

Working with SIMPACK Automotive+, Release 8.5

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Working with SIMPACK Automotive+, Release

Overview: 8.5

- ▶ General
- ▶ Model Setup/Preprocessing
- ▶ Modelling Elements
- ▶ Solver
- ▶ Postprocessing
- ▶ User Subroutines
- ▶ Interfaces

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General

- ▶ Improved Open Model Window
- ▶ New Start Model and Userspecific New Model
- ▶ New Licensing Mechanism
- ▶ Multi Plattform Support
- ▶ **Userspecific Dimensions**
- ▶ First Version of New Documentation

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General: Multi Plattform Support 8.5

Functionality:

- Only one SIMPACK MAIN installation for all platforms
- The user configuration of a SIMPACK user has been fully adapted to support multiple different hardware and operating system platforms for one user setup.

Advantage/Application Cases:

Multi platform architecture (NT, UNIX) within a company:

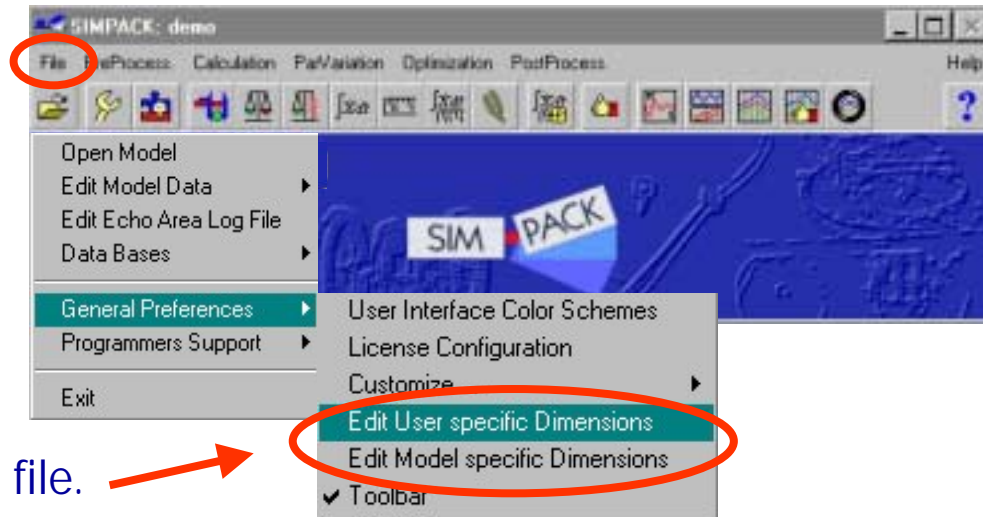
- > No need anymore to have different user configurations for different platforms
- > Less hard disc space required

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General: Userspecific Dimensions 8.5

Functionality:

- SIMPACK executable dimensions no longer hard coded.
- Installation-, user- and model-specific dimensions configuration file.
- No recompile necessary after changing required dimensions.



Advantage/Application Cases:

- > User can always work with an optimized set of SIMPACK dimensions.
- > No special SIMPACK version necessary if dimension limit exceeded
- > Basis for completely automatical memory allocation mechanism of later versions of SIMPACK.

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Model Setup

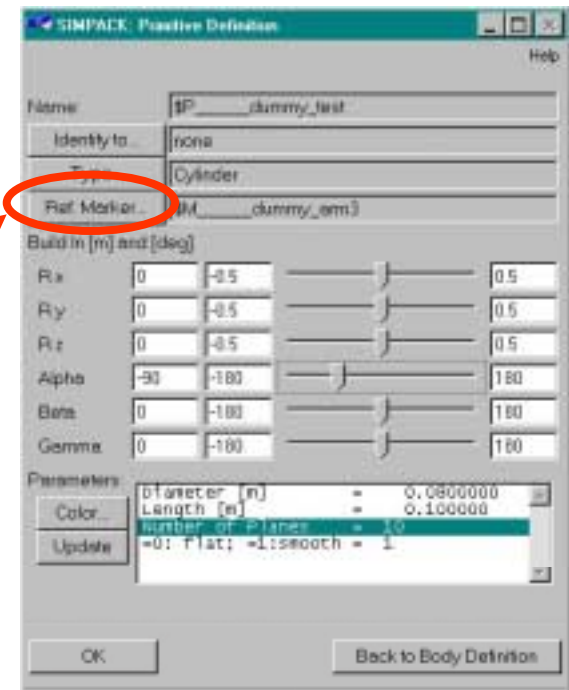
- ▶ Element Comments
- ▶ Support of all Units
- ▶ **Primitive Definition With Respect to Markers**
- ▶ **Complete Bushing Force Element Described by one File**
- ▶ **New Functionality within Parametrization**
- ▶ Tree Views for Marker and Modelling Element Selections
- ▶ Multi Select within Nominal Force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

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Model Setup: Primitive Definition With Respect to Markers

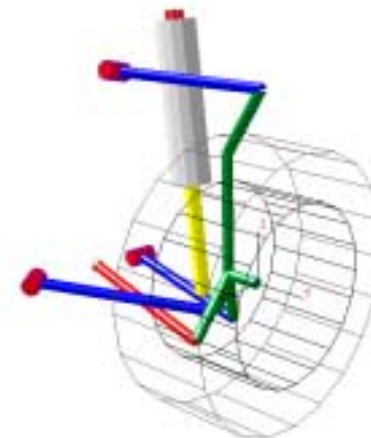
Functionality:

- All SIMPACK graphical primitive definition can be done with respect to existing marker positions/orientations
- No additional Sensor and Ensemble necessary



Advantage/Application Cases:

- > Easy and helpfull visualisation of orientation and displacements of e.g.: bushings, engine mounts, ...
- > No unnecessary sensor output values.



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Model Setup: Complete Bushing Force Element Described by one File

Functionality:

- Definition of a complete ($c_{trans/rot}$, $d_{trans/rot}$) bushing referring only one single Input Function Set from database.
- Linear or nonlinear in any combination.
- Parametrization supported by new Substitution Variable Type.

Advantage/Application Cases:

- > Quick an easy model setup concerning bushings.
- > Clear and concise data structure



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Model Setup: New Functionality within Parametrization

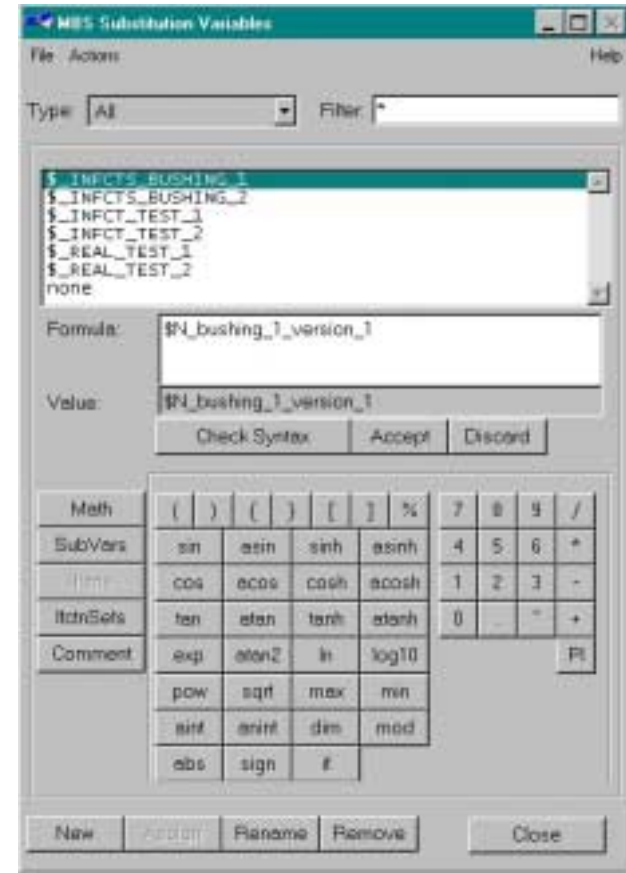
Functionality:

- Completely new GUI for editing Substitution Variables
- Substitution Variable window can always be kept open now
- Filtering while listing the Substitution Variables
- Parameterization of Input Functions and Input Function Sets
- New functionality "Arithmetic If"
- Rename of all Substitution Variables
- Arbitrary length of Substitution Variables
- Upper and Lower Case in combination

Advantage/Application Cases:

---> Extensive improvement of parametric model setup:

1. Intelligent parametrization using "Arithmetic If"
2. Clear data structure using parametrized Input Functions and Input Function Sets
3. ...

