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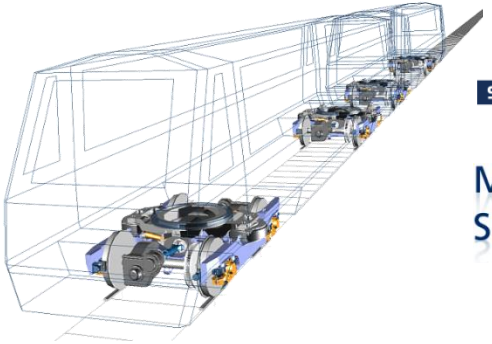
SIMPACK Rail

@ the FRA Vehice-Track Simulation Software Workshop



SIM PACK

Multibody Simulation Software

Christoph Weidemann – 2015-06-30

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Contents

- What is SIMPACK? What is SIMPACK Rail?
- How to Model Rail Vehicles in SIMPACK
- Rail-Wheel Contact
- Advanced Modeling Elements
- Flexible Bodies & Track
- Add-Ons & Interfaces
- Postprocessing
- Solvers
- DoE
- Model Library

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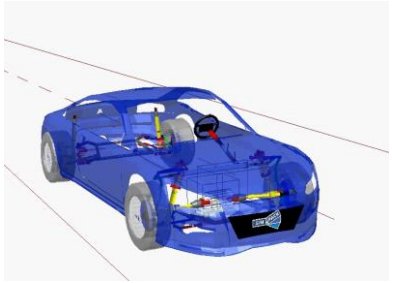
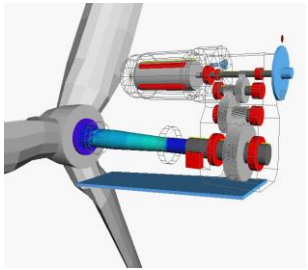
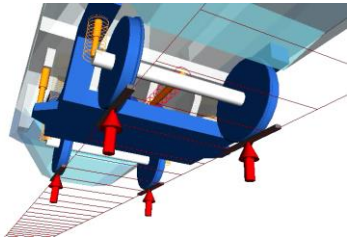
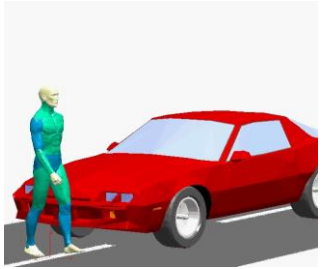
What is SIMPACK?

- General Multi-Body Simulation software
- More than 350 commercial and academic customers in all industries
- First lines of code in 1987 at DLR and MAN Technologie (Germany)
- 2001: Development and sales by Intec GmbH, Weßling (Germany)
- 2011: Completely refurbished user interface with SIMPACK 9.0
- Since July 2014: Integration into Dassault Systèmes Simulia brand



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What is SIMPACK Rail?

- Add-on module to general MBD tool SIMPACK, enabling simulation of any rail vehicle
- Joint development German Aerospace Center (DLR) and Siemens Verkehrstechnik starting in 1993
- General availability since 1996
- Used all over the world as standard MBD tool
- Some of our customers:
  Siemens Mobility – Alstom Transport – Bombardier Transportation – Stadler Rail – Vossloh – Voith Turbo – PESA – CNR/CSR – Nippon Steel and Sumitomo Metal – Kawasaki Heavy Industries – Hyundai Rotem – Ansaldobreda – Knorr-Bremse – Deutsche Bahn – SNCF – SBB|CFF|FFS – Japan Rail – Metro de Madrid – RATP – Prose – NedTrain Consulting – RailcarCo. – RVBA – Interfleet – Logomotive – RTRI – CNRC – …

Download customer stories at
http://www.simpack.com/mbs-software-product-rail.html
http://www.simpack.com/simpack_news.html → Rail
http://www.simpack.com/user_meetings.html → Rail

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How to Model Rail Vehicles in SIMPACK Rail

Main Features

- SIMPACK is a general MBD tool → in SIMPACK, …
- … a rail vehicle is just a generic mechanism, running on rails (hopefully).
- Kinematics and dynamics are fully non-linear.
- All degrees of freedom are available, like in reality:
  - Gravity (crests, dips) fully considered
  - Centrifugal forces (curving) and gyroscopic moments resulting from actual movements
  - Vehicle actually slowing down from energy dissipation (rail-wheel contact, dampers, friction)
  - Derailment and post-derailment simulation possible

