SIMPACK User Meeting 200

Working with SIMPACK Wheel/Rail

Release 8.5

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intec

SIM PACK

Working with SIMPACK Wheel/Rail 8.5

Overview:

- **Model Setup/Preprocessing**
- **Modelling Elements**
- **Solver**
- **Postprocessing**

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Model Setup:

- Element Comments
- Support of all Units
- Primitive Definition With Respect to Markers
- Complete Bushing Force Element Described by one File
- New Functionality within Parametrization
- Tree Views for Marker and Modelling Element Selections
- **Multi Select within Nominal Force Parameter Calculation**
- **Initializing States and Prestress Forces with Zero**
- *.LIST.dat files within Database Handling no longer necessary
- Time Excitations Defined in Substrutures Usable in Main Structure
- Copy End of Run 1 to Linearization States
- Info about Inertia Tensor of Complete Model
- Context Sensitve Display of Element Parameter Descriptions
- Miscellaneous (Coulor Display, Marker Layout, Reload Model, ...)

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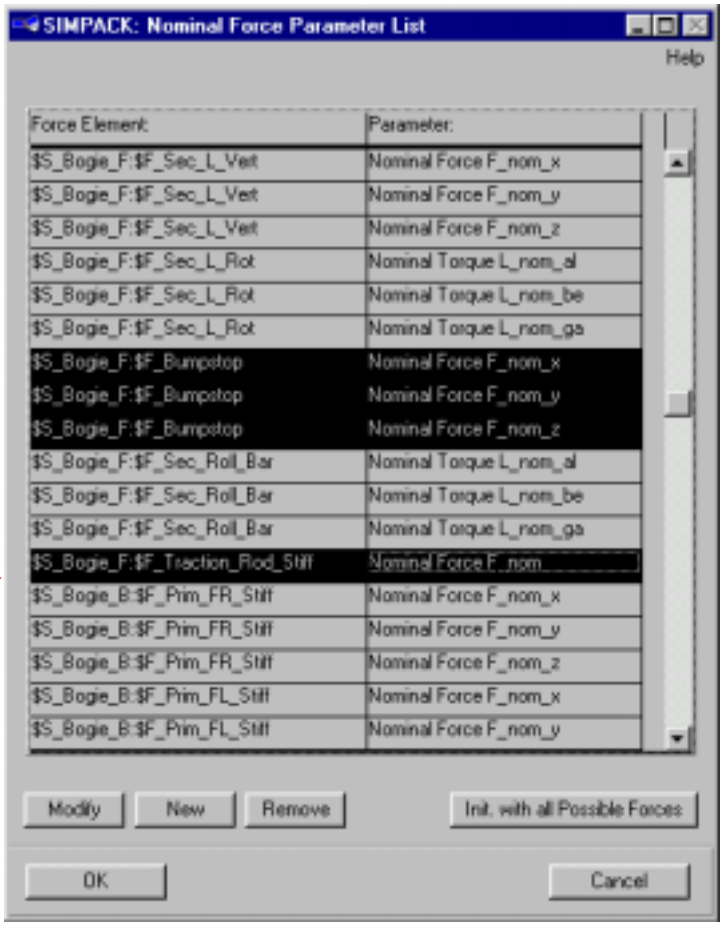
Model Setup: Multi Select within Nominal Force Parameter Calculation

- Selection of multiple force elements or force element parameters at the same time now possible
- Useful when deleting many entries after „initializing with all possible forces“