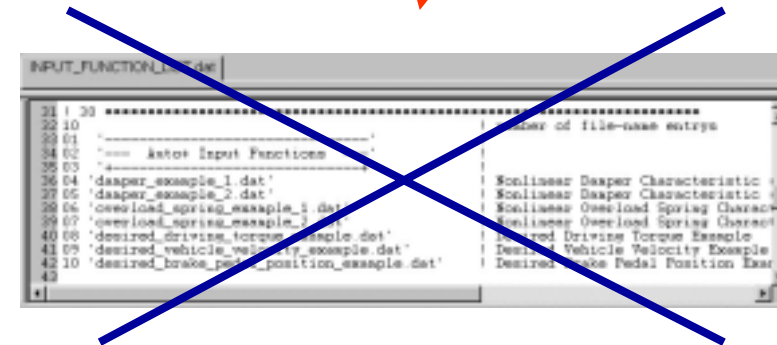
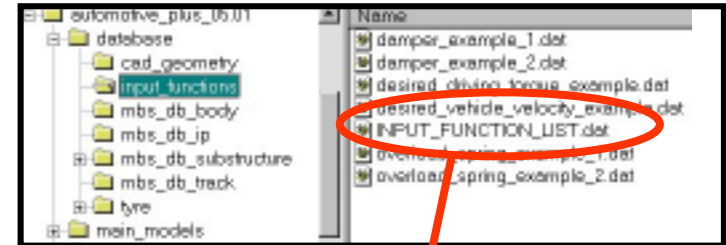


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Model Setup: *.LIST.dat files within Database Handling no longer necessary

Functionality:

- „*_LIST.dat“ files no longer necessary
- Additionally still available if required
- All SIMPACK database directories affected



Advantage/Application Cases:

---> Much more comfortable model setup and data maintenance using SIMPACK database structures.

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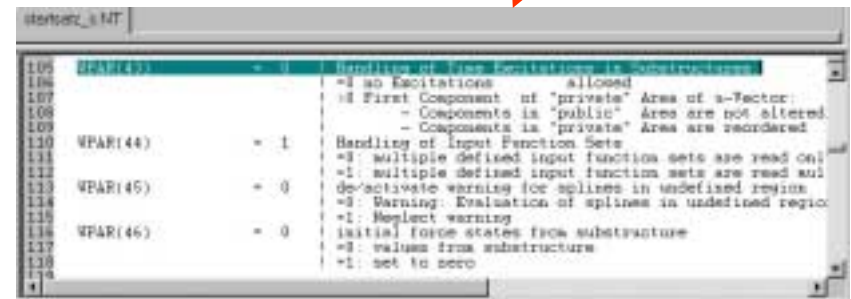
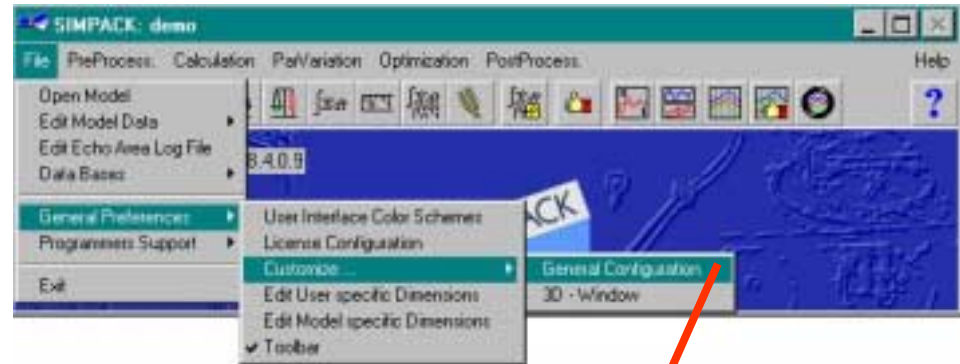
Model Setup: Time Excitations Defined in Substructures Usable in Main Structures

Functionality:

- Time Excitations defined in substructure also available in main models
- „Private“ and „public“ area of Time Excitation vectors
- Flag to switch on/off this functionality

Advantage/Application Cases:

- > Simple switch between different driving maneuvers by switching predefined substructures

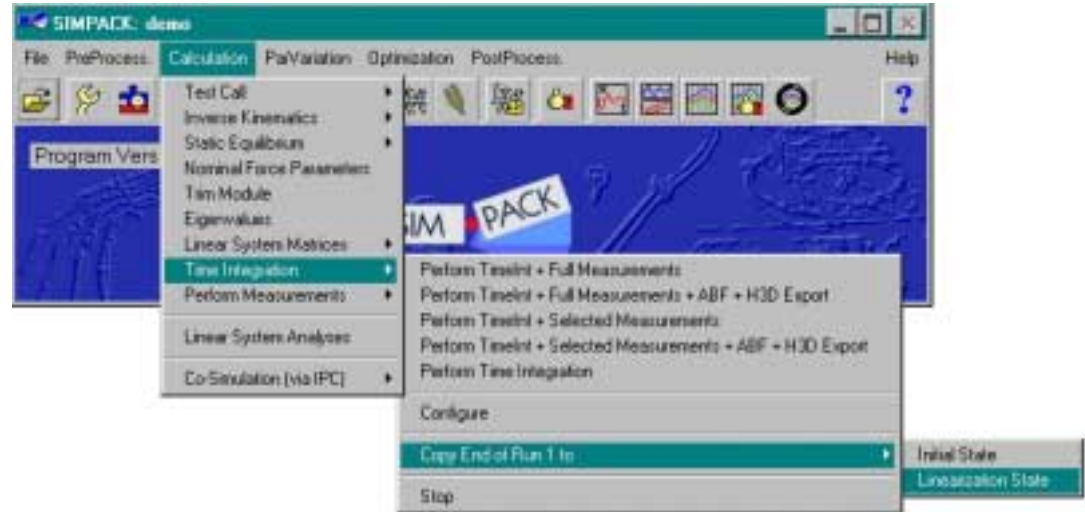


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Model Setup: Copy End of Run 1 to Linearization State

Functionality:

- Copy end states of time integration runs to Initial State and/or to Linearisation State



Advantage/Application Cases:

- > Quasistatic Equilibrium States to use for Linearisation (Eigenvalues, Mode Shapes, Linear System Response, ...) without losing basic Initial State of the model.

