Working with SIMPACK Automotive+, Release 8.5

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Overview

- 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

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 plattforms 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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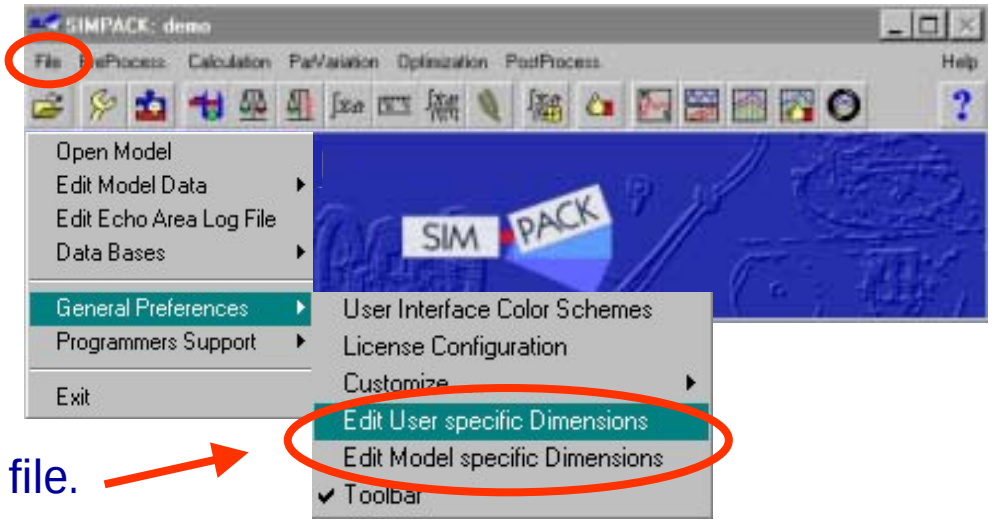
General: Userspecific Dimensions



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 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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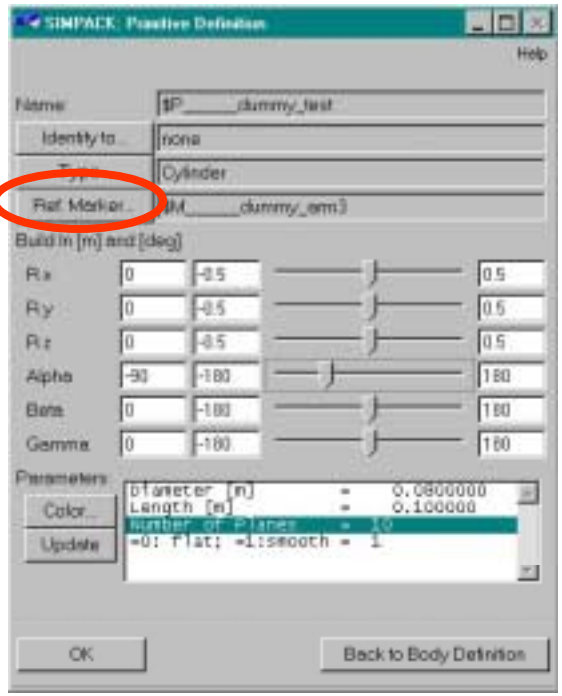
Model Setup: Primitive Definition With Respect to Markers

Functionality:

- All SIMPACK graphical primitive definition can be done with respect to existing marker positions/orientations

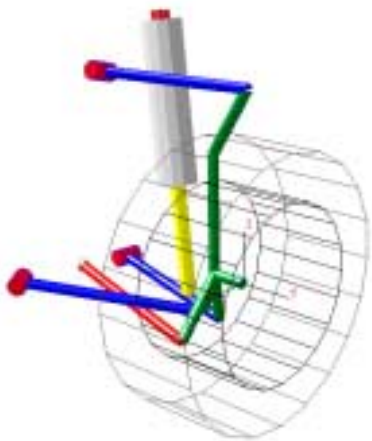
- No additional Sensor and Ensemble necessary



Advantage/Application Cases:

---> Easy and helpfull visualisation of orientation and displacements of
e.g.: buschings, engine mounts, ...

---> No unnecessary sensor output values.



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Model Setup: Complete Bushing Force Element Described by one File

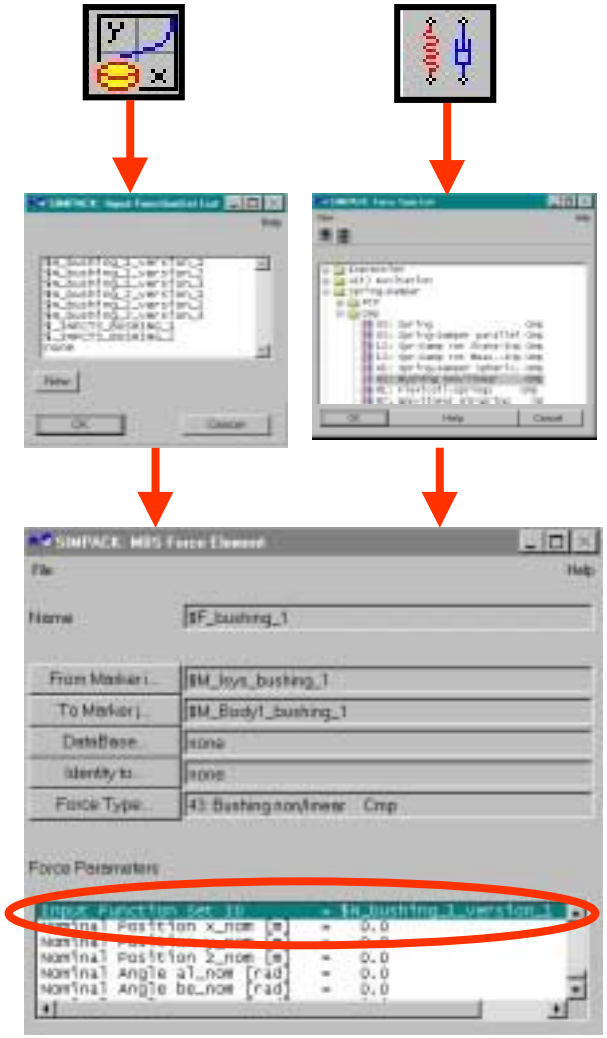
Functionality:

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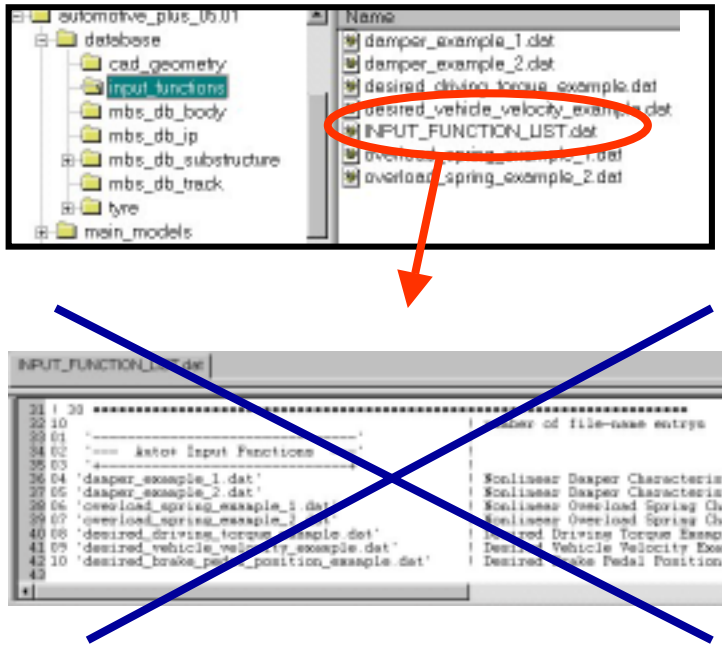
Model Setup: *.LIST.dat files within Database Handling no longer necessary

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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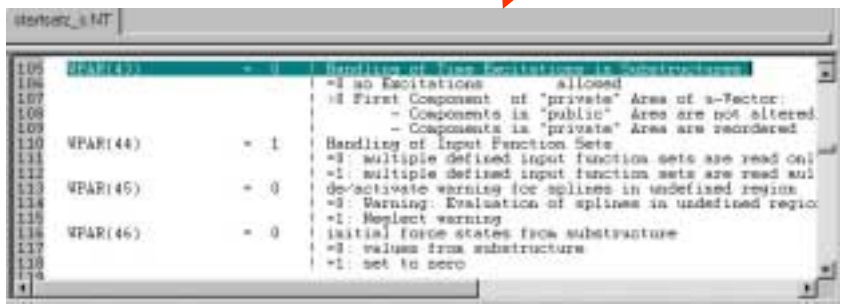
Model Setup: Time Excitations Defined in Substrutures Usable in Main Structure

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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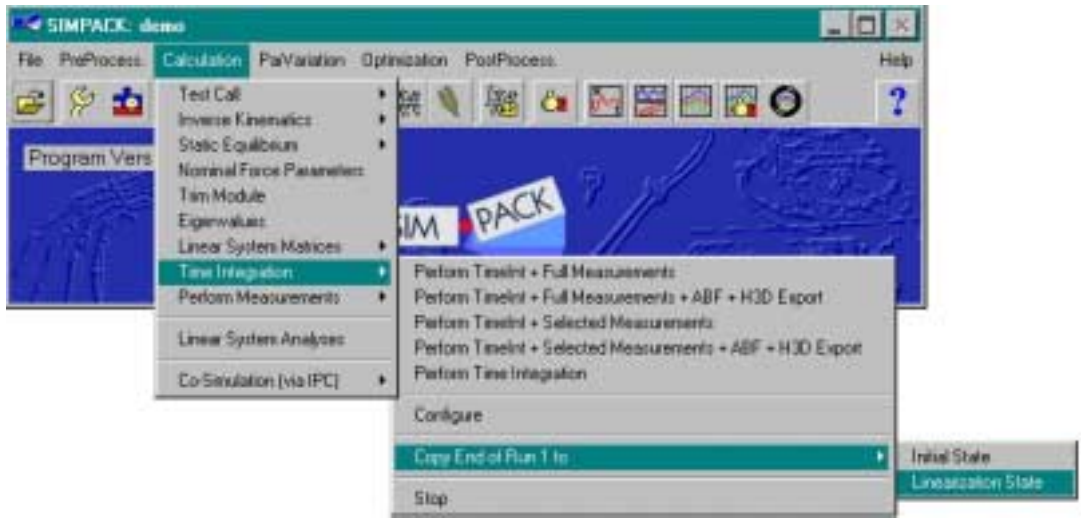
Model Setup: Copy End of Run 1 to Linearization States

Functionality:

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



Advantage/Application Cases:

---> Quasistatic Equilibrium States to use for Linearistaion (Eigenvalues, Mode Shapes,

Linear System Response, ...) without losing basic Initial State of the model.

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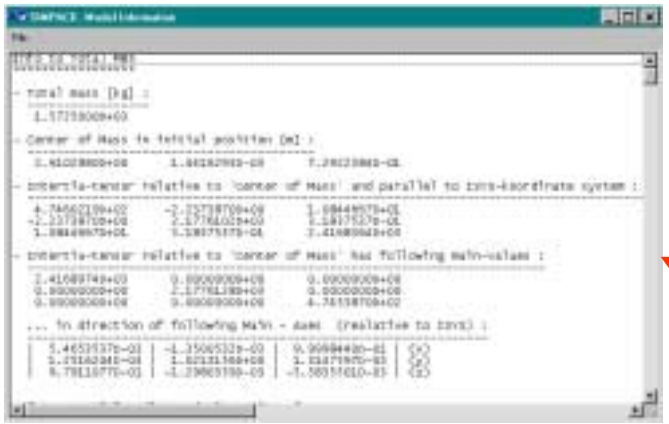
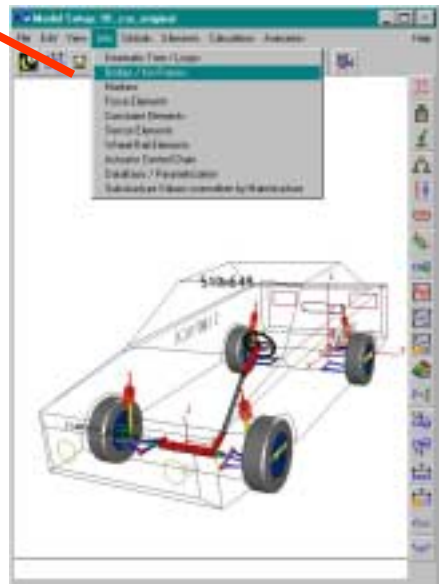
Model Setup: Info about Inertia Tensor of Complete Model





Functionality:

Information about:

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

of a complete model

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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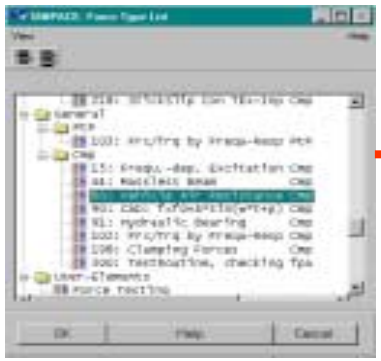
Modelling Elements: New Air Resistance Force Element