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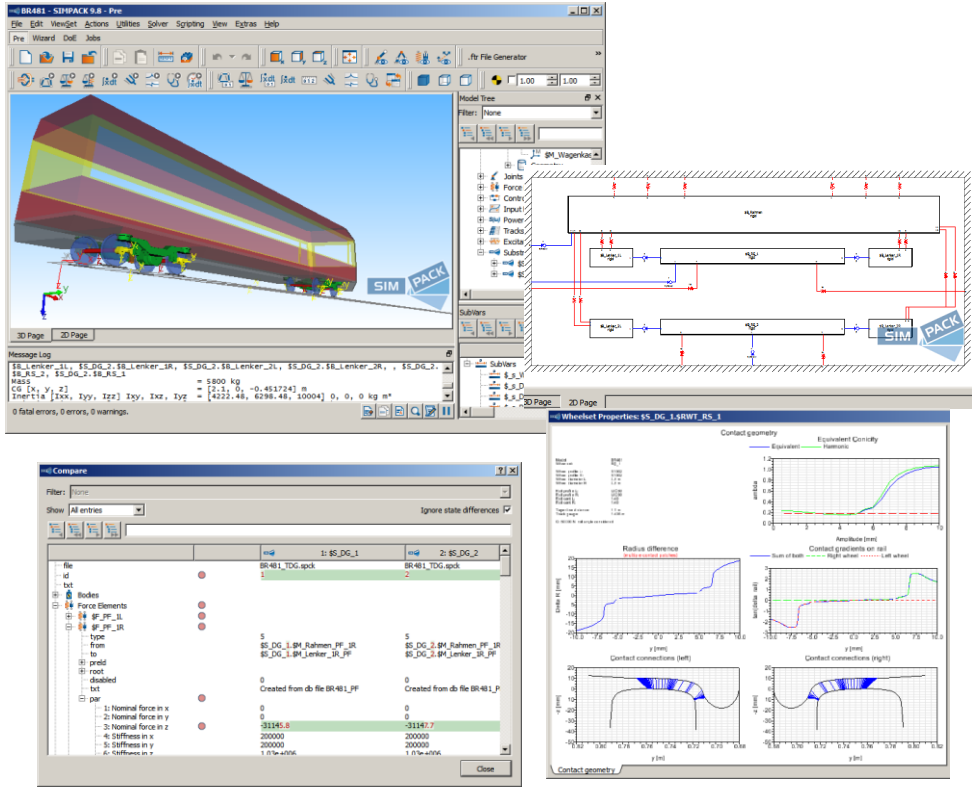
How to Model Rail Vehicles in SIMPACK Rail

User Interface

- Full Graphical User Interface
- Tree structure for modeling elements
- Multiedit, copy&paste, drag&drop, undo&redo
- Fully scriptable (JavaScript)
- 3D view and 2D topology view
- Immediate graphical feedback
- Model and element compare tool
- Powerful checkplots with export



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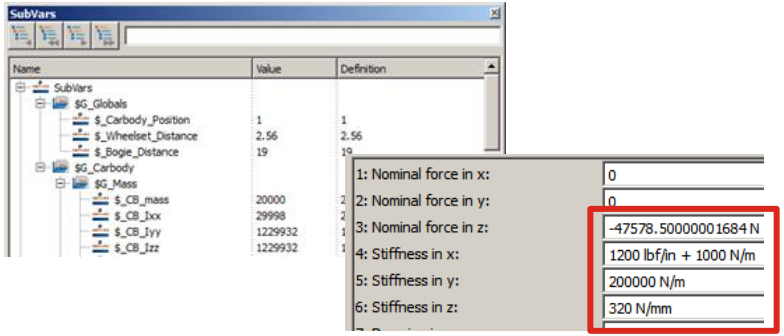
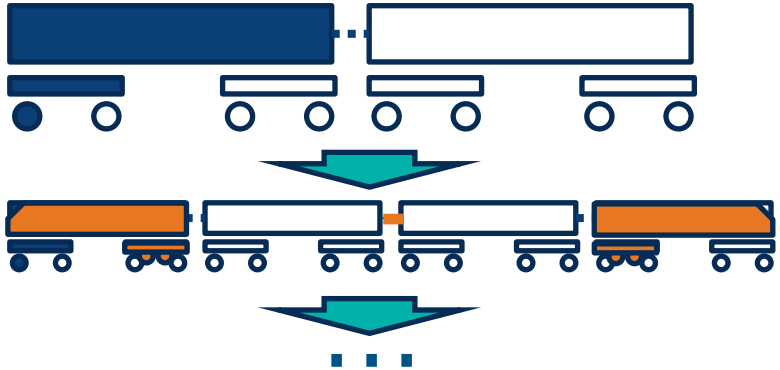
How to Model Rail Vehicles in SIMPACK Rail