... with Shift

... with Ctrl



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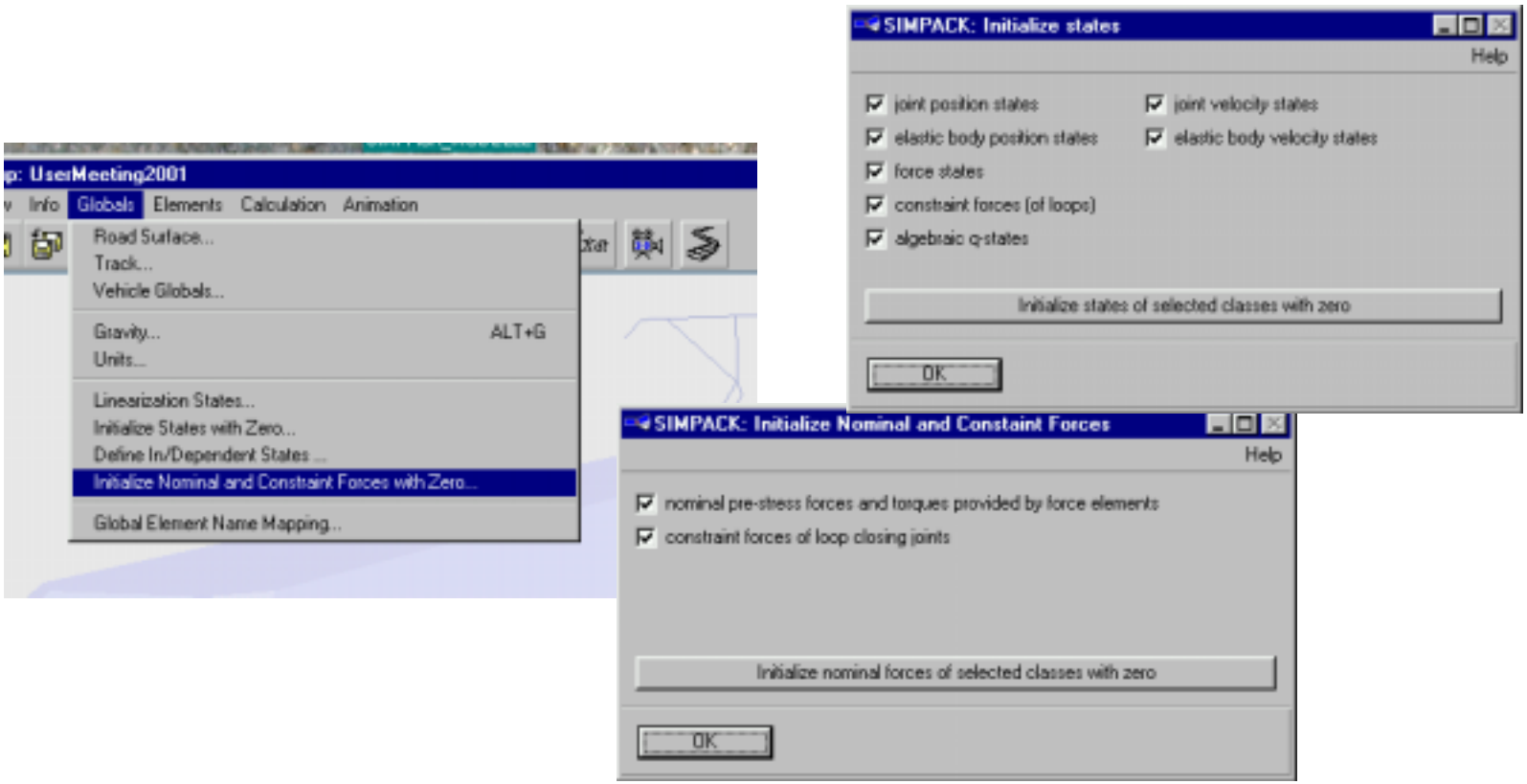
Model Setup: Initializing States and Prestress Forces with Zero

Instead of manually editing the .sys file, all types of states, nominal forces, and constraint forces can now be set to zero with one mouse click.



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Modelling Elements:

- **New Air Spring Force Elements**
- **New Flexicoil Force Element**
- New Air Resistance Force Element
- New Force Elements: Gas Force, HLA, Hertzian Contact
- **New Track Module**
- New Tyre Modules (MF-MC, SWIFT, RMOD-K)
- **Creep Force Calculation according to Polách Theory**
- Partial Coherence of Stochastic Excitations and μ(s,y) / μ(x,y)
- Congruent Marker
- Instant Centre/Axis Calculation and Representation
- New Element Type: Function Expression
- Input Functions: Extrapolation and New File Format
- Input Function Sets/Arrays: Handling and New File Format
- **Simulation of Switch Crossing**

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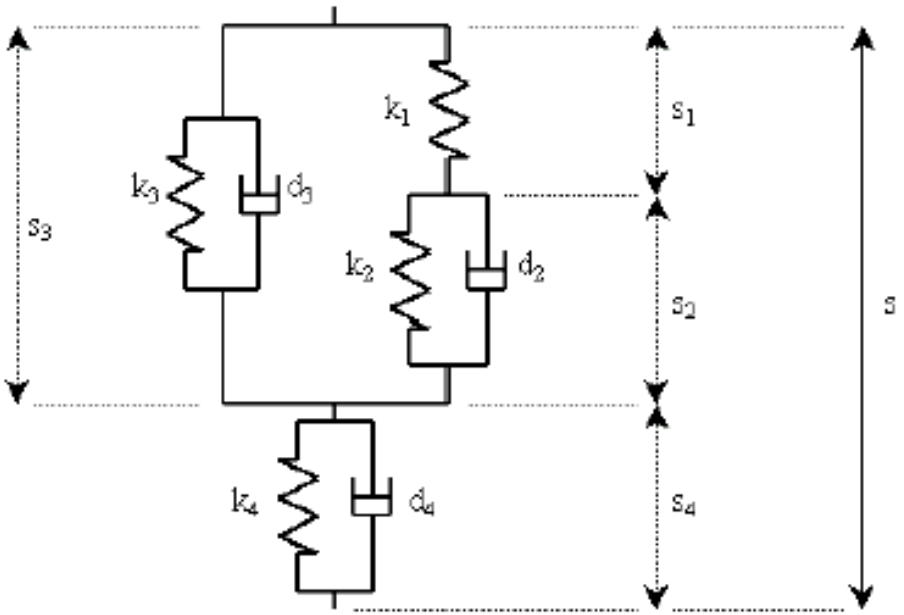
Modelling Elements: New Air Spring Force Elements: Linear Air Spring

Features

- based on thermodynamic equations
- variable effective area
- linear orifice damping
- rubber mounting in series