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Model Setup: Info about Inertia Tensor of Complete Model

Functionality:

Information about:

- mass
- centre of mass
- inertia tensor values
- main values of inertia tensor
- orientation of main axes

of a complete model

```

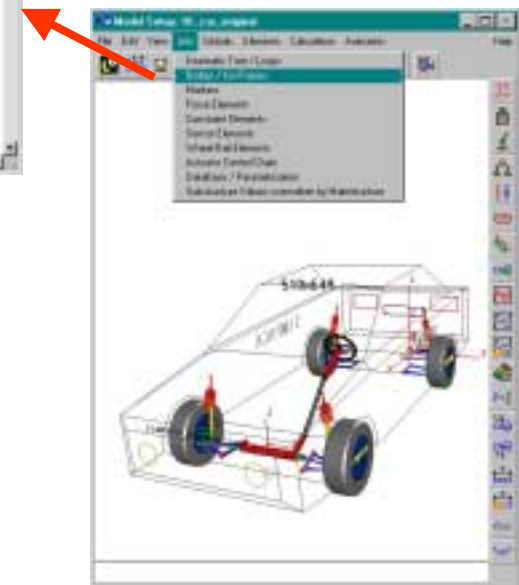
SIMPACK Model Information
-----
Total mass [kg] :
1.5715909+03

Center of Mass in initial position [m] :
0.41028900+00  1.80247940-01  7.28223860-02

Inertia-tensor relative to 'center of mass' and parallel to axis-coordinate system :
-----
-4.74660190+02  -2.23738700+00  1.08449070+02
-2.23738700+00  2.17160200+00  2.28170270-02
1.08449070+02  2.18175170-01  2.41489940+00

Inertia-tensor relative to 'center of mass' has following main-values :
-----
2.41489940+00  0.00000000+00  0.00000000+00
0.00000000+00  2.17160200+00  0.00000000+00
0.00000000+00  0.00000000+00  4.74660190+02

... in direction of following Main - Axis (relative to Esys) :
-----
0.46531370-01  -1.35005120-02  0.99984400-01  (X)
0.23140280-01  1.82121160+00  1.23271970-01  (Y)
0.78113770-01  -1.29063190-03  -1.50031610-01  (Z)
    
```



Advantage/Application Cases:

---> Check of model parameters concerning mass, centre of mass and inertia tensor parameters of all defined bodies.

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Modelling Elements:

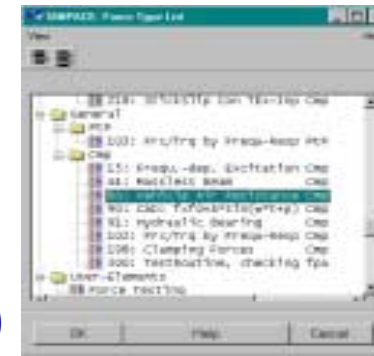
- ▶ New Air Spring Force Elements (3)
- ▶ New Flexicoil Force Element
- ▶ **New Air Resistance Force Element**
- ▶ New Force Elements: Gas Force, HLA, Hertzogan Contact
- ▶ New Track Module
- ▶ **New Tyre Modules (MF-MC, SWIFT, RMOD-K)**
- ▶ Creep Force Calculation in Accordance to Polach
- ▶ **Partial Coherence of Stochastic Excitations and $Mue(s,y)$ / $Mue(x,y)$**
- ▶ **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 Resistance Force Element

Functionality:

- Simple Automotive Airdrag Model (only longitudinal component of air resistance)
- Complex Automotive Airdrag Model (all components of aerodynamic forces)
- Cross wind definition available



Advantage/Application Cases:

- > Driving dynamics within high speed manouvers
- > Acceleration behavior with airdrag

$$F_{x,AD} = -\frac{1}{2} \rho_{air} A_{vehicle} c_x(\gamma) v_{veh,xp}^3$$

$$F_{y,AD} = -\frac{1}{2} \rho_{air} A_{vehicle} c_y(\gamma) v_{veh,xp}^2 \text{sign}(\gamma)$$

$$F_{z,AD} = \frac{1}{2} \rho_{air} A_{vehicle} c_z(\gamma) v_{veh,xp}^2$$

$$M_{x,AD} = \frac{1}{2} \rho_{air} A_{vehicle} c_{M_x}(\gamma) v_{veh,xp}^2 l_{veh} \text{sign}(\gamma)$$

$$M_{y,AD} = -\frac{1}{2} \rho_{air} A_{vehicle} c_{M_y}(\gamma) v_{veh,xp}^2 l_{veh}$$

$$M_{z,AD} = -\frac{1}{2} \rho_{air} A_{vehicle} c_{M_z}(\gamma) v_{veh,xp}^2 l_{veh} \text{sign}(\gamma)$$

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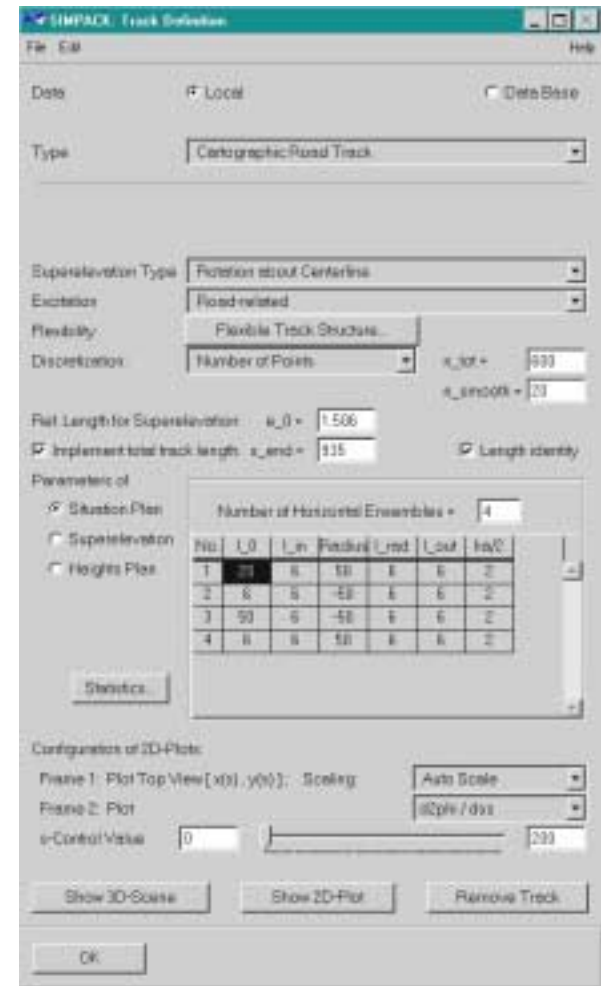
Modelling Elements: New Track Module 8.5

Functionality:

- New cartographic track with independent situation, super-elevation and (new) heights plan
- Extended road excitation and road friction functionalities

Advantage/Application Cases:

- > Definition of Closed Loop maneuvers with predefined tracks
- > Definition road excitations



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Modelling Elements: New Tyre Modules (MF-MC, SWIFT, RMOD-K)