Avoiding Redundancy

- SubVars = named model parameters
- Formulas
- Can be used in any place
- Unit support (metric, US/UK, …)



- Substructures = SIMPACK models, referenced by filename
- Unlimited number and nesting levels
- Inheritance and overwrite track-keeping



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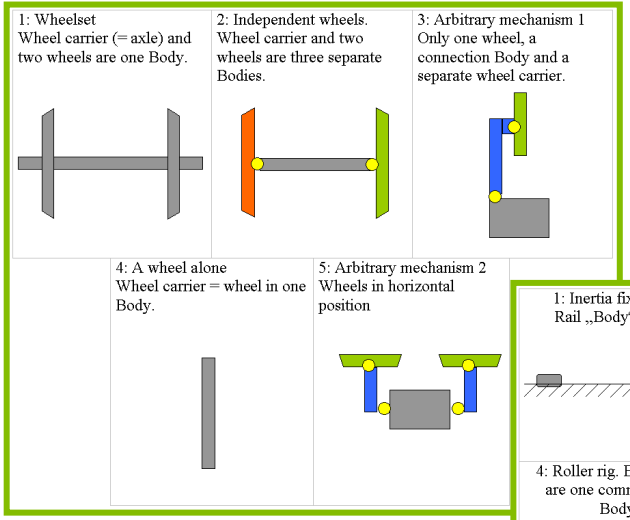
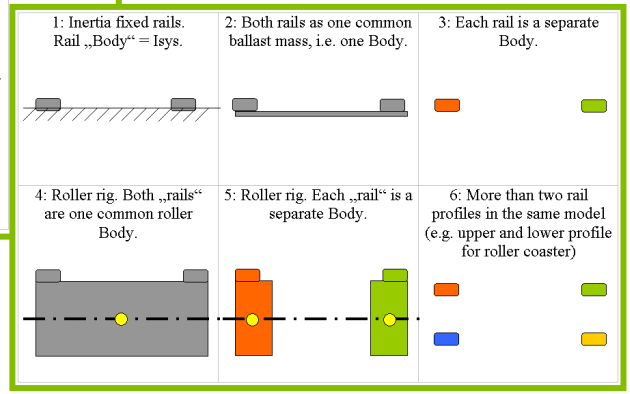
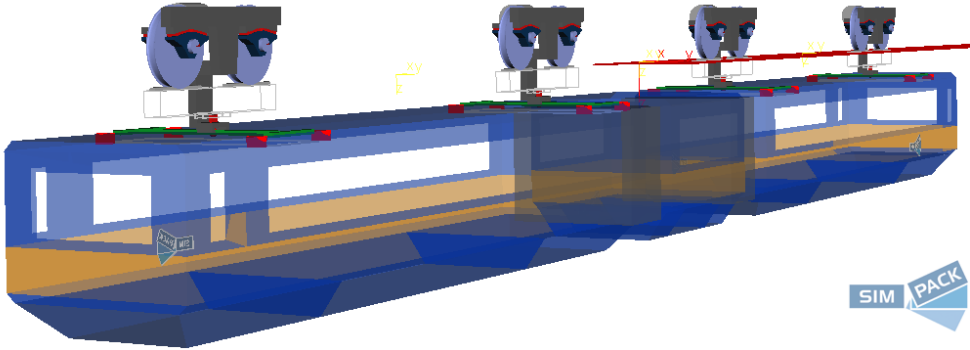
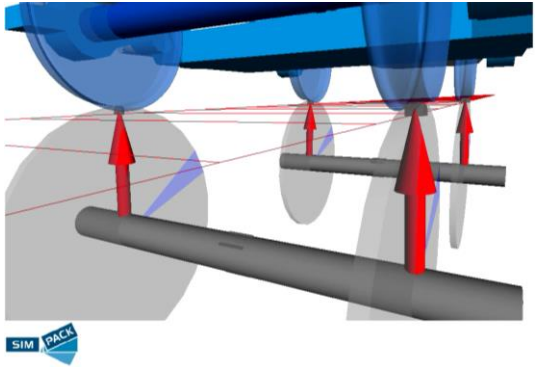
How to Model Rail Vehicles in SIMPACK Rail