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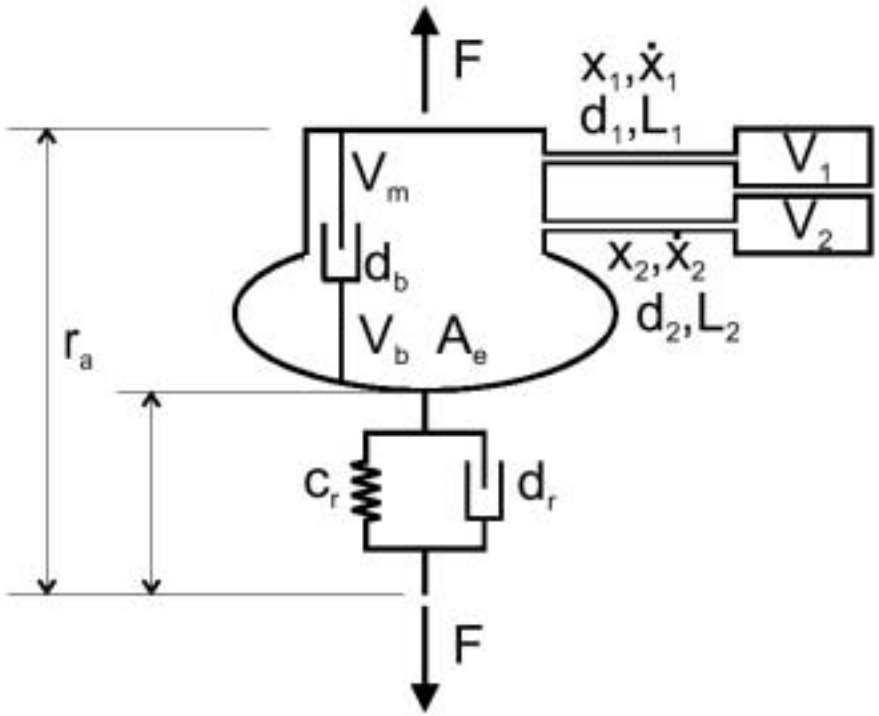
Modelling Elements: New Air Spring Force Elements: Nonlinear Air Spring

Features

- based on thermodynamic equations
- variable effective area
- main volume as sum of the volume of the bellow and the mounting
- two auxiliary air volumes usable, connected by pipes
- non-linear orifice damping, defined by geometric properties
- rubber mounting in series



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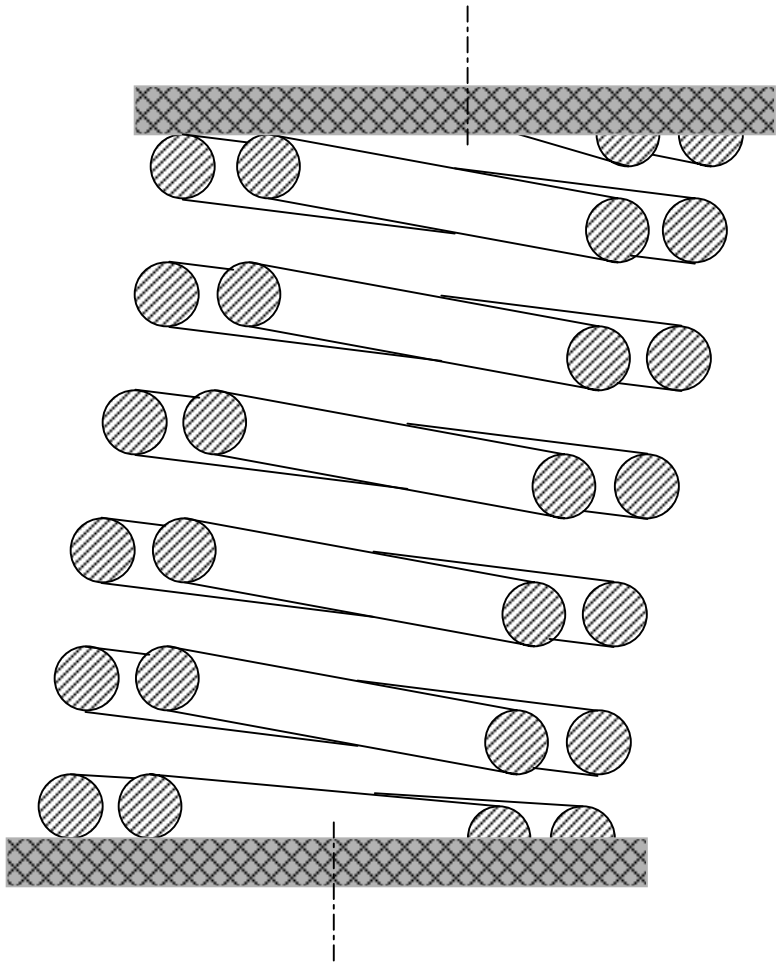
Modelling Elements: New Flexicoil Force Element

Features

- Consists of two helical flexicoil springs between two rubber elements
- Flexicoil springs according to Krettek/Sobczak 1988
- Uses „low level“ parameters like spring radius, unloaded height, wire diameter, number of turns