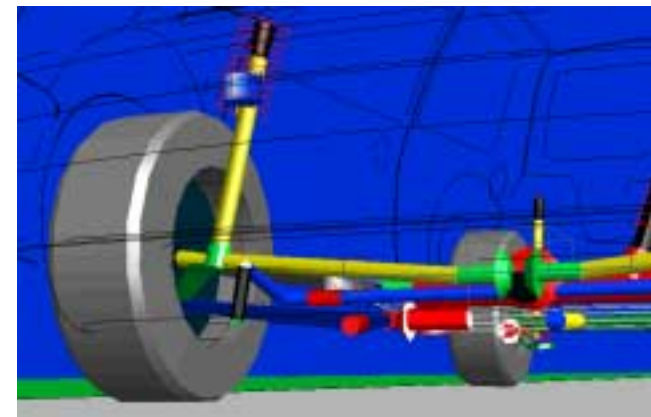
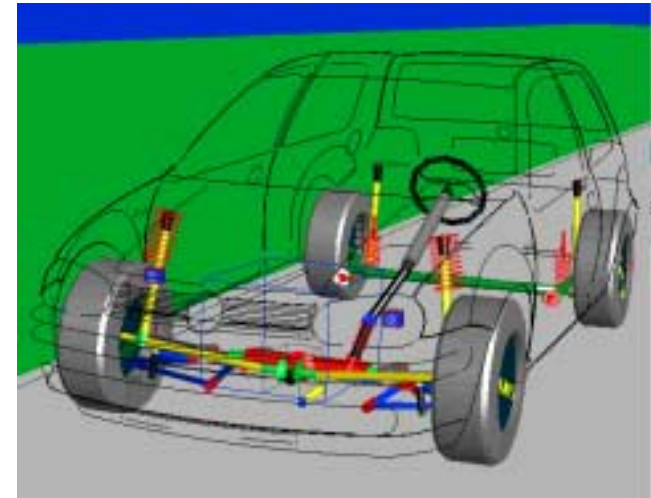
Functionality:

New Tyre Modules available with Force Element 49 (General SIMPACK Tyre):

- MF-MC Tyre by TMO (Motorcycle Tyre)
- SWIFT by TNO (Comfort Tyre Model)
- RMOD-K by GEDAS (Comfort Tyre Model)

Advantage/Application Cases:

- > Motorcycle applications (larger camber angles)
- > Ride and NVH complete vehicle analysis
- > Compatible and usable with special SIMPACK Automotive features (Vehicle Globals, Road Excitations, ...)



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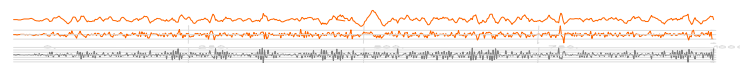
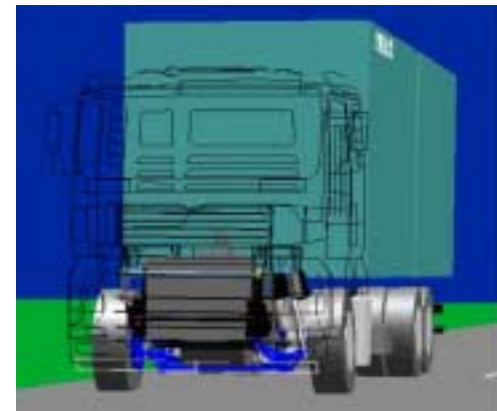
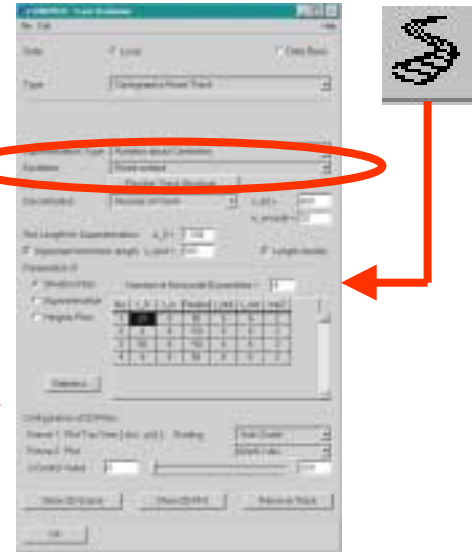
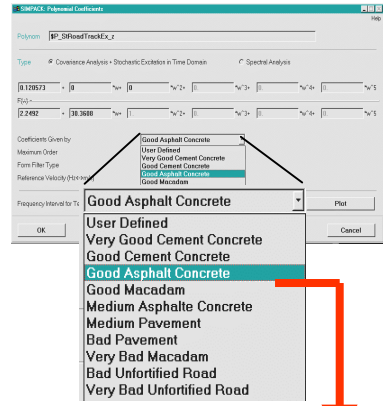
Modelling Elements: Partial Coherence of Stochastic Excitations

Functionality:

- Available within track definition
- Based on SIMPACK predefined polynomialas describing road PSD's
- Different correlations of long and short wave length excitations between left and right vehicle side.
- Different types of coherence function definition.

Advantage/Application Cases:

---> Very comfortable definition of ride and NVH complete vehicle maneuvers

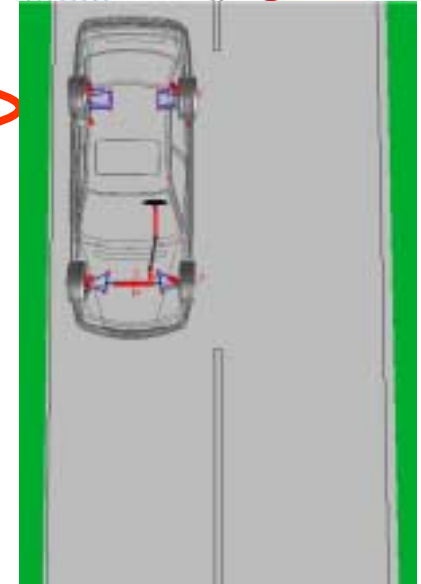
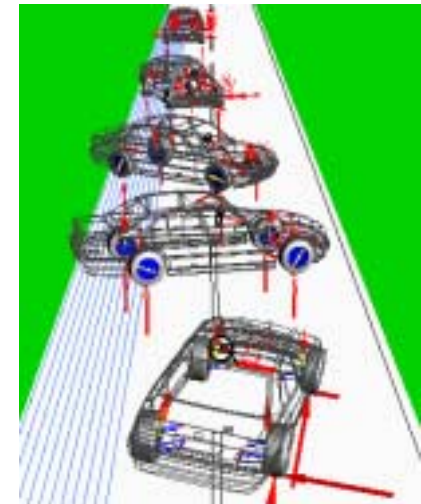
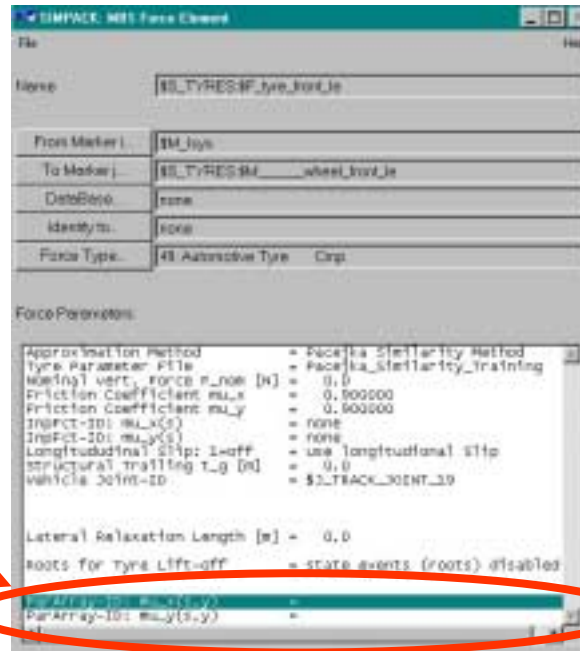


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Modelling Elements: Road Friction Coefficients $\mu(s,y)$ and $\mu(x,y)$