No limitations in what you model









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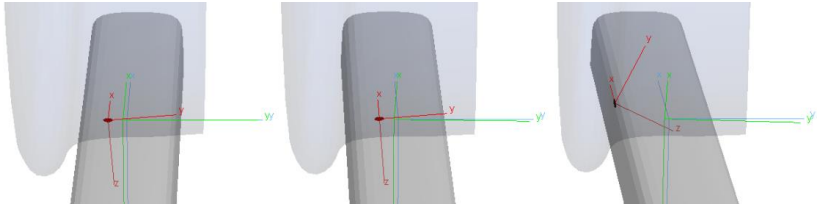
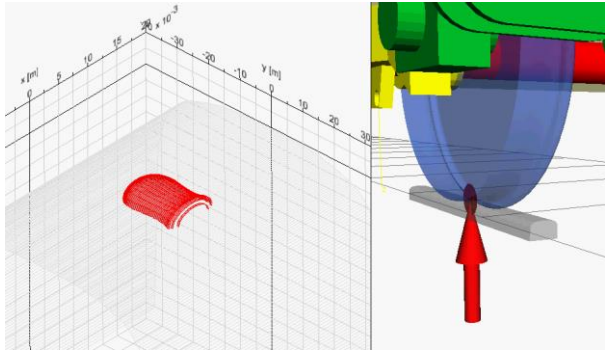
Rail-Wheel Contact

- Standard: Equivalent Elastic Contact
  - Elliptic contact patches (unlimited no.)
  - Hertzian normal force
  - FASTSIM, Polách, … creep forces



- Wear & RCF: Discrete Elastic Contact



  - Actual contact patches (unlimited no.)
  - Predicts surface stress distribution
- Also: Interface to CONTACT software

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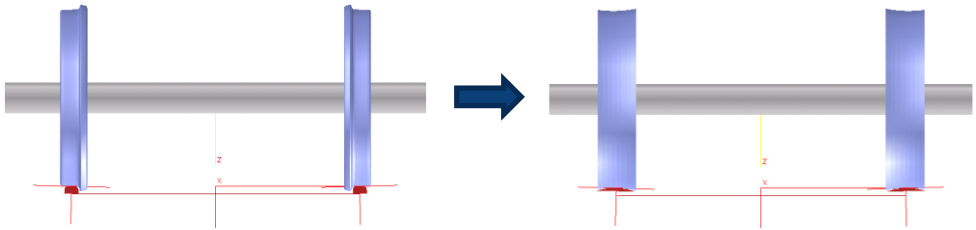
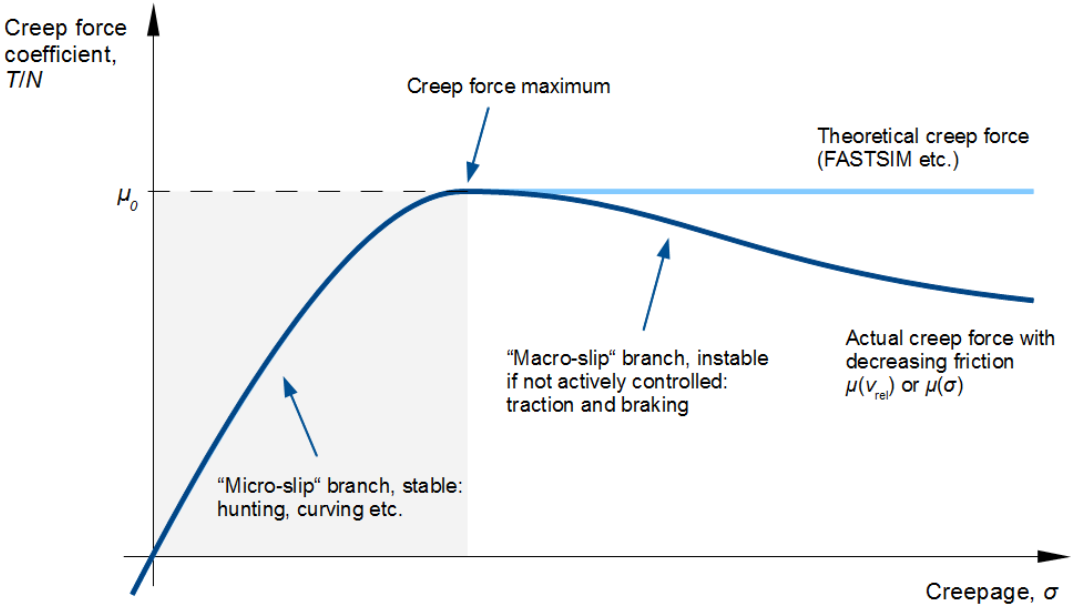
Rail-Wheel Contact