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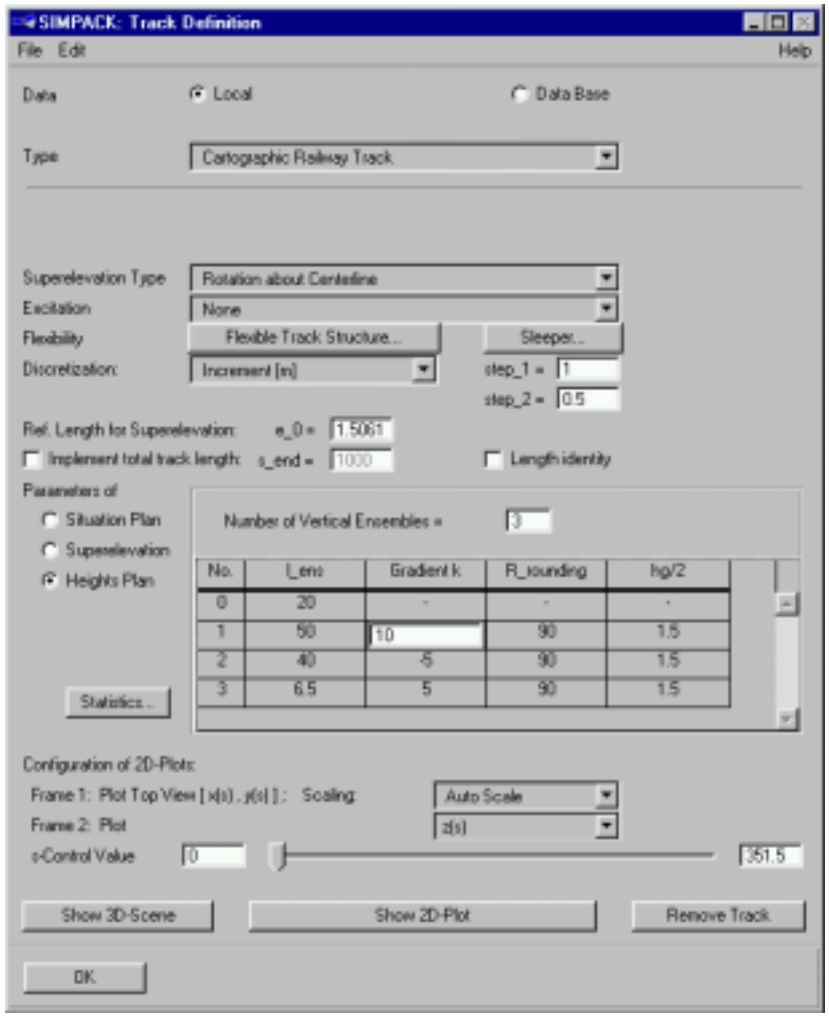
Modelling Elements: New Track Module

- New cartographic track with independent situation, super-elevation and (new) heights plan

- A track can consist of several ensembles with independent parameters
- No limit in track length



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Modelling Elements: New Track Module

Situation plan (curves)

- length of straight track
- length of curve entry
- curve radius
- length of curve
- length of curve exit
- smoothing length

Parameters of: (•) Situation Plan ( ) Superelevation ( ) Heights Plan

Number of Horizontal Ensembles = 3

No.	L_0	L_in	Radius	L_rad	L_out	ha/2
1	30	20	300	100	20	1.5
2	0	0	-200	75	20	1.5
3	10	25	200	25	25	1.5

Parameters of: ( ) Situation Plan (•) Superelevation ( ) Heights Plan

Number of Superelevation Ensembles = 3

No.	L_0	L_in	sup	L_sup	L_out	hs/2
1	30	20	0	100	20	1.5
2	0	0	0	75	20	1.5
3	10	25	0	25	25	1.5

Superelevation plan

- same parameters as situation plan
- identity mode: superelevations = curves

Heights plan

- length of track section
- gradient of track section (in %)
- rounding radius
- smoothing length

Parameters of: ( ) Situation Plan ( ) Superelevation (•) Heights Plan

Number of Vertical Ensembles = 3

No.	L_ens	Gradient k	R_rounding	hg/2
0	20	-	-	-
1	50	10	90	1.5
2	40	-5	90	1.5
3	65	5	90	1.5

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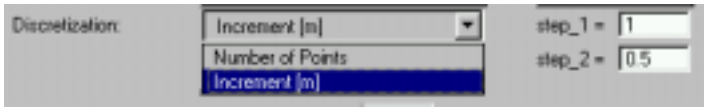
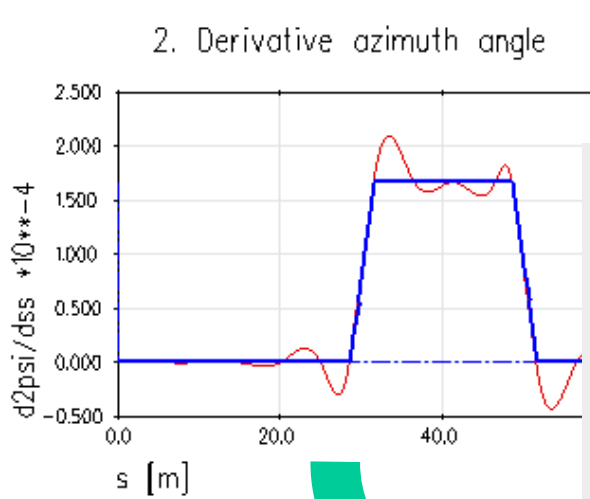
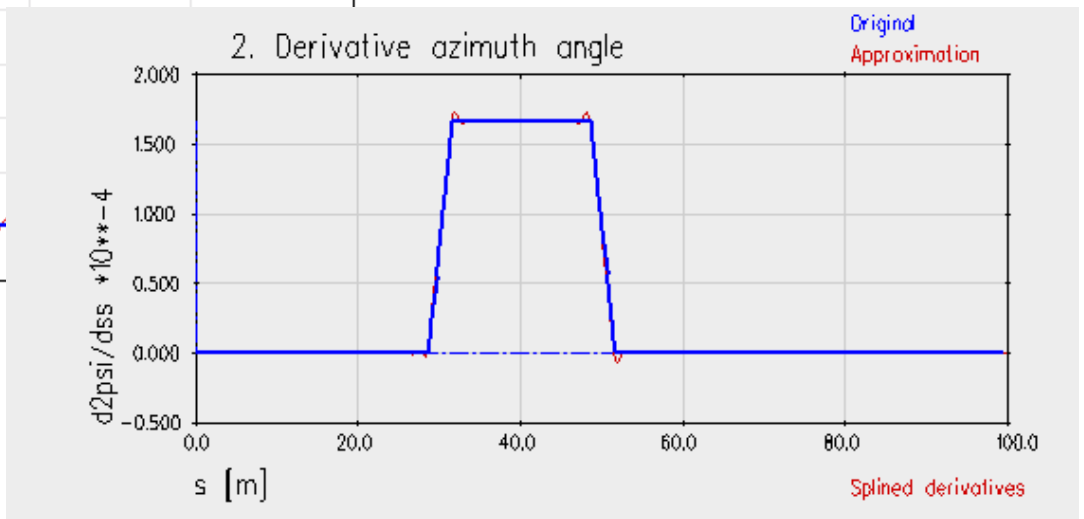
Modelling Elements: New Track Module

