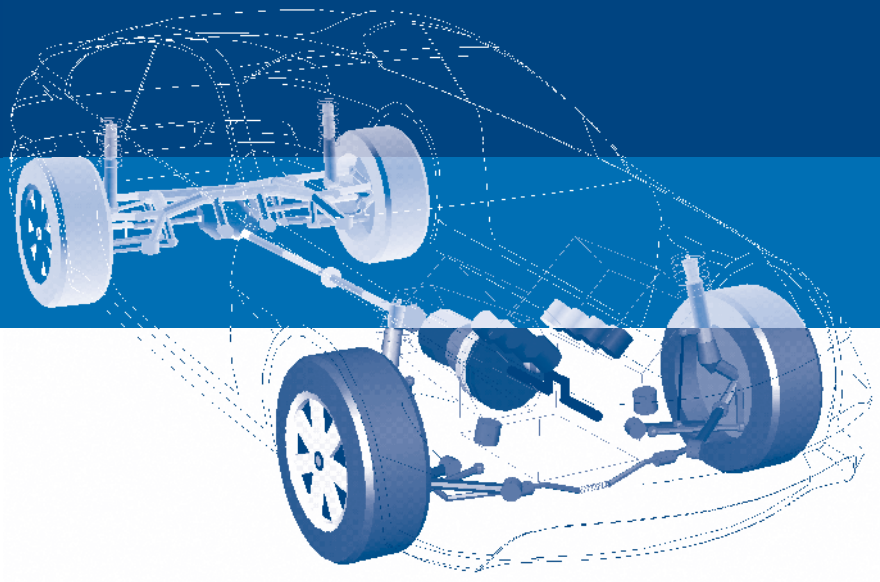
SIMPACK Automotive



What Are You
Intending To Do?

Content

SIMPACK Automotive

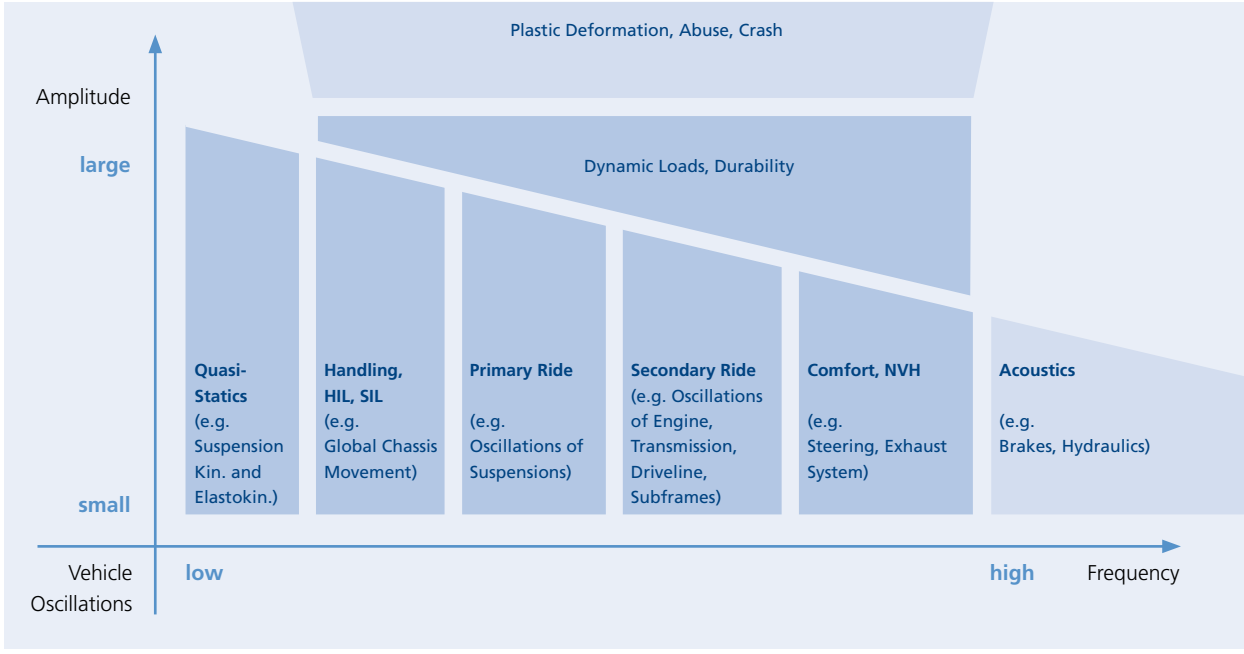
The SIMPACK Automotive product family is used for the dynamic analysis, prediction and optimisation of all automotive mechanical and mechatronic components and vehicles.