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

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

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

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

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

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

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

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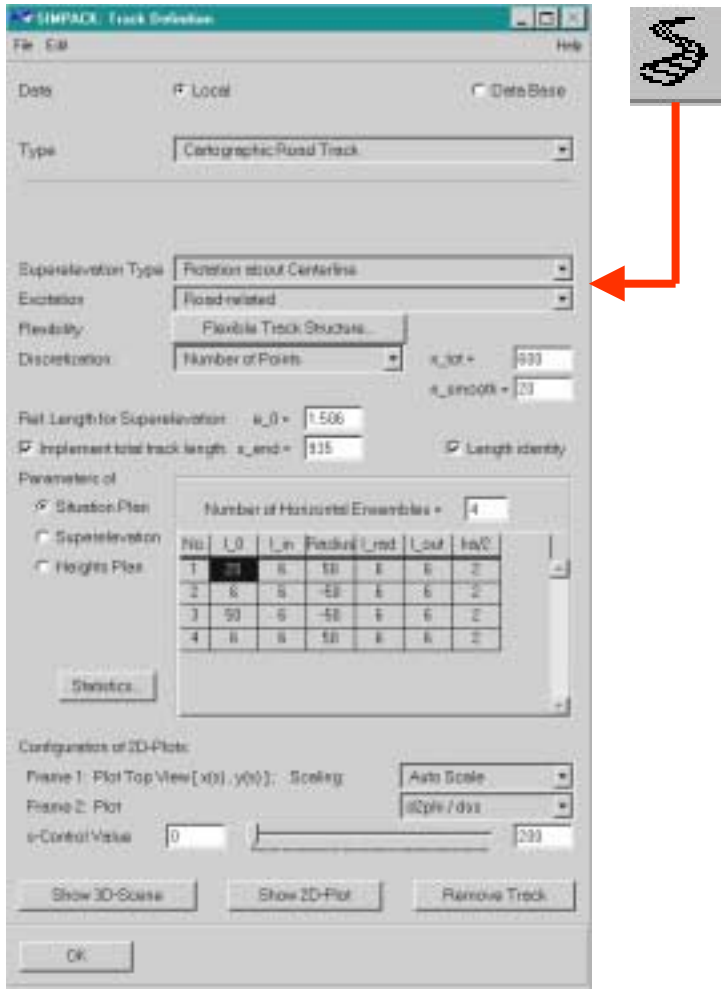
Modelling Elements: New Track Module

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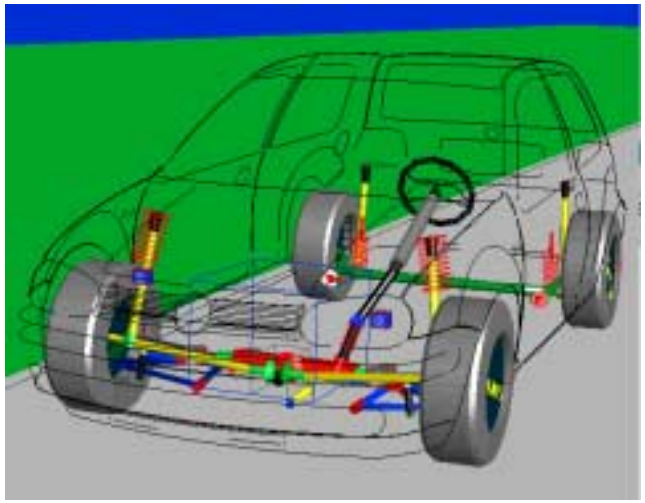
Modelling Elements: New Tyre Modules (MF-MC, SWIFT, RMOD-K)

Functionality:

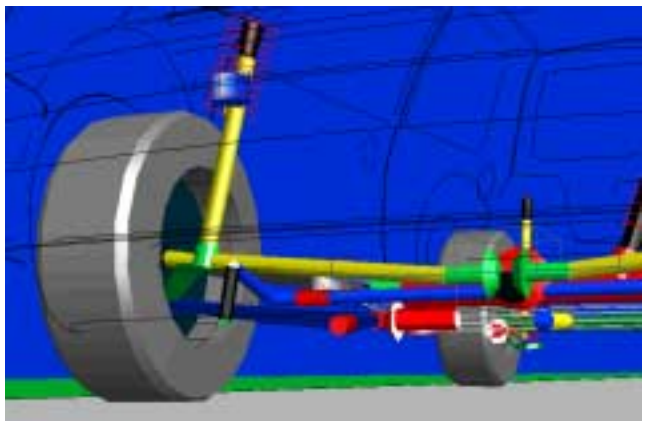
New Tyre Modules available with Force Element 49 (General SIMPACK Tyre):

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



Advantage/Application Cases:

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



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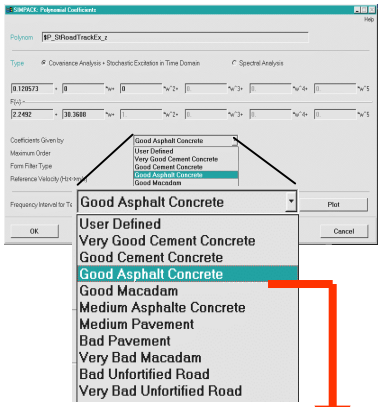
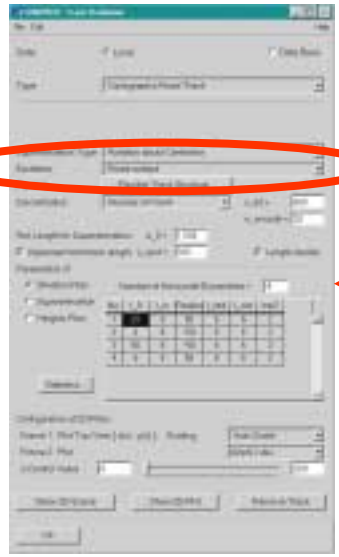
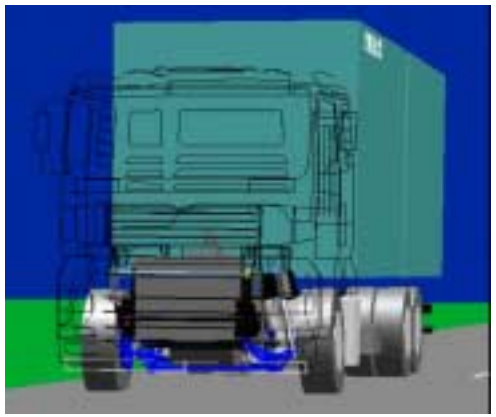
Modelling Elements: Partial Coherence of Stochastic Excitations

Functionality:

- Available within track definition
- Based on SIMPACK predefined polynomilas 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 comfortabel definition of ride and NVH complete vehicle maneuvers

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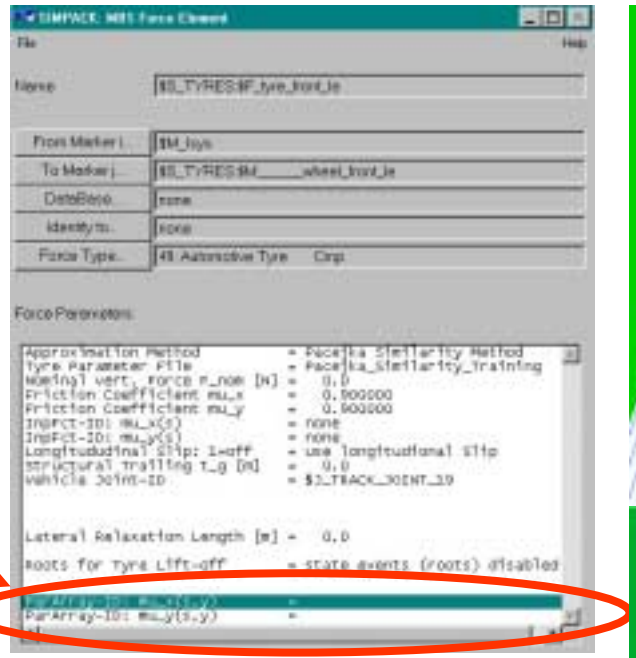
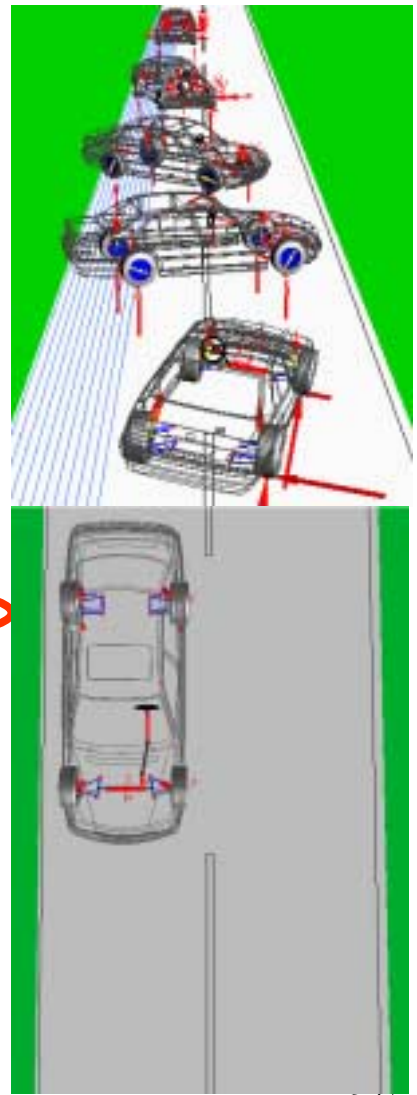
Modelling Elements: Road Friction Coefficients μ(s,y) and μ(x,y)

Functionality:

-- Friction coefficient (μ) definition with SIMPACK Parrameter Array

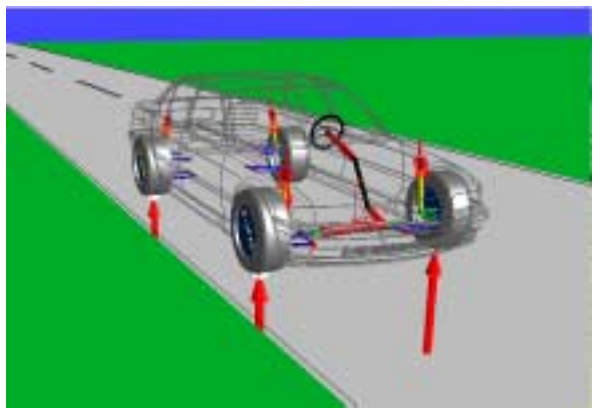
-- Usable as μ(s,y) or μ(x,y) within tyre force element 49





Advantage/Application Cases:

---> Any kind of mue-split maneuvers



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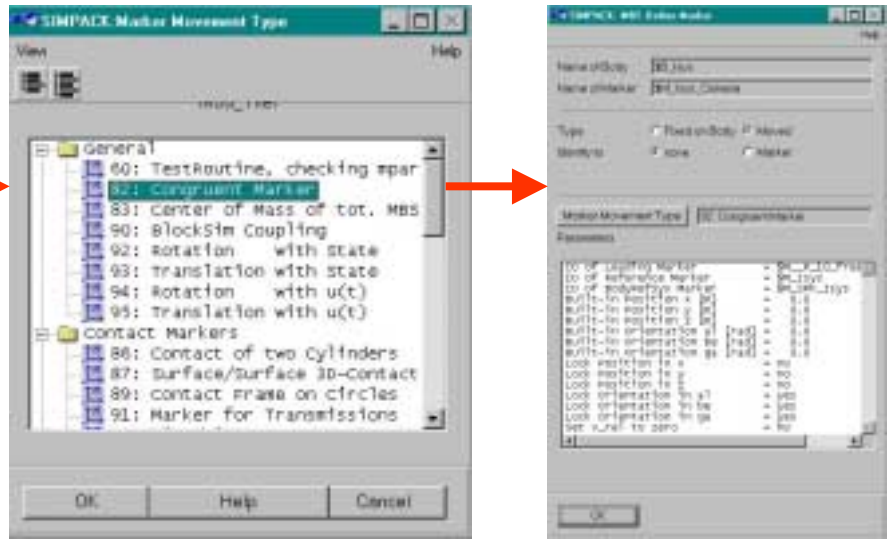
Modelling Elements: Congruent Markers

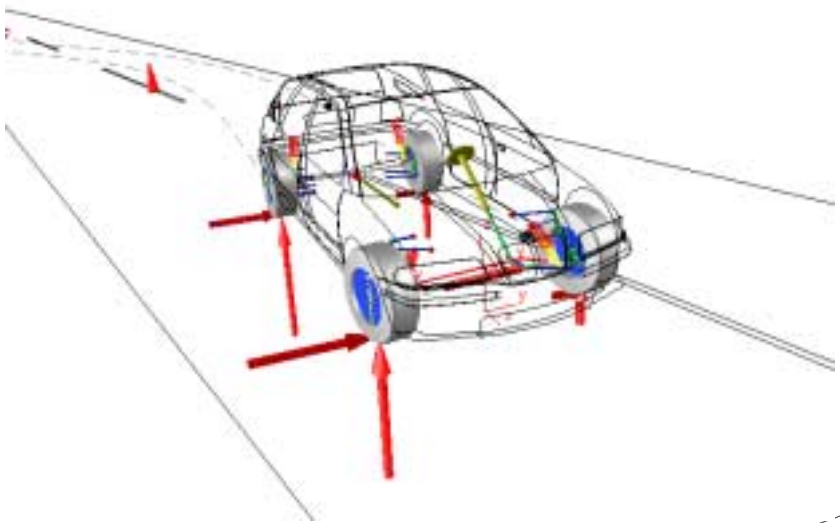
Functionality:

-- 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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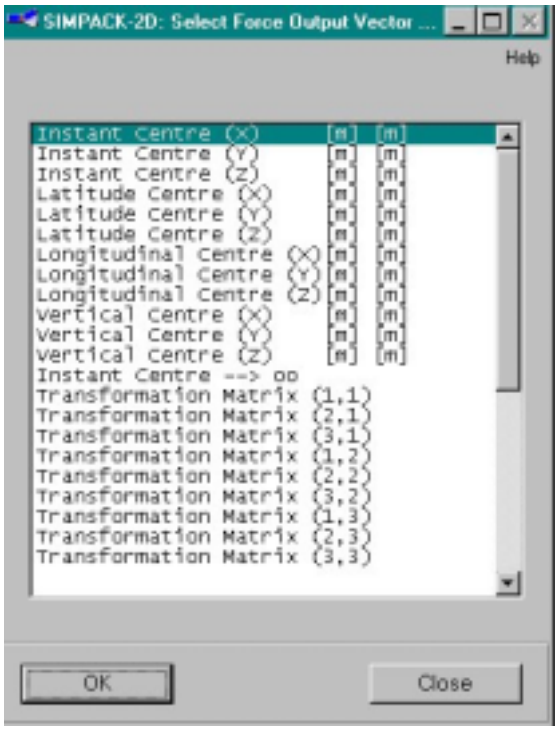
Modelling Elements: Instant Centre/Axis Calculation and Representation

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)

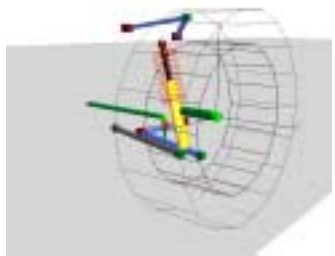


Advantage/Application Cases:

---> 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:

-- Optinally switch to linear extrapolation of spline interpolation

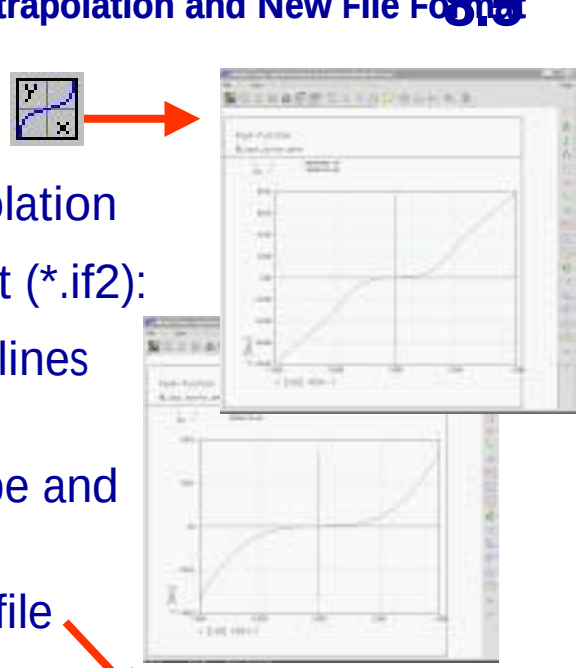
New Input Function File Format (*.if2):

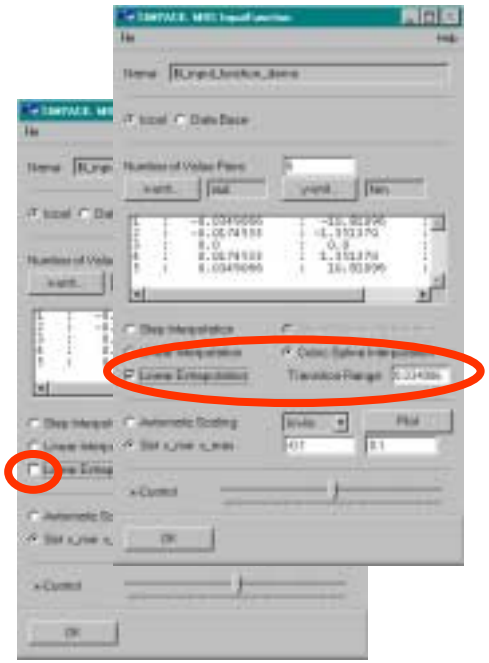
-- No declaration of number of lines and number of valuepairs

-- 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_demo.if2*
1 $SIMPACK_Input_Function_Set4
2  1.1                          ! Release
3  0                            ! Format: 0/1/2 = ASCII/real/double
4
5
6 $I_Function_cubic             ! Input Function 1
7  1                            ! Interpolation Method: 0/1/2/3/4 = Step/CubicSpline/Linear/AkimaSpline/ConstGradient
8  1  2.0000000000000000E+00    ! Extrapolation: 0/1 = CubicSpline/Linear ; Transition Range
9   5.729577E+01   7.39989E-01  ! UnitFactors = (x,y)[User] / (x,y)[SI]  ([deg],[lbft])
10  angle          torque       ! Unit Types
11 -2.000000E+00 -8.000000E+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  8.000000E+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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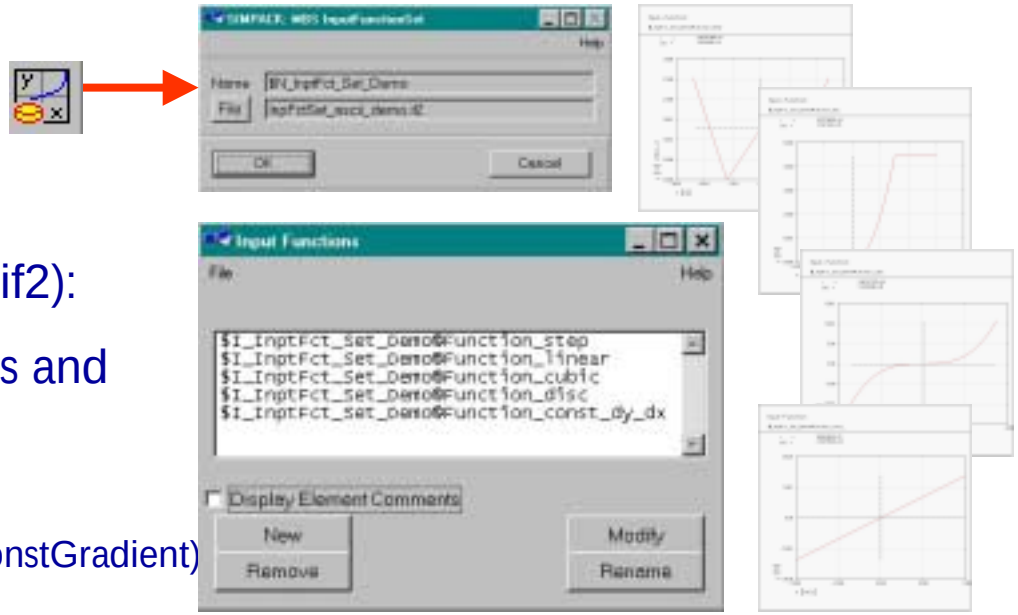
Modelling Elements: Input Function Sets: Handling and New File Format