Additional Features

- Automated quasilinearization
  - For linear stability calculations
- Wheel profile outline
  - Changes with yaw angle
- Variable friction coefficient
  - Position on wheel profile
  - Position along track
  - Creep velocity





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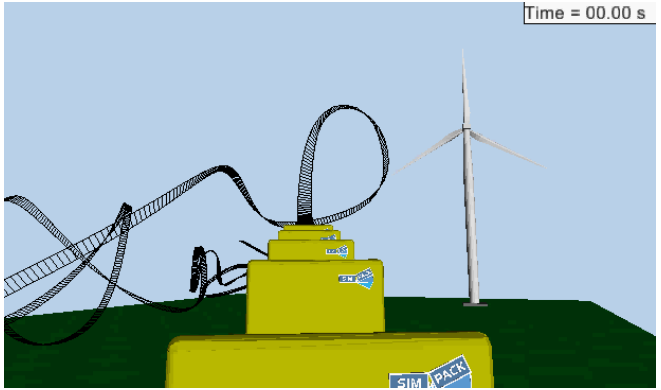
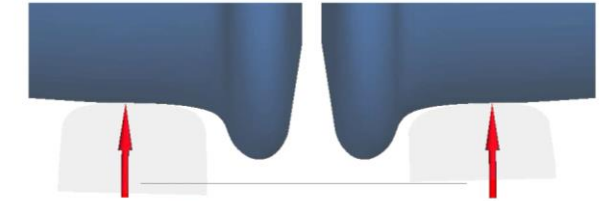
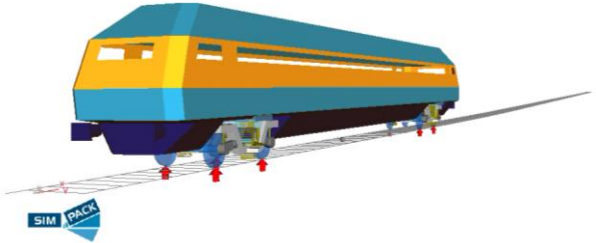
Advanced Modeling Elements

- Track layout and irregularities
  – various models and methods
- Arbitrary track suspension
- Varying stiffness, defects

- Variable rail profiles for turnouts & crossings







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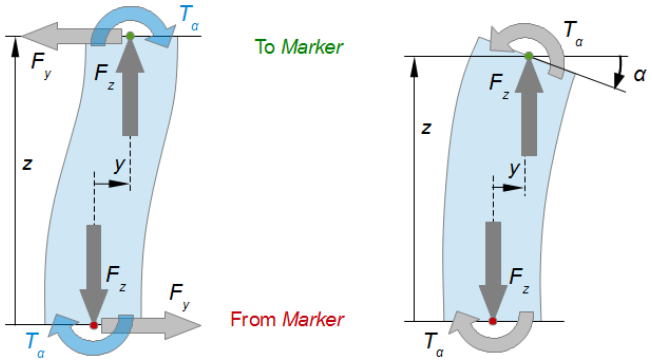
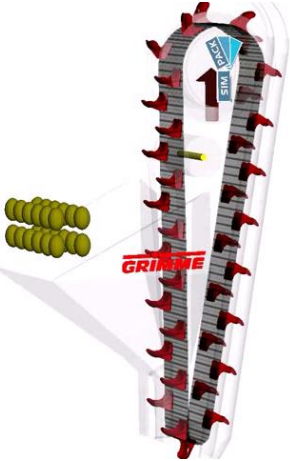
Advanced Modeling Elements