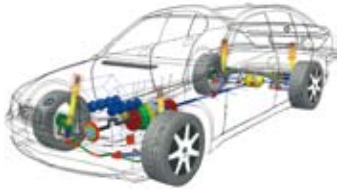
SIMPACK's ability to simulate high-frequency vibration and harsh shock contact, in both the frequency and time domain, makes SIMPACK Automotive the number one choice of leading automobile manufacturers for ride and comfort analyses. Due to SIMPACK's powerful solver and use of relative kinematics, extremely fast and accurate calculations can be carried out, from low frequency dynamic handling all the way up to high frequency durability studies. SIMPACK also has an optimum connectivity to control software and can even export entire models as code for SIL and HIL applications.

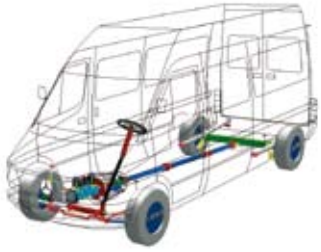
The versatility and range of analyses with SIMPACK Automotive are virtually limitless, which translates directly to a huge potential for reducing development costs. Consequently, an ever-increasing number of automotive manufacturers and component suppliers are turning to SIMPACK Automotive as their preferred choice for multibody simulation.

The versatility and range of analyses with **SIMPACK** Automotive are virtually limitless.

SIMPACK Automotive Application Areas



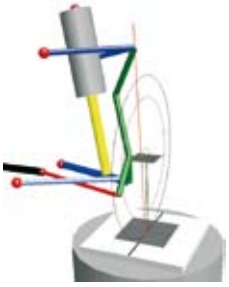


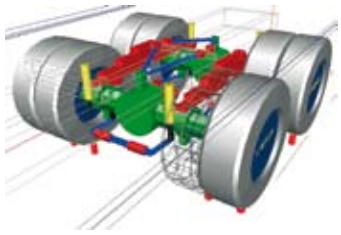


Suspension Design

Using predefined templates of parameterised standard suspensions enables users to quickly and easily achieve standard single suspension analysis results, for both kinematics and elastokinematics. Not only can quasi-static characteristics like camber, toe, etc. be calculated during jounce/rebound and steering, but also additional results like natural frequencies, mode shapes, transfer function, etc. Standard models can always be further enhanced with more detailed modelling and specialised elements like:

- Single sided contacts (bump stops)
- Friction, stick-slip and hysteresis effects
- Non-linear, frequency dependent bushings
- Flexible components (leaf springs, twist beam suspension, flexible damper rods, etc.)
- User specific routines



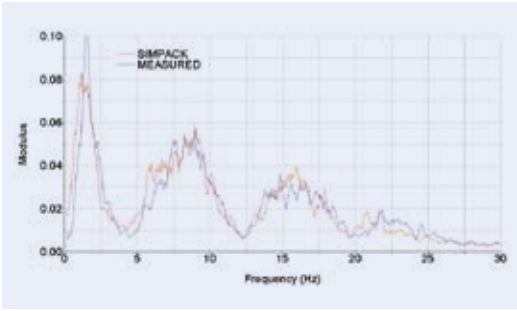


A SIMPACK user can always further enhance standard models with more detailed modelling and specialised elements.