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 comlete 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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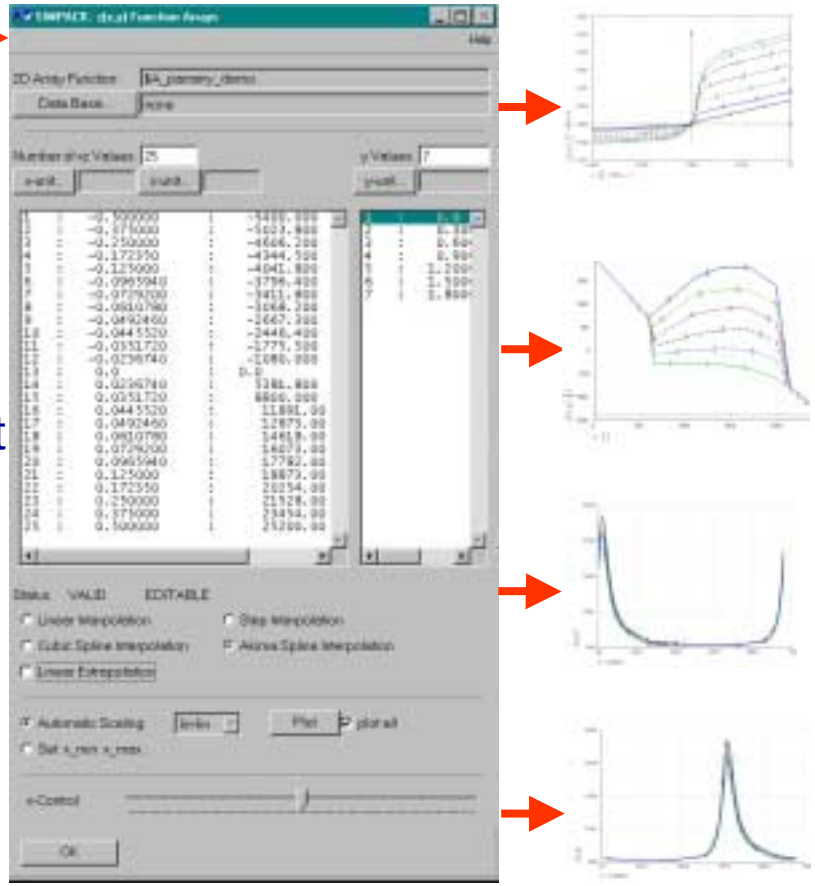
Modelling Elements: Handling of Input Function Arrays

Functionality:



-- GUI and Akima Spline Interpolation

-- Optinally switch to linear extrapolation of spline interpolation

-- Handling like any other SIMPACK element

-- File Format (*.if3):

Advantage/Application Cases:

--> Semiactive dampers

--> Engine characteristic diagrams

--> ...

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Solver:

- 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. Caculation

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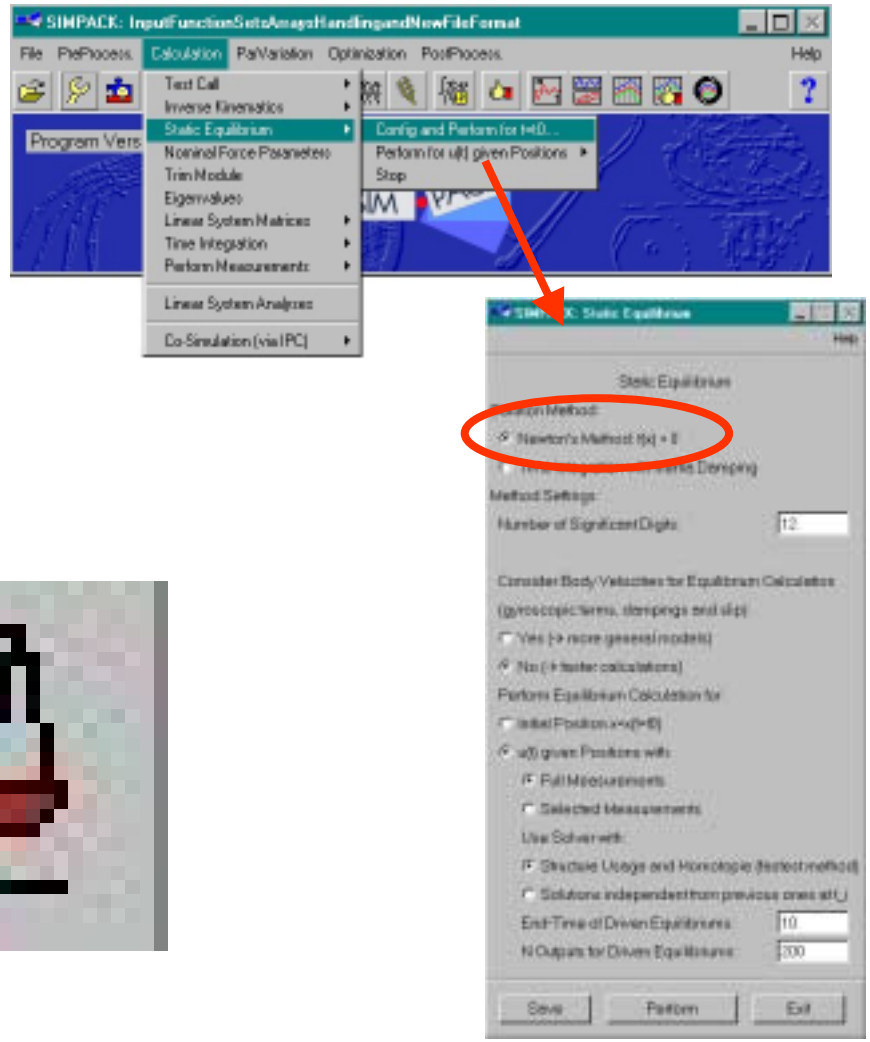
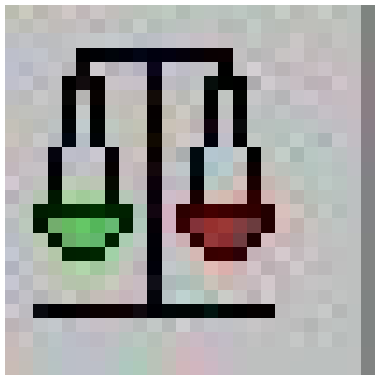
Solver: Static Equilibrium: Newtons Method much more Robust and Faster