- Improved spline approximation with arbitrary points distribution
- Check of approximation quality







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Modelling Elements: Creep Force Calculation according to Polách Theory

- Non-linear theory
- Fast computation, avoids pre-calculated tables
- Spin is considered
- Elliptical contact areas
- Experience since 1990

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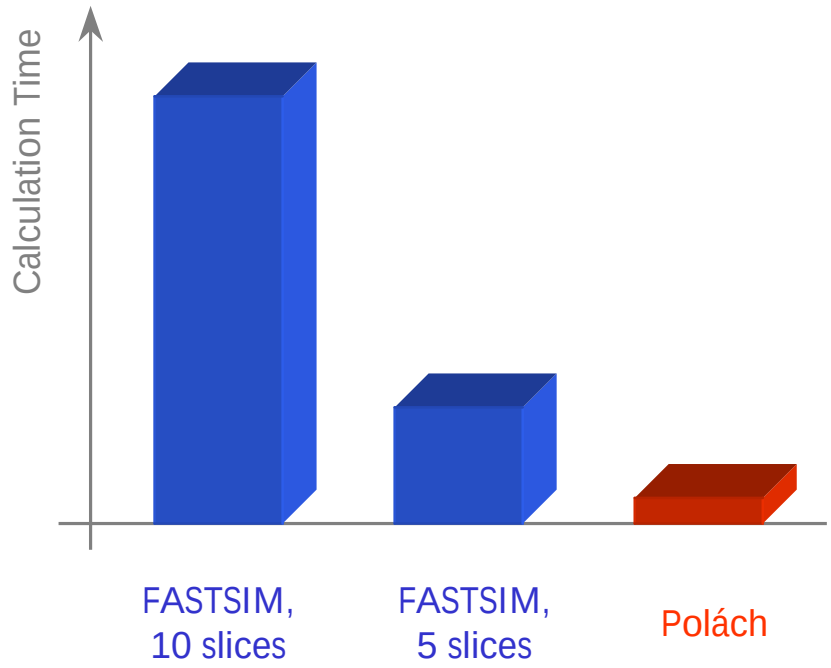
Modelling Elements: Creep Force Calculation according to Polách Theory

- Good agreement with FASTSIM results
- Calculation much faster than FASTSIM



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Modelling Elements: Creep Force Calculation according to Polách Theory

Ranges of application for the different creep force models

	Numerical efficiency	spin	longitudinal and lateral creepages	steadily differentiable
Linear	extremely high	small	small	yes
Linear with Saturation	extremely high	medium	medium	no
Vermeulen Johnsohn with Extension	high	medium	large	no
Tangens Hyperbolicus	moderate	medium	medium	yes
Polách	high	medium	medium	no
Simplified non-linear Kalker Theory	moderate	large	large	no