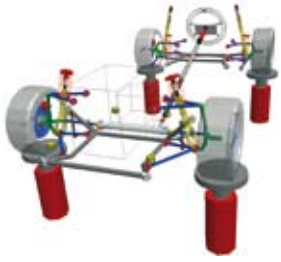
Virtual Component Test Rigs

Due to SIMPACK's transparent and simple modelling structure, any type of single automotive component and virtual test rig can be set up by the user. Easy comparison and validation (using virtual test rigs with real measurements), enables users to carry out further optimisation, with confidence, on well verified virtual components. With SIMPACK substructure techniques, these verified components can easily be used within more complex complete system models, without additional modelling and verification effort. Application examples of general automotive components within virtual test rigs include:

Seat Rail Vertical



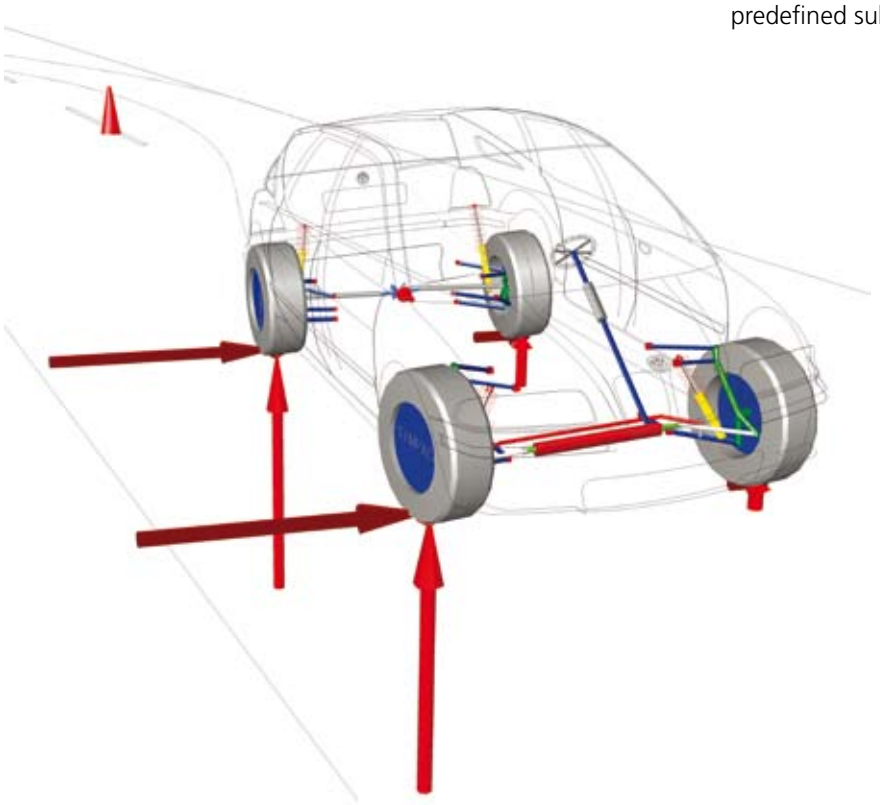
- Oil pump velocity sweep
- Chassis mechanisms
- Steering shimmy test rig
- Single suspension transfer function
- Engine bearing test rig
- Exhaust system transfer function
- Truck cabin excitation test rig
- Driveline roller test rig
- Hydropulse test rig



All components and vehicles can be easily investigated in SIMPACK using virtual test rigs.