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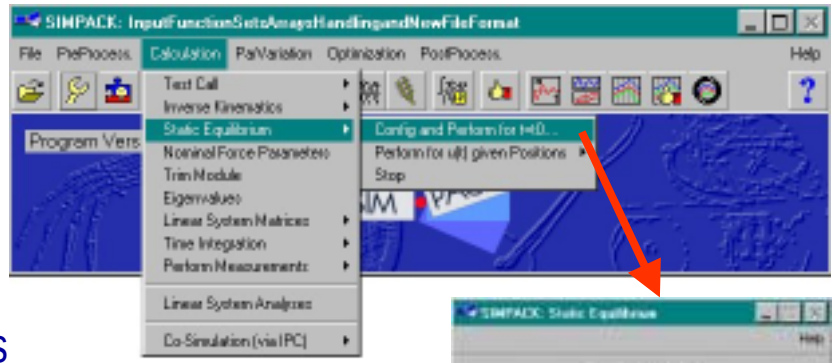
Solver: Static Equilibrium: New Solver Mode „Driven Equilibrium“

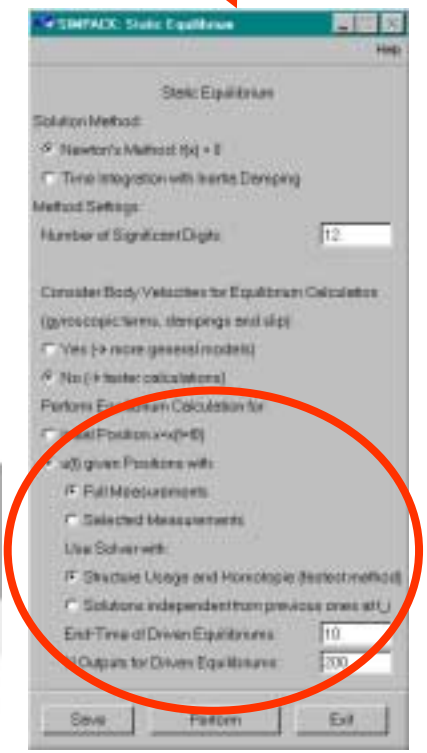
Functionality:

-- Series of Static Equilibrium calculatitions

-- Definition of required positions and forces by Time Excitations and u-Vectors

-- Automatic generation of ‚static‘ time history



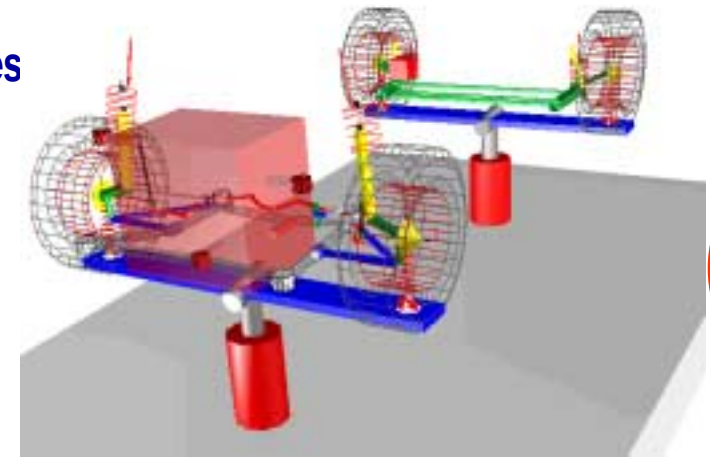


Advantage/Application Cases

--> 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

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Solver: Eigenvalues: Improved Calculation, Configuration and Representation

Functionality:

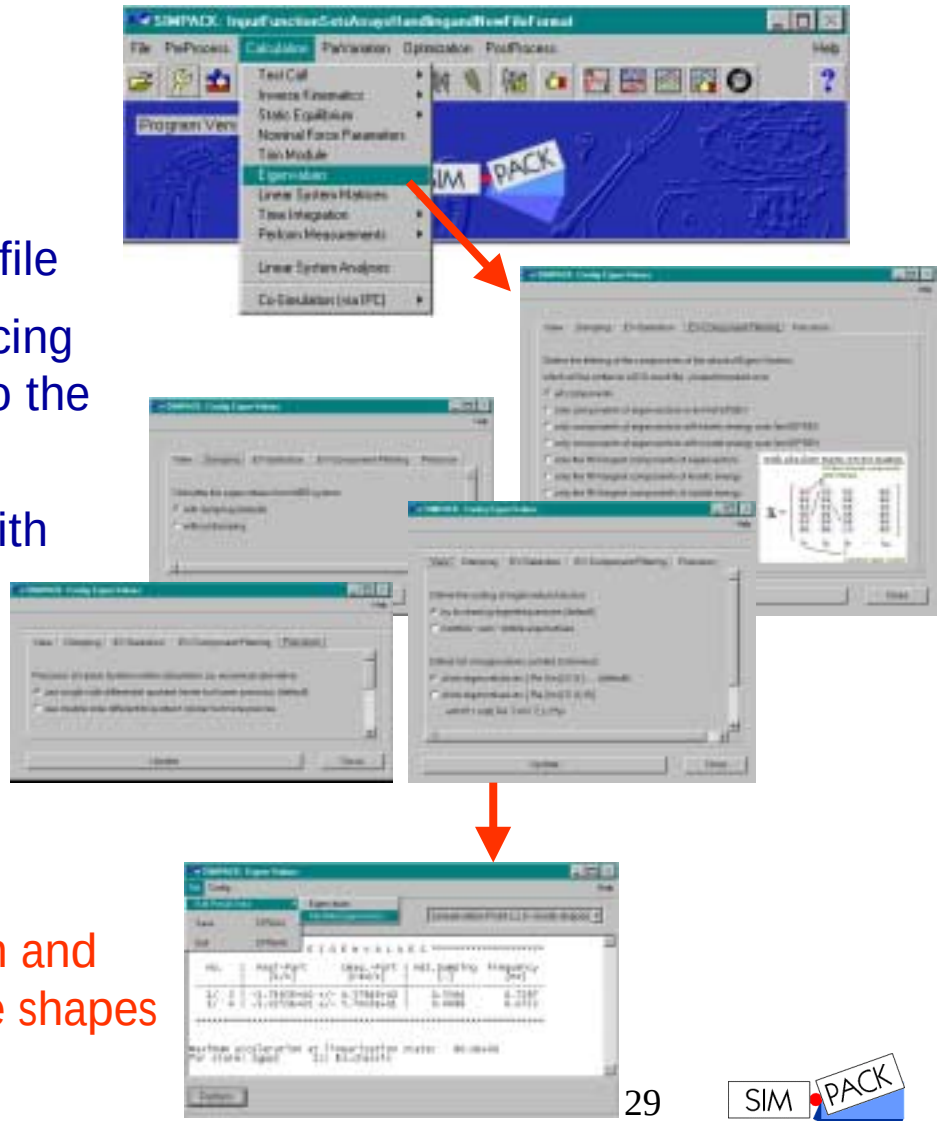
-- Absolute modal results in addition to the relative modal results.