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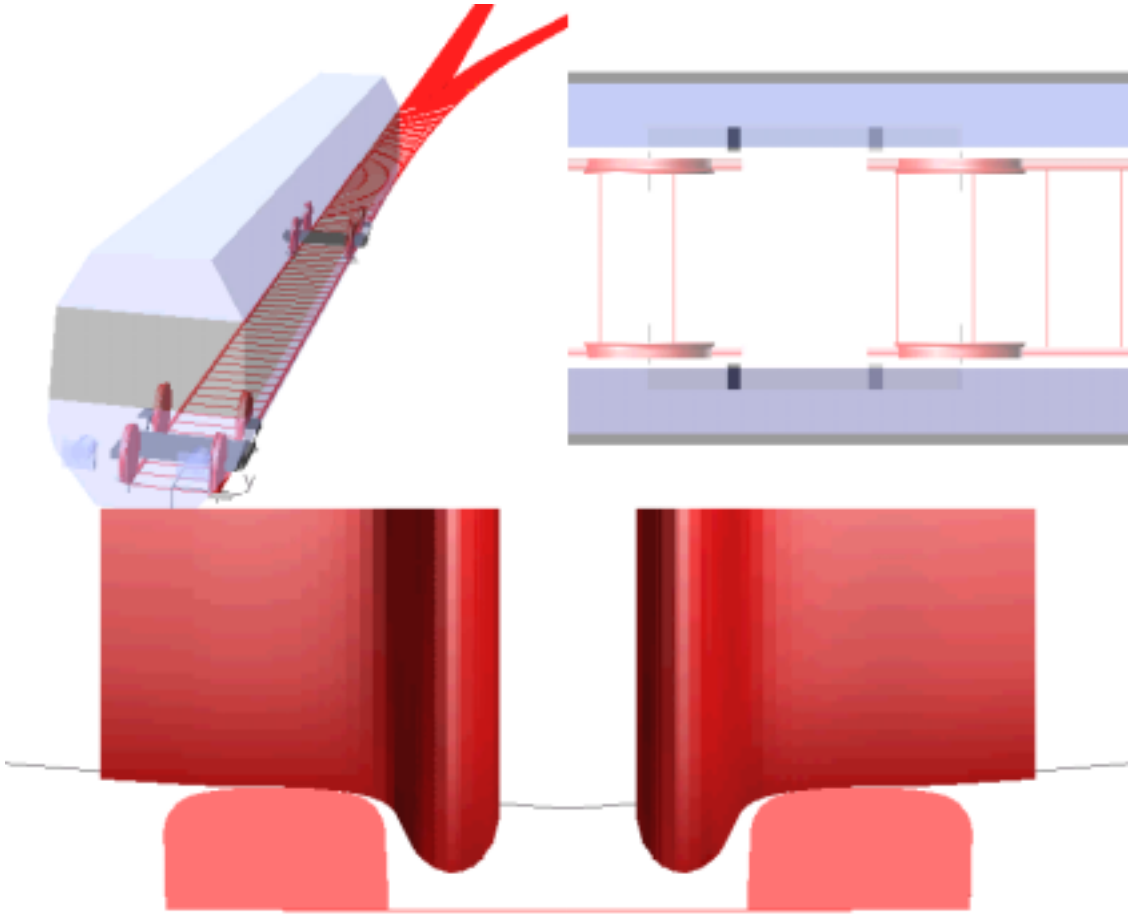
Modelling Elements: Simulation of Switch Crossing

- *s*-variable rail profiles
- Guard rail with contact at back of wheel
- Up to three contact points



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Solver:

- Time Integration Configuration: Output Stepsize/Sampling Frequency
- **Static Equilibrium: Newton‘s Method much more Robust and Faster**
- Static Equilibrium: New Solver Mode „Driven Equilibrium“
- Linearisation Process: Increased Speed and Robustness
- Eigenvalues: Improved Calculation Configuration and Representation
- Force Element Consideration: Optionally with or without „rxF“
- **Automatic Suggestion of Independent and Dependent Settings**
- Parameter Variation: Max. Frequency for Critical Param. Calculation

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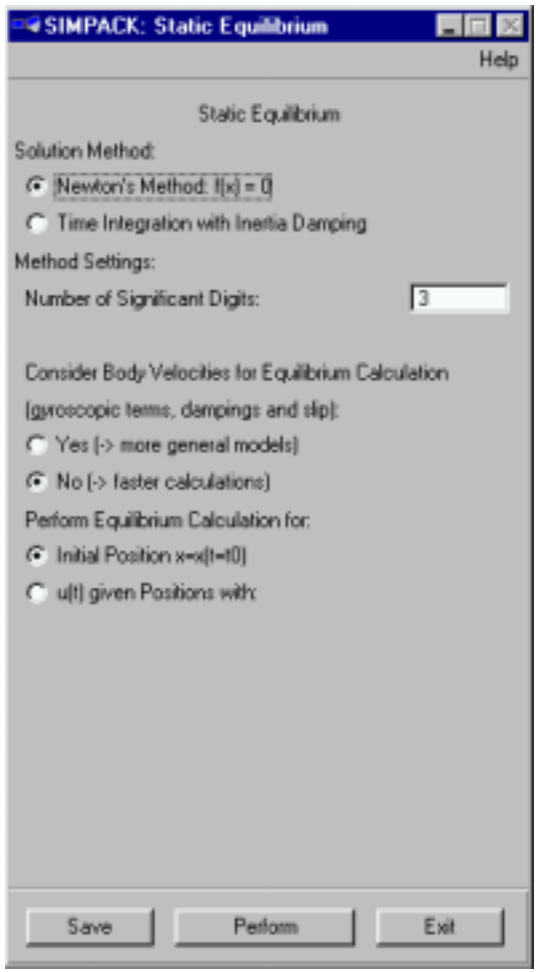
Solver: **Static Equilibrium: Newton's Method much more Robust and Faster**

- Uses new solver
- Faster than before
- Much more robust for systems with kinematic loops (constraints) → railway vehicles
- Consideration of body velocities is now optional