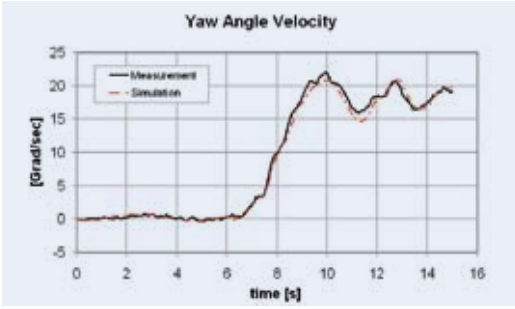
Handling and Driving Dynamics

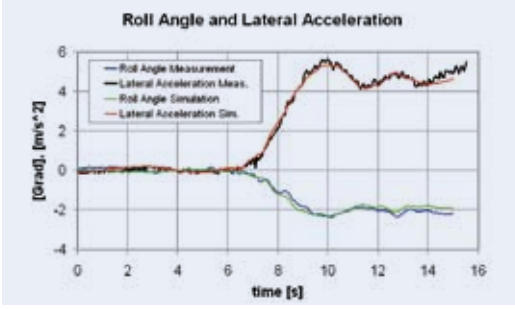
Complete vehicle models are set up very effectively, efficiently and clearly using SIMPACK Autmotive predefined and parameterised component models. With substructure techniques all components can be exchanged easily with user defined components in order to refine the level of model detail. Standard open and closed loop handling and driving dynamic simulation scenario definitions (e.g. constant radius cornering, lane change, sinusodial steering, braking while cornering) are also available with predefined substructures.



Various vehicle configurations and manoeuvres may be easily set up in SIMPACK for the simulation of handling and driving dynamics.

Result Comparison of Driving Dynamics Manoeuvres

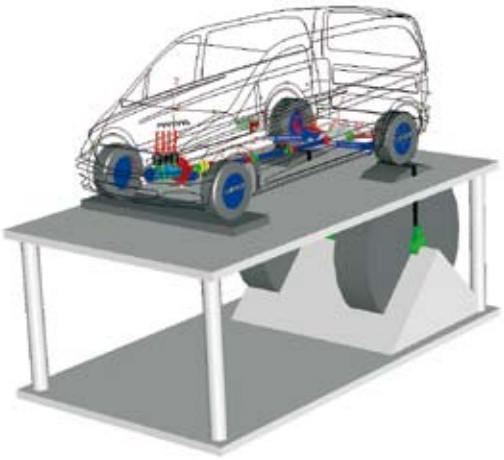




In order to adapt complete vehicle models and associated simulation scenarios many SIMPACK Automotive specific modelling elements are available:

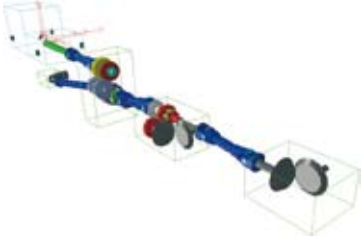
- Various tire models
- Tire characteristic test plots
- Track (road) definition
- Curve superelevations
- Road height plan
- Single obstacles
- Deterministic road irregularities
- Longitudinal and lateral vehicle controller (driver model)

Powertrain and Driveline



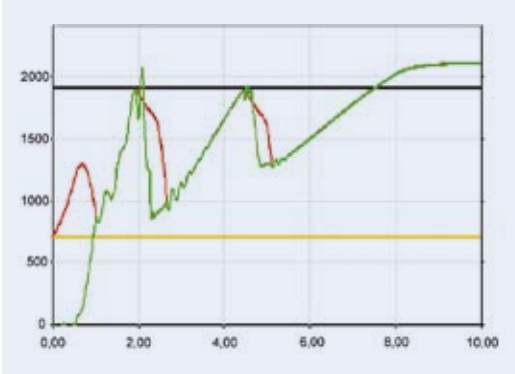
SIMPACK Automotive offers a detailed library of specialised powertrain and driveline components. Therefore, complete, detailed vehicle models can be set up in order to study the complex 3D behaviour during engine-powertrain-driveline-vehicle interactions.

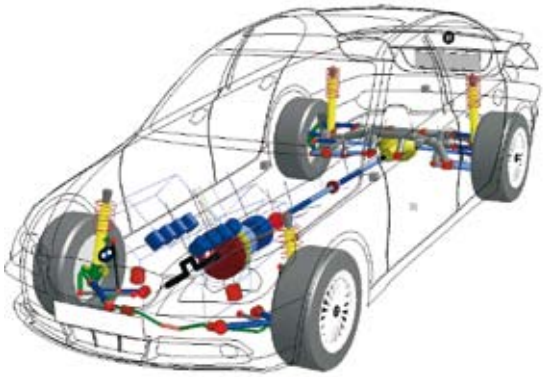
All associated modelling components are compatible and communicate with the SIMPACK time domain solver in order to optimise solver stability, accuracy and performance