-- 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

Working with SIMPACK Automotive+, Release 8.5

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
- Aq-Sensor

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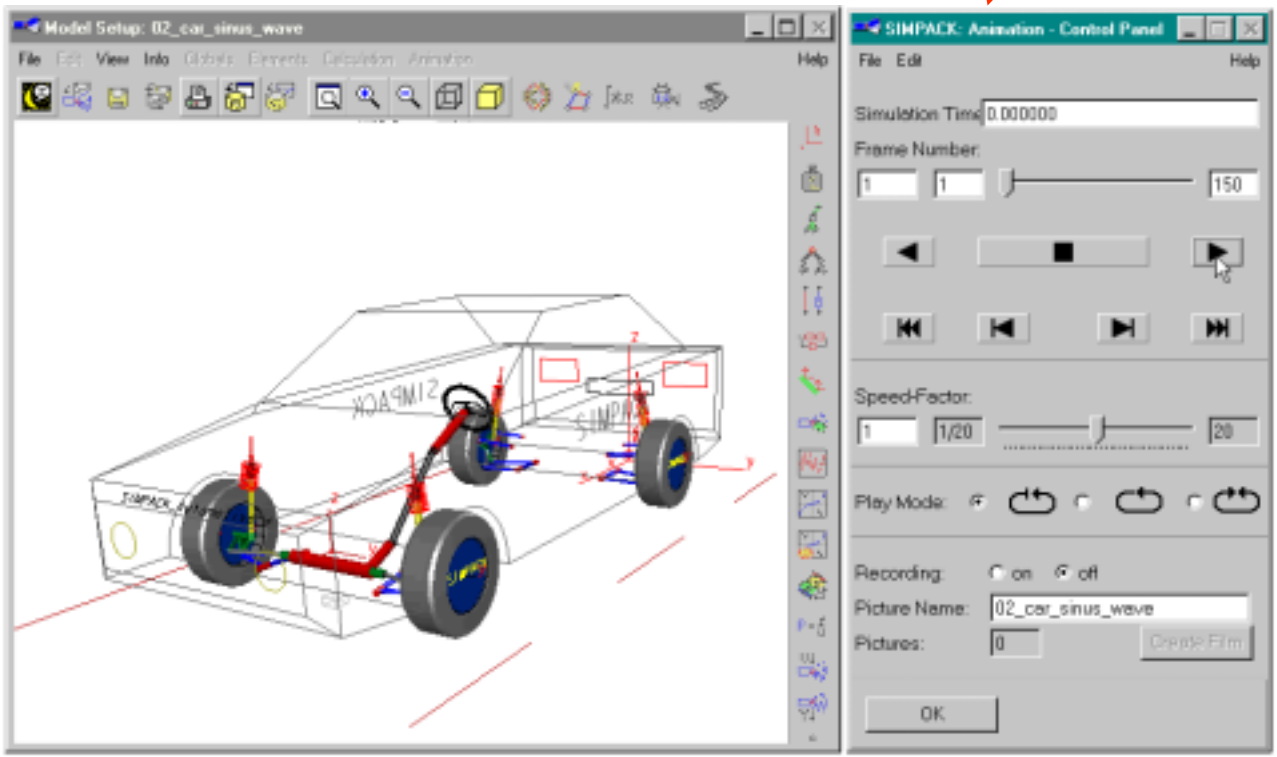
Postprocessing: Animation Data with Display of Current Simulation Time

Functionality:

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



Application Case:

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

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User Subroutines

- String Elements for Transfering String Type Information
- **Only One Routine to Describe a Complete Userelement**
- Acces Functions for all Data During Simulation
- New User Routine Type: Y-Output Vector
- Fully Comply with Shared Libary Approach and Units

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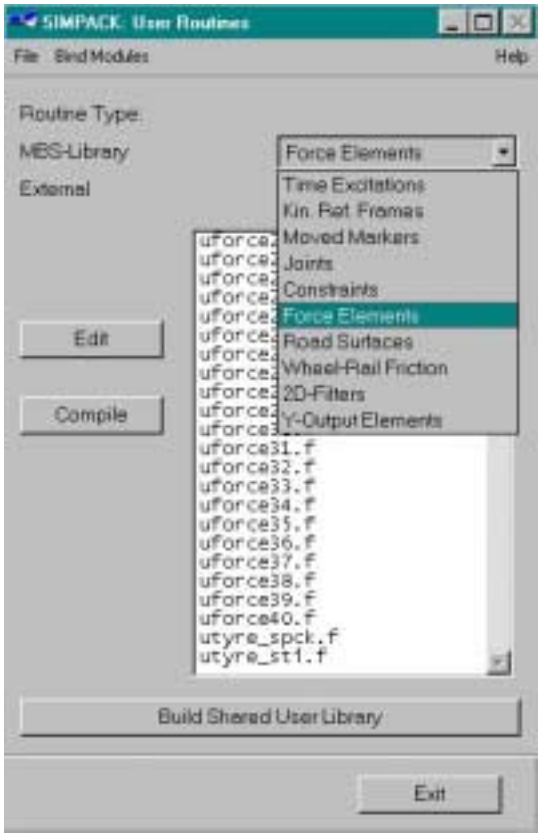
User Subroutines: Only One Routine to Describe a Complete Userelement

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

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Interfaces:

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

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Interfaces: ALTAIR (Hypergrap, HyperView, Motion View)

Functionality:

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

-- Creating SIMPACK model data input files (*.sys and *.ani) with Motion View

-- Transfering plotting data via the Altair Binary Format (ABF).

-- Transfering 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