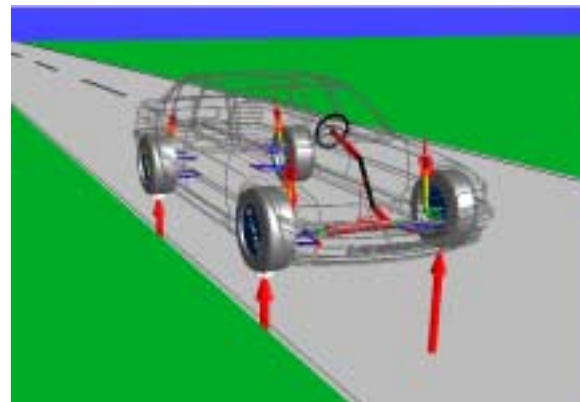
Functionality:

- Friction coefficient (μ) definition with SIMPACK Parameter Array
- Usable as $\mu(s,y)$ or $\mu(x,y)$ within tyre force element 49



Advantage/Application Cases:

- > Any kind of mue-split maneuvers

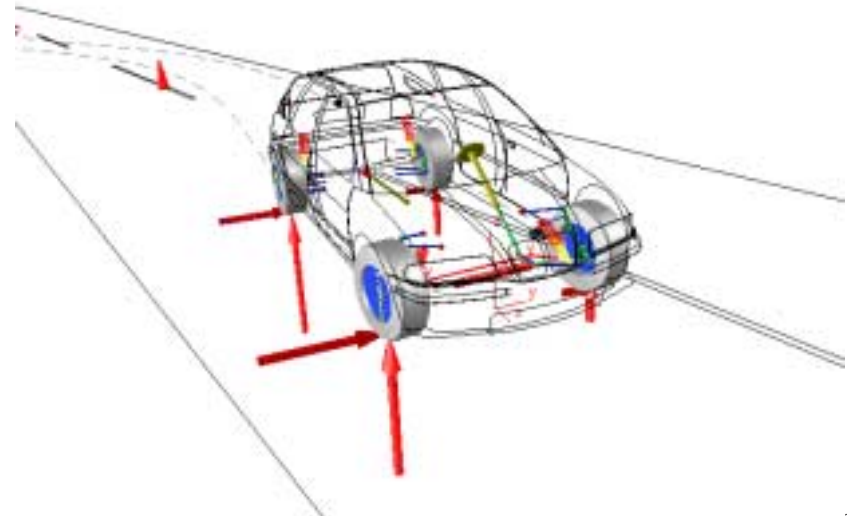
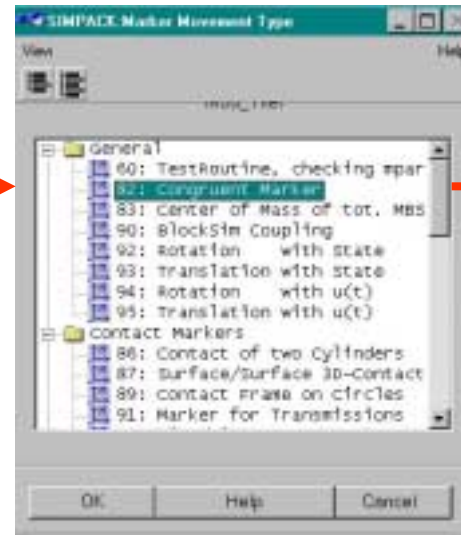


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Modelling Elements: Congruent M8k5

Functionality:

- Moved Marker (Type 82) which is always at the same position as a marker on a different body.
- The position and orientation can be made congruent for all directions or selected directions only.
- Can have a velocity relative to the referenced marker or not, selectable by the user.



Advantage/Application Cases:

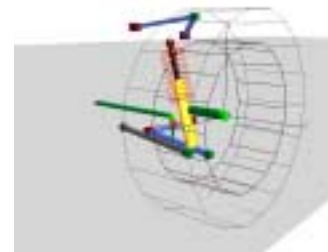
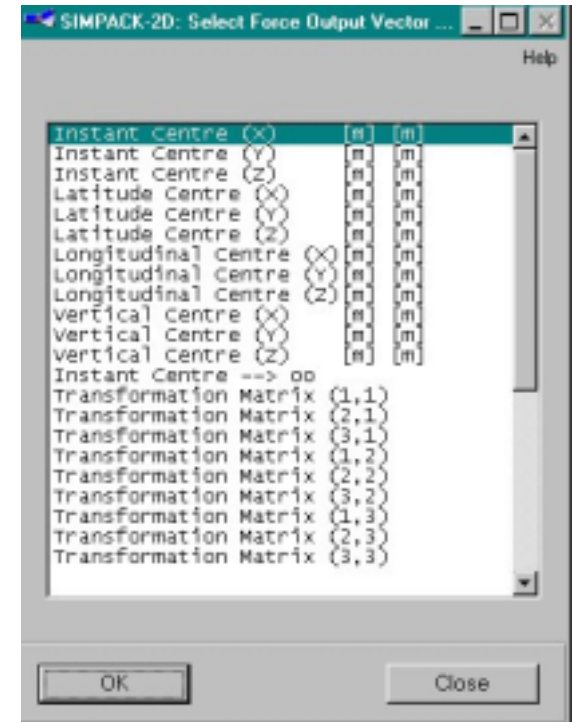
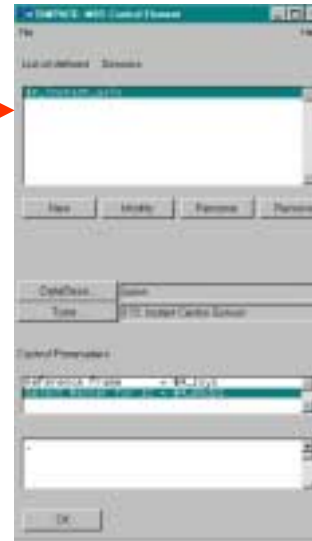
- > Any kind of moved views
- > representation of moved force contact points (e.g.: tyre forces)

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Modelling Elements: Instant Centre/Axis Calculation and Representation

Functionality:

- Sensor element to calculate instant axis
- Moved marker to visualize instant axis and instant centres
- Additional calculation and visualization of different instant centres (intersections of instant axis and user defined planes)



Advantage/Application Cases:

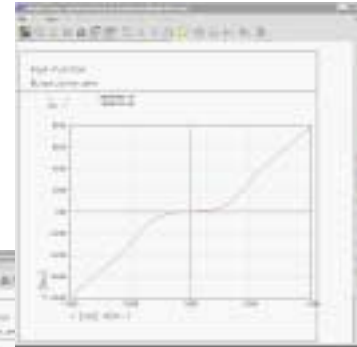
- > Visualization virtual steering axes
- > Visualization longitudinal and transversal instant centres
- > General visualization of instant axes

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Modelling Elements: Input Functions: Extrapolation and New File Format

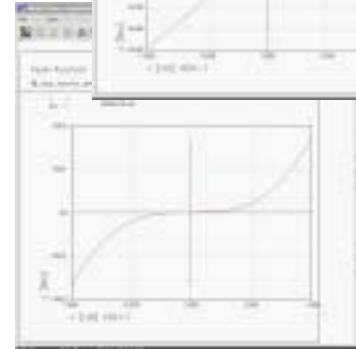
Functionality:

- Optimally switch to linear extrapolation of spline interpolation



New Input Function File Format (*.if2):