- Detailed coil spring models
- Airsprings with pipe connections, level control, valves, …
- Elastomer springs, leaf springs
- Contact (2D & 3D) and friction elements





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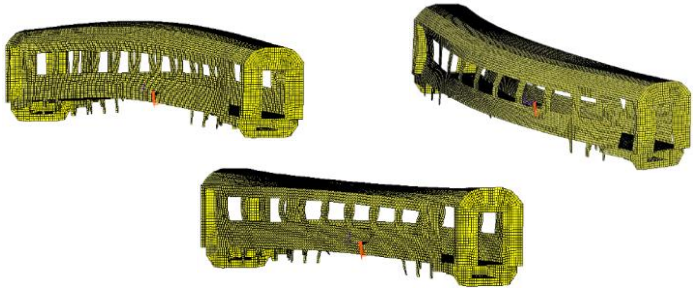
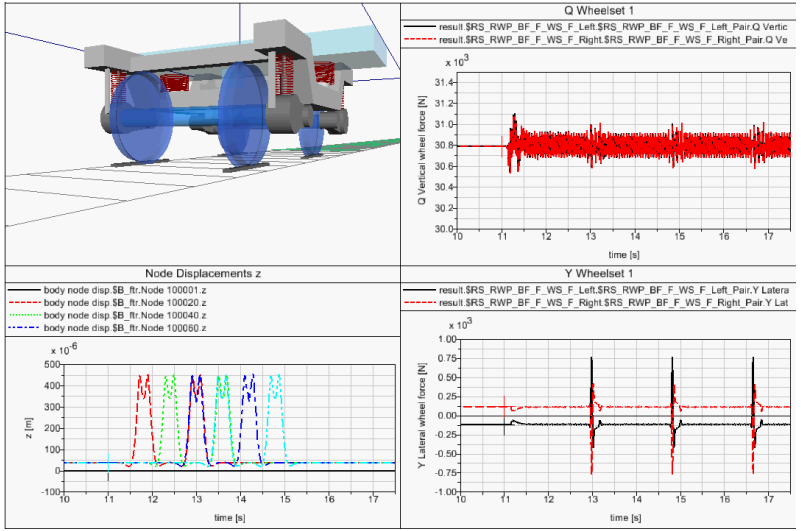
Flexible Bodies, Flexible Track

- Number of flexible bodies unlimited
- Interfaces to all main FE packages
- Integrated 3D beam FE tool



  - Carbodies, truck frames, wheelsets
  - Pantograph, overhead line, ...

- Flexible track from FE software



  - New track designs
  - Bridges, turnouts, crossings, …

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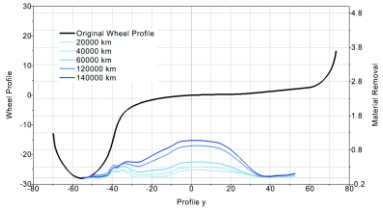
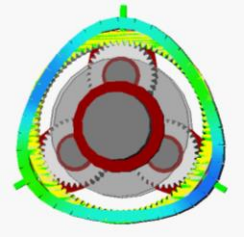
Add-Ons and Interfaces

SIMPACK Add-ons:

- Wheel and rail wear / RCF
- Drivetrain simulation
  - Cardan shafts
  - Gearwheels
  - Bearings
- Active control
  - Tilting trains
  - Cross-wind iteration process





Interfaces to

- CAD
- Abaqus, ANSYS, Nastran, …
- Matlab/Simulink co-simulation
- FMI (Dymola, AMESim, …) co-simulation and model import&export
- Kalker/Vollebregt's CONTACT
- Biomechanics: Human body models