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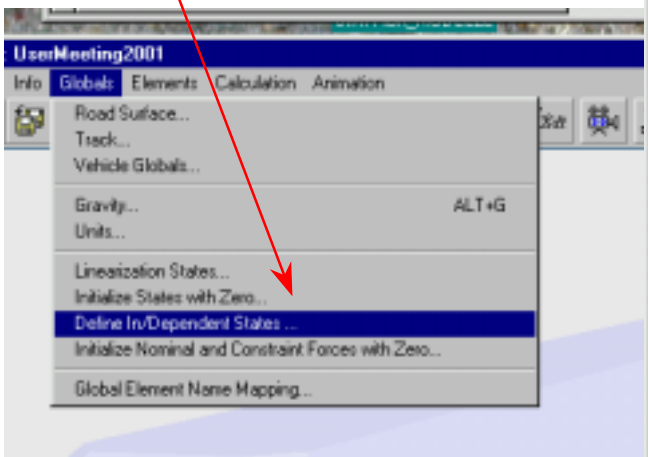
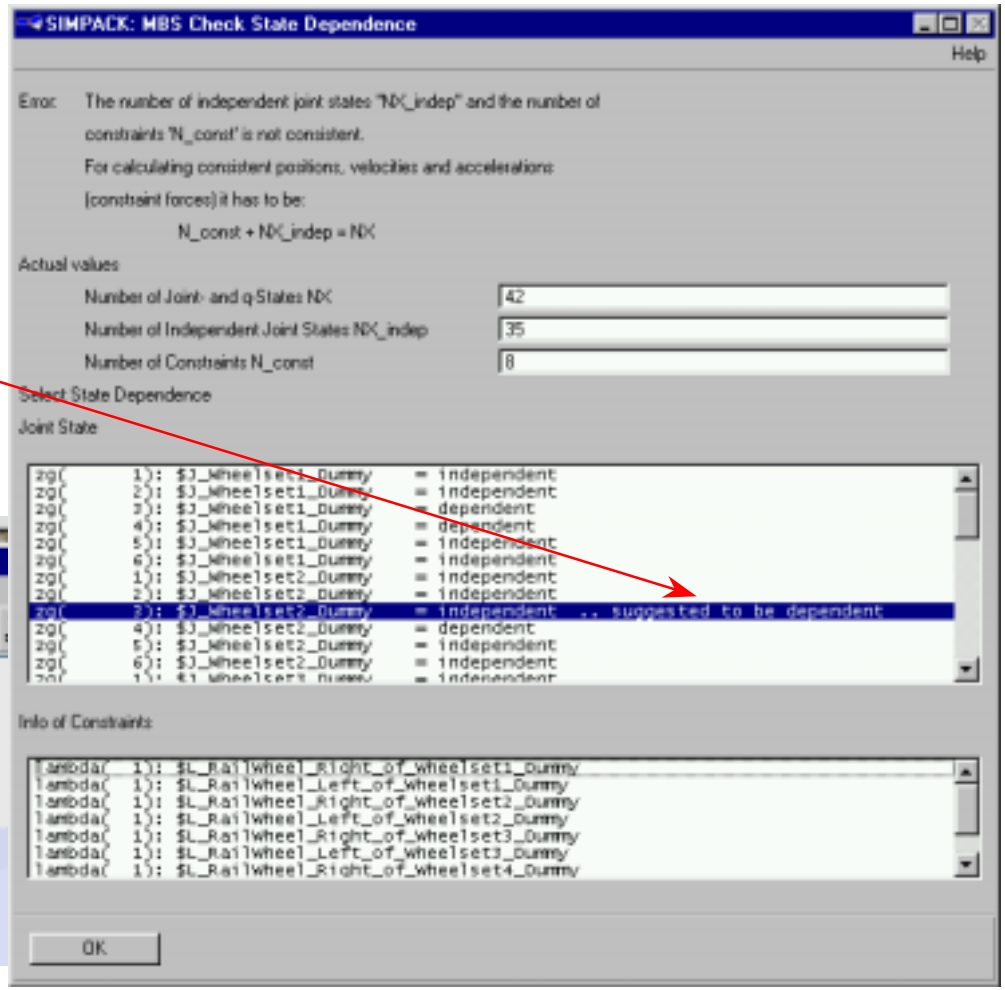
Solver: Automatic Suggestion of Independent and Dependent Settings

Which joint state should be dependent and which should be independent?

- Now automatic suggestion
- Selectable from menu





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Postprocessing:

- Animation Data with Display of Current Simulation Time
- Animation Data without Reload
- Support of Alias Wavefront Files (*.obj) with Line Entity
- New 2D Filter
- **Plot of Wheel/Rail Profile Functions**
- **a_q Sensor**