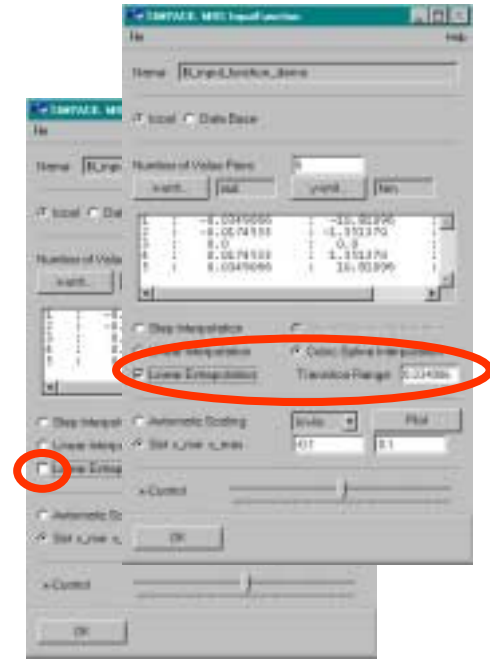
- No declaration of number of lines and number of valuepairs
- Definition of interpolation type and discontinuirties within the file
- Definition of units within the file additionally to model units
- Support by Sustitution Variables



```
inpFct_ascii_demoC*
1 $SIMPACT_Input_Function_Set$ | Release
2 1,1 | Format: 0/1/2 = ASCII/real/double
3 0
4
5
6 $I_Function_cubic | Input Function 3
7 1 | Interpolation Method: 0/1/2/3/4 = Step/CubicSpline/Linear/AkimaSpline/ConstGradient
8 1 2.000000E+00 0.000000E+00 | Extrapolation: 0/1 = CubicSpline/Linear : Transition Range
9 5.729577E+01 7.39969E-01 | UnitFactors = (x.y)[User] / (x.y)[SI] ((desl.(lbfitt))
10 angle torque | Unit Types
11 -2.000000E+00 -0.000000E+00 | x y d 1
12 -1.000000E+00 -1.000000E+00 | x y d 2
13 0.000000E+00 0.000000E+00 | x y d 3
14 1.000000E+00 1.000000E+00 | x y d 4
15 2.000000E+00 0.000000E+00 | x y d 5
16
```

Advantage/Application Cases:

- > Comfotabel definition of spline extrapolation areas
- > Clear data structure due to all infomation stored in new file format



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Modelling Elements: Input Function Sets: Handling and New File Format 8.5

Functionality:

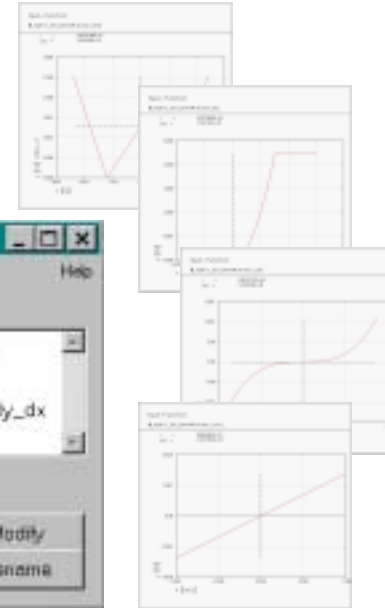
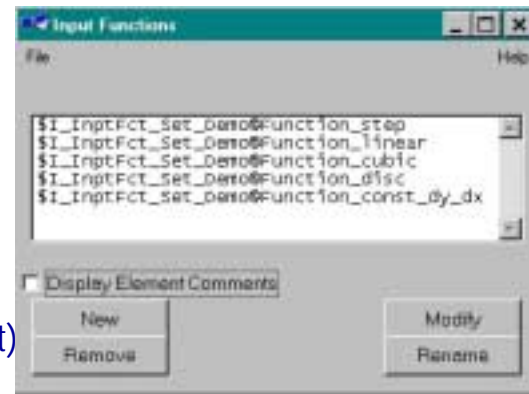
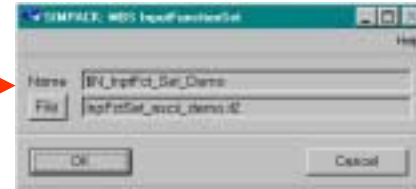
- Handling like any other SIMPACK element

New Input Function File Format (*.if2):

- No declaration of number of lines and number of valuepairs necessary
- Definition of interpolation type (Step/CubicSpline/Linear/AkimaSpline/ConstGradient) and discontinuities in the file
- Definition of units within the file additionally to model units
- Support by Sustitution Variables

Advantage/Application Cases:

- > Comfotabel definition of complete bushing force elements (linear and nonlinerar in combination) by only one file.
- > Clear data structure due to all infomation stored in new file format



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Modelling Elements: Handling of Input Function Arrays

Functionality:

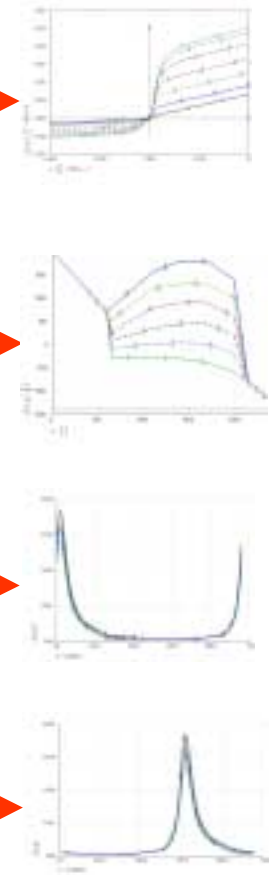
- GUI and Akima Spline Interpolation
- Optimally switch to linear extrapolation of spline interpolation
- Handling like any other SIMPACK element
- File Format (*.if3):

Advantage/Application Cases:

- > Semiactive dampers
- > Engine characteristic diagrams
- > ...



x	y	z
-0.500000	-5400.000	0.000
-0.070000	-5007.800	0.000
-0.250000	-4666.200	0.000
-0.172370	-4344.500	0.000
-0.125000	-4041.800	0.000
-0.0965940	-3796.400	0.000
-0.0779700	-3481.800	0.000
-0.0607980	-3088.200	0.000
-0.0462460	-2667.200	0.000
-0.0331720	-2246.400	0.000
-0.0236740	-1779.500	0.000
0.0	-1280.000	0.000
0.0236740	-788.800	0.000
0.0331720	-380.000	0.000
0.0462460	1188.00	0.000
0.0607980	2487.00	0.000
0.0779700	3487.00	0.000
0.0965940	3792.00	0.000
0.125000	3887.00	0.000
0.172370	3734.00	0.000
0.250000	3128.00	0.000
0.370000	2144.00	0.000
0.500000	1120.00	0.000



