br&gt;• Weld, High Temperature, Non-metallics</td>
<td>Safety Factors&lt;br&gt;Creep-Fatigue Interaction&lt;br&gt;Weld Fatigue</td>
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<tr>
<td><strong>Simpack</strong></td>
<td>• 3D Multibody Dynamics Simulation&lt;br&gt;• Mechanical or Mechatronic Systems&lt;br&gt;• Detailed Transient Simulation (Offline and Realtime)</td>
<td>Complete System Analyses (Quasi-)Static, Dynamics, NVH&lt;br&gt;Flex Bodies, Advanced Contact</td>
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- **Safety Factors**
- **Creep-Fatigue Interaction**
- **Weld Fatigue**
- **Durability Simulation**
- **Low Cycle and High Cycle Fatigue**
- **Weld, High Temperature, Non-metallics**
- **Realistic Human Simulation**
- **High Speed Crash & Impact**
- **Noise & Vibration**
- **Material Calibration**
- **Workflow Automation**
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- By Location
- By Course

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- Full Schedule
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# Revision Status

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Lesson 1: Basic Elements

Lesson content:

- Simpack Rail
- Track Joints
- Specific Modeling Elements
- Model Setup Strategy
- Rail-Wheel Pairs
- Rail Element
- Geometry Data
- Profile Position and Projection
- Possible Configurations for Wheel Setup
- Possible Configurations for Rail Setup
- Contact Search
- Normal Contact Evaluation
- Creepage
- Tangential Forces
- Wheelset
- Basic Rail Elements Overview
- Typical Rail Vehicle Model
- Data Handling

1 Hour
Workshop 1: Single Wheelset

Aim:

1. Understand how a Wheelset is set up
2. Become familiar with the Railway Specific Elements
3. Learn how Rail-Wheel Pairs are used
4. Create a Wheelset Element
Lesson 2: Plots and Outputs

Lesson content:

- General
- Rail-Wheel Pair Plots
- Rail Plots
- Wheelset Plots
- Result Elements
Lesson content:

- Track Types
- Superelevation
- General Track Settings
- Cartographic Track
- Measured Track
- Plots
- Follow Track Joint Marker
- Active Track
Aim:

1. Become familiar with the set-up of a Cartographic Track

2. Understand the different settings for the **Follow Track Joint** Marker
Lesson 4: Suspension Modeling

Lesson content:

- Overview
- Rubber Spring
- Shear Spring
- Coil Spring
- Damper
- Graphical Representation of Force Elements
Workshop 3: Full Vehicle

Aim:

1. Build up a Bogie (Truck) model in Simpack
2. Build up a full train model in Simpack
3. Understand and use common rail modeling elements

2 hours
Lesson 5: Finalize Model Setup

Lesson content:

- Model Check – Graphical
- Model Check – Test Call
- Vehicle Globals
- Static Equilibrium and Preload
- Preload
- Solver Settings

40 minutes
Workshop 4: Preloads and Solver

Aim:

1. Understand how to check model plausibility
   a. Graphical
   b. Test Call

2. Understand the Vehicle Globals

3. Understand how to bring a rail vehicle model into equilibrium

45 minutes
Lesson content:

- Principle of a Guided Wheelset
- Quasilinearization
- Linearization Process
Workshop 5: Calculate Eigenvalues

Aim:

1. Learn how to use the Online Eigenvalues calculator
2. Learn how to adjust the linear arc profiles

20 minutes
Lesson 7: Critical Speed

Lesson content:

- DoE
- Critical Speed
- Track Excitations
- Model Setup
- Stop Integration Force Element
Aim:

1. Understand how to perform a Root Loci calculation using:
   a. the Simpack DoE and/or
   b. a Simpack Post Script

Workshop 6: Root Loci (Linear Critical Speed)

30 minutes

Damping [-]
Frequency [Hz]
Workshop 7: Nonlinear Critical Speed

Aim:

1. Understand how to perform a simple nonlinear critical speed analysis in Simpack
Lesson 8: Typical Applications

Lesson content:

- Derailment
- Mover Bodies
- Comfort
- Roll coefficient
Aim:

1. Understand how to perform a Derailment analysis in Simpack
Aim:

1. Understand how to perform a simple Comfort Analysis in Simpack
Aim:

1. Understand how to determine the Roll Coefficient using Simpack
Lesson 9 : Additional Rail Topics

**Lesson content:**

- Generating Wheel/Rail Profiles
- Variable Rail Profiles
- Independent Wheels
- Roller Rigs
- Elastic Foundation
- Rail–Wheel Wear

This lecture and workshops 11-13 are optional.
Workshop 11: Independent Wheels

Aim:

1. Understand the influence of Rail-Wheel Pairs in Simpack
2. Learn how to setup independent Wheels in a Wheelset

20 minutes
Workshop 12: Roller Rig

Aim:

1. Learn how to define a basic roller rig in Simpack
2. Convert a Rail-mounted wheelset to roller-mounted
3. Create a roller Body and its Primitives
4. Define Rail-Wheel Pairs for a roller rig

20 minutes
Workshop 13: Elastic Track Foundation

Aim:

1. Learn how to set up an Elastic Track Foundation in Simpack