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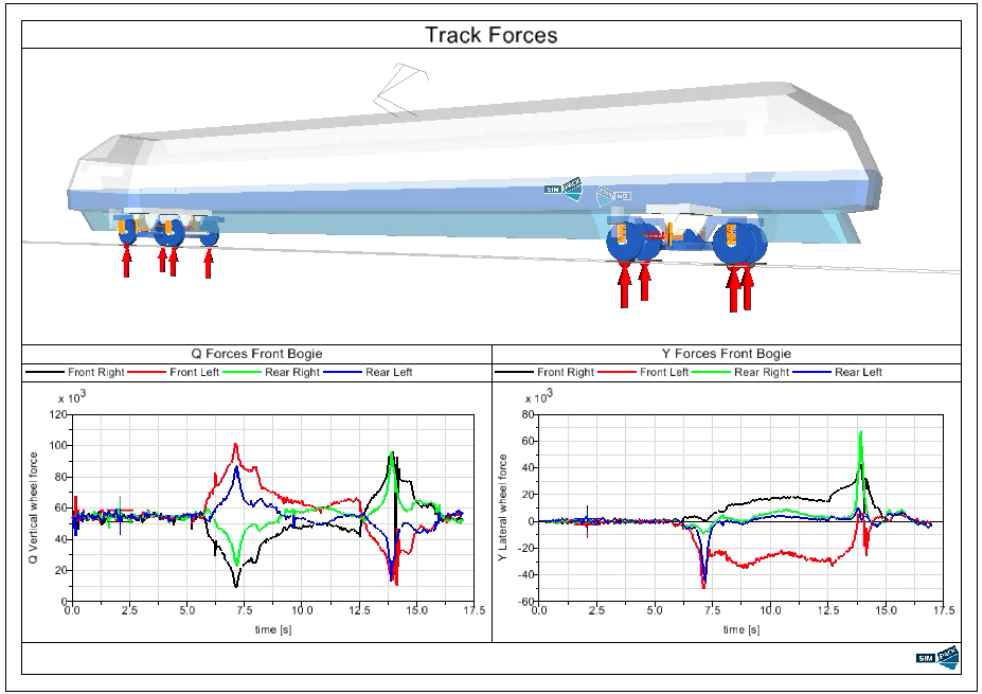
Postprocessing

- Easy access to any result
- Page and report editor
- Extensive signal filter library
- Watch animation and curves simultaneously
- Results of multiple models/runs simultaneously
- Export to any format
- Fully scriptable (JavaScript)



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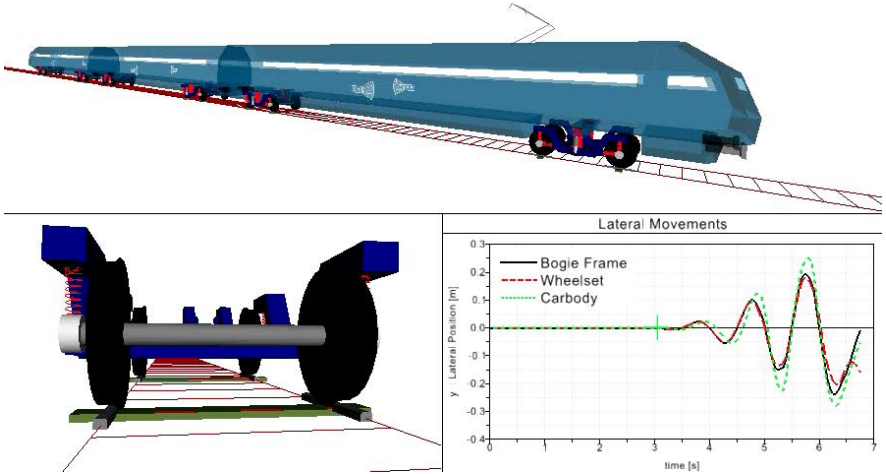
Solvers

- Preloads and equilibrium
- Time domain integration
  - Variable stepsize and order: high accuracy
  - Extremely robust: reliable & easy to handle
  - Realtime simulation (fixed stepsize)
- Kinematics
- Eigenmodes
- Linear response, transfer functions
- Operating Deflection Shapes (ODS)
- Parallel solving (scaling nearly linear)
- Fully scriptable (JavaScript)