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Solver 8.5

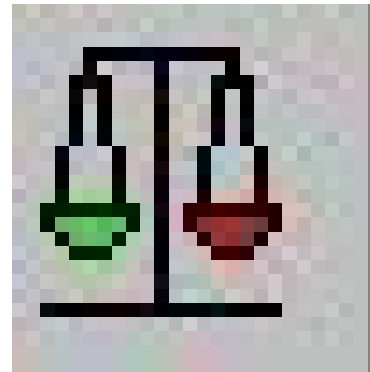
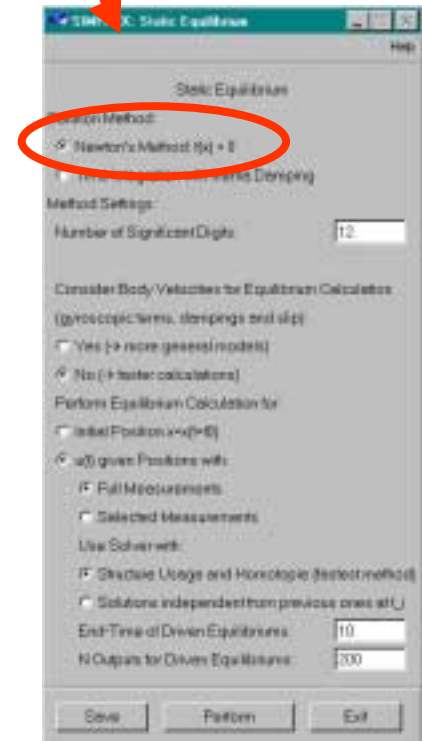
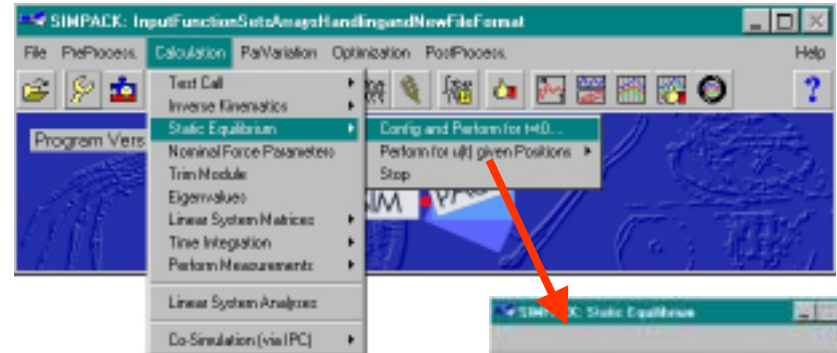
- ▶ Time Integration Configuration: Output Stepsize/Sampling Frequency
- ▶ Static Equilibrium: Newtons Method much more Robust and Faster
- ▶ **Static Equilibrium: New Solver Mode „Driven Equilibrium“**
- ▶ **Linerisation Process: Increased Speed and Robustness**
- ▶ **Eigenvalues: Improved Calculation 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: Newtons Method much more Robust and Faster

Functionality:

- Finding the static equilibrium with the "Newtons Method", i.e. by directly solving the nonlinear equations was made much more faster and robust for models with kinematic loops, i.e. constraints.

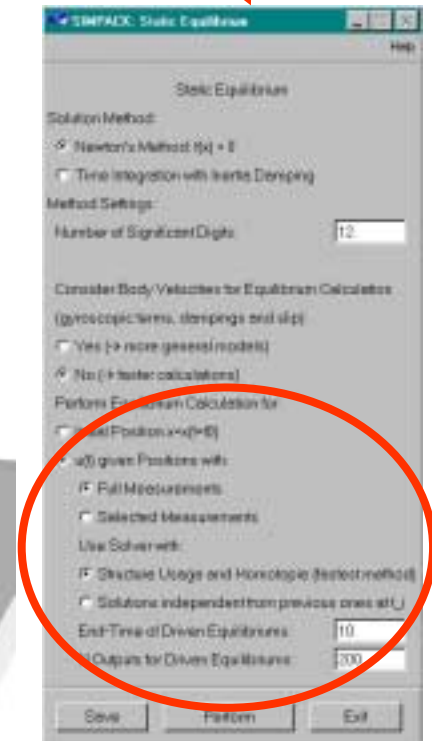
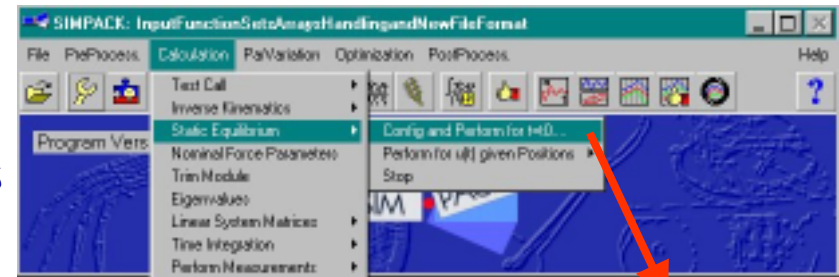


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Solver: Static Equilibrium: New Solver Mode „Driven Equilibrium“

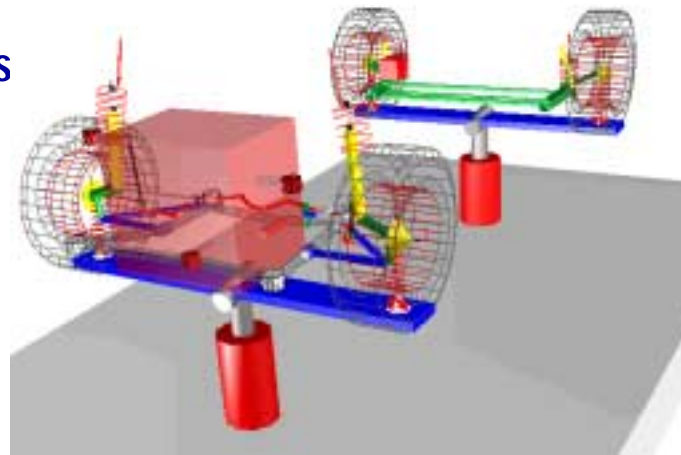
Functionality:

- Series of Static Equilibrium calculations
- Definition of required positions and forces by Time Excitations and u-Vectors
- Automatic generation of ‚static‘ time history



Advantage/Application Cases

- > No care about suitable damping parameters like in dynamic simulations
- > Elastokinematic testbeds
- > ...



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Solver: Linerisation Process: Increased Speed and Robustness

Functionality:

- The linearization process was speed up significantly for closed loop systems
- Linearization process extendet for q-States
- Mode shape matrix available for absolut and relative body motions
- Calculation of kinetic and modal energy

Advantage/Application Cases:

- > Fast and robust linearization for closed loop systems
- > Much more comfortable calculation of Eigenvalues/Mode Shapes
- > Much more comfortable working with SIMPACK Linear System Analysis

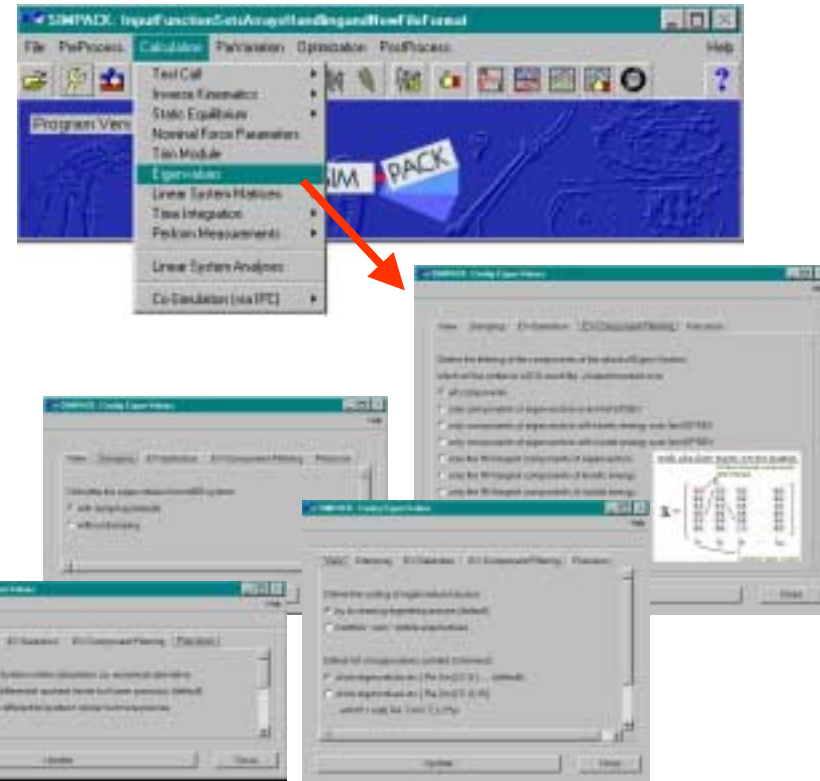


Working with SIMPACK Automotive+, Release 8.5

Solver: Eigenvalues: Improved Calculation, Configuration and Representation

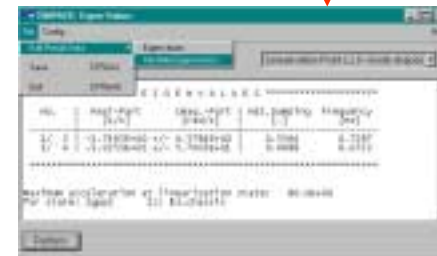
Functionality:

- Absolute modal results in addition to the relative modal results.
- Modal results are written to an ascii file
- Various filtering techniques for reducing the amount of information written to the modal result file
- Modal Analysis can be performed with or without regarding damping
- Energy partizipations are written out to the ascii modal result file



Advantage/Application Cases:

--> Much more comfortable calculation and representation of eigenvalues/mode shapes



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Postprocessing 8.5

- ▶ **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
- ▶ Aq-Sensor

Working with SIMPACK Automotive+, Release

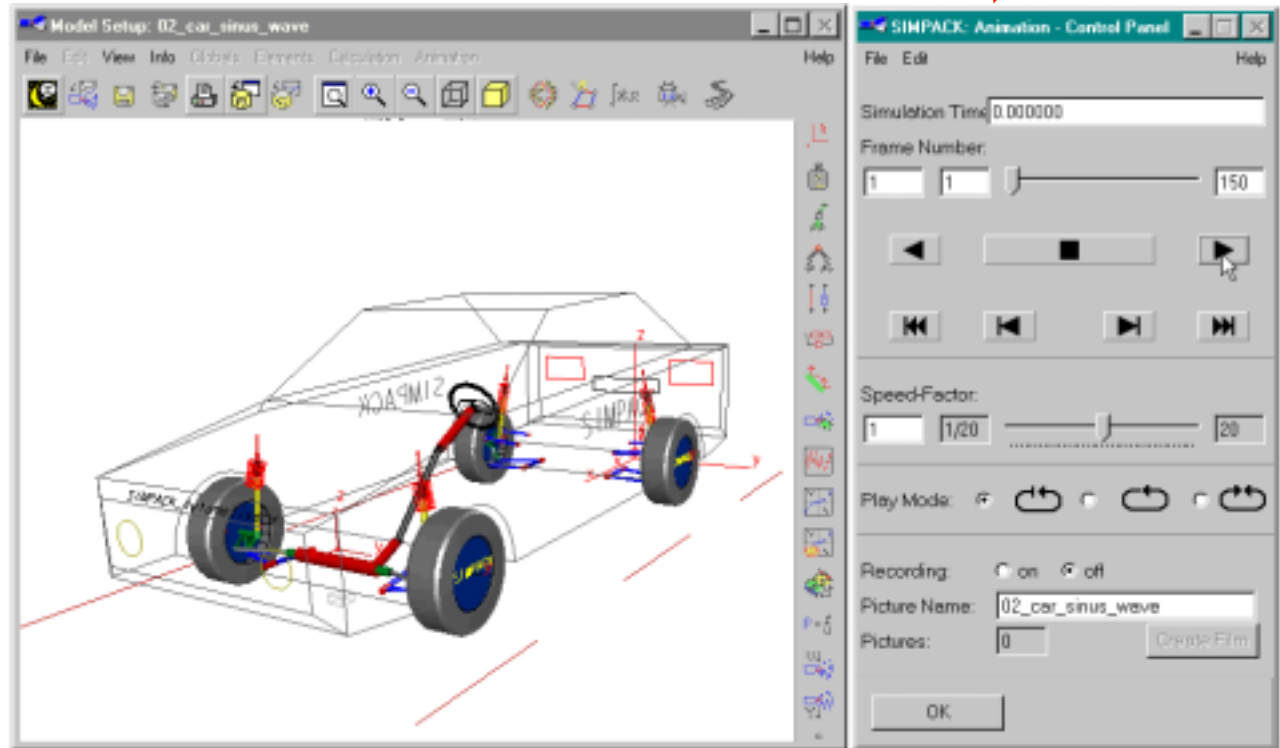
Postprocessing: Animation Data with Display of Current Simulation 8.5

Functionality:

- Display of current simulation time in 3D-animation control panel

Application Case:

--> Improved model/result check with 3D-animation



Working with SIMPACK Automotive+, Release

User Subroutines

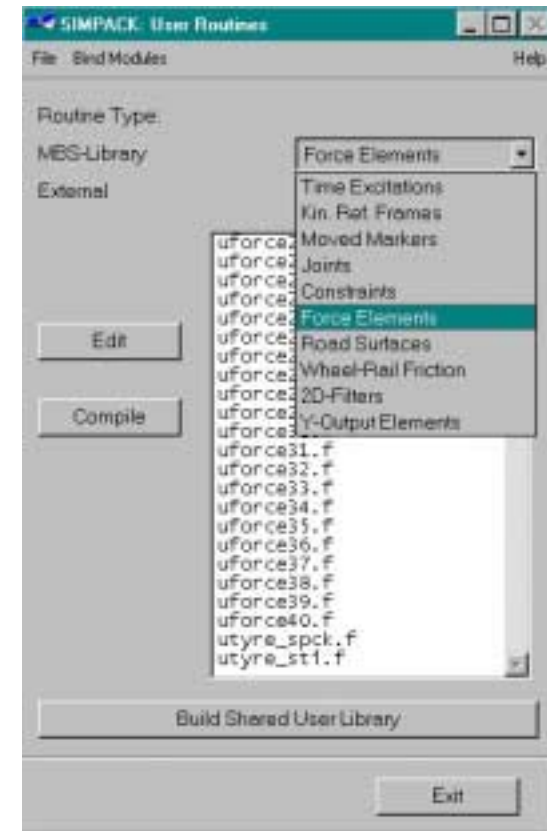
- ▶ String Elements for Transferring String Type Information
- ▶ **Only One Routine to Describe a Complete User element**
- ▶ Access Functions for all Data During Simulation
- ▶ New User Routine Type: Y-Output Vector
- ▶ Fully Comply with Shared Library Approach and Units

Working with SIMPACK Automotive+, Release

User Subroutines: Only One Routine to Describe a Complete Userelement **8.5**

Functionality:

- New GUI for SIMPACK userroutines
- All User Routine functionalities necessary to describe a userelement now available within only **one** file.



Advantage/Application Cases:

--> Ease the process of creating and maintaining user subroutines

Working with SIMPACK Automotive+, Release

Interfaces:

- ▶ FEMBS: SIMPACK GUI Integration and Functionality
- ▶ **ALTAIR (Hypergrap, HyperView, Motion View)**
- ▶ Inter Process Communication (IPC)/ AMESim:

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Interfaces: ALTAIR (Hypergrap, HyperView, Motion View) 8.5

Functionality:



Interface to ALTAIR Inc. Products: Hypergraph/HyperView/Motion View

- Creating SIMPACK model data input files (*.sys and *.ani) with Motion View
- Transferring plotting data via the Altair Binary Format (ABF).
- Transferring animation data via the Altair Hyper 3D format (H3D)
- H3D format can also be used for deploying fully 3D graphics on the internet by utilizing the Hyper3D Player (small and light Plug In for NETSCAPE, Internet Explorer, ...)

Advantage/Application Cases:

- > Predefined SIMPACK model creation/ model transfer out of ADAMS models.
- > 2D and 3D Postprocessing with ALTAIR Inc. Products