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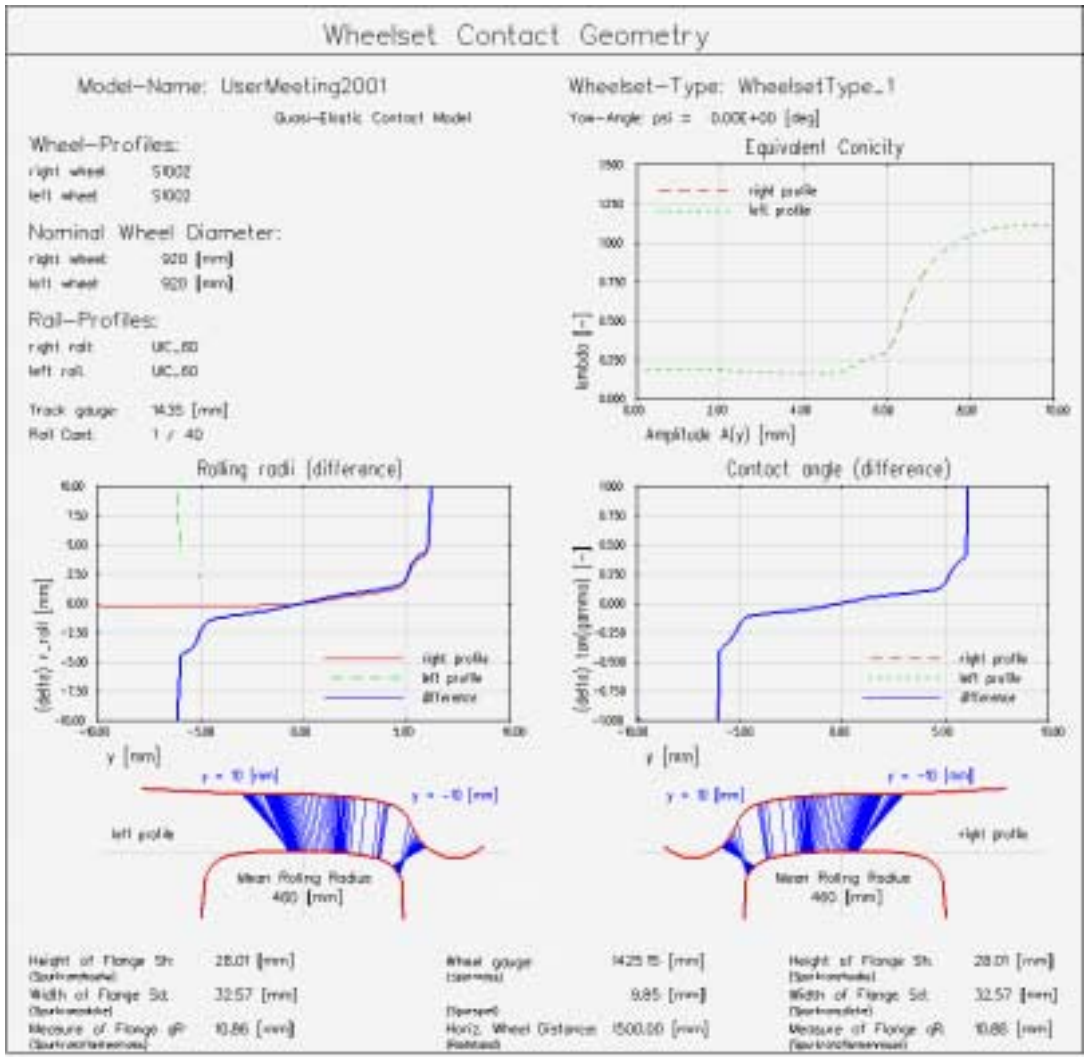
Postprocessing: Plot of Wheel/Rail Profile Functions

- Contact geometry of both wheels of a wheelset
- Equivalent conicity function
- Rolling radii difference
- Contact angle difference
- Contact points on wheel and rail
- Characteristic profile data



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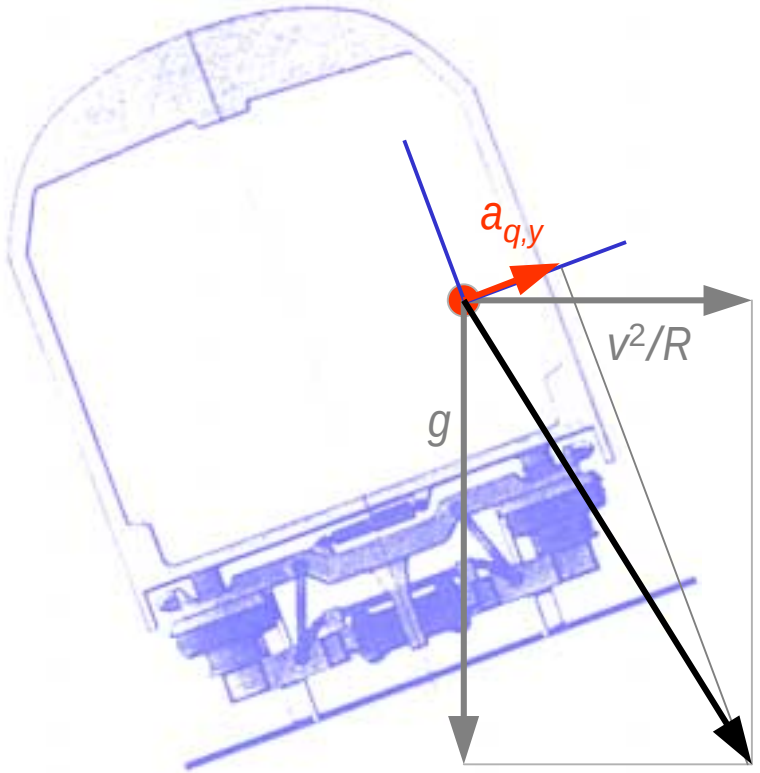
Postprocessing: a_q Sensor

The a_q sensor calculates the accelerations e. g. of a vehicle negotiating a curve:

- in coordinate system of the vehicle
- gravity is considered

New: a_q sensor is licensed also with SIMPACK Wheel/Rail and/or SIMPACK Automotive+



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Modelling Elements: New Nonlinear Air Spring Control Element

Features

- based on thermodynamic equations
- variable effective area
- main volume as sum of the volume of the bellow and the mounting
- two auxiliary air volumes usable, connected by pipes
- non-linear orifice damping, defined by geometric properties
- rubber mounting in series

- connection pipes between several air spring elements
- level control