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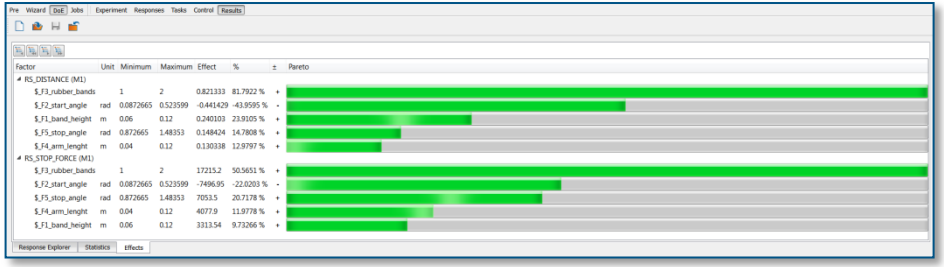
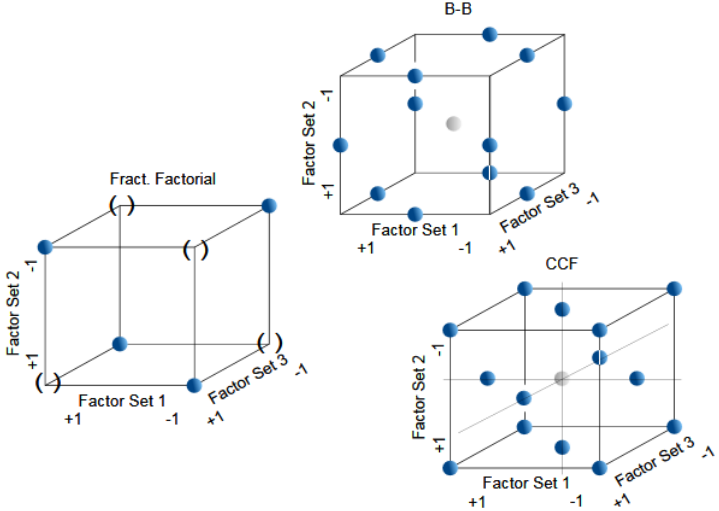
Design of Experiments

Parameter Studies Made Easy

- Automated run of the same model(s) with varied parameters
- Response surface generation, Pareto analysis of main effects
- Statistic experiment designs





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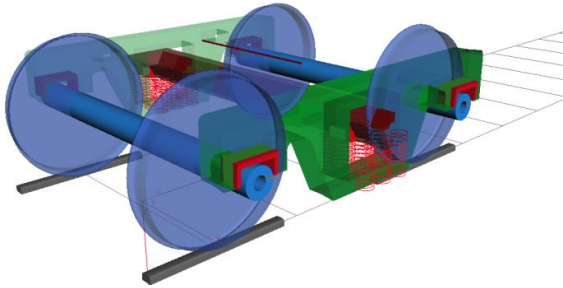
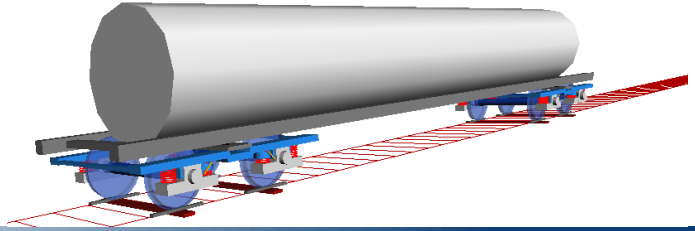
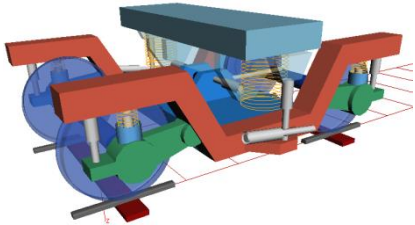
Example Model Library

- Standard passenger car
- Freight cars
  - Y-25 truck
  - Three-piece truck
- All models parameterized
- Users are free to extend/modify models in any way







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Conclusions

- Modeling with unlimited flexibility and low redundancy
- Advanced rail-wheel contact modeling
- Various advanced modeling components for Rail, Contact, Drivetrain, …
- Powerful flexible body interfaces
- All modeling components fully compatible

- Fast, accurate and extremely robust solver

- Large number of interfaces to 3rd party software
- Versatile postprocessing

Download customer stories at
http://www.simpack.com/mbs-software-product-rail.html
http://www.simpack.com/simpack_news.html → Rail
http://www.simpack.com/user_meetings.html → Rail

SIM PACK ***provides "Leading Technology for Technology Leaders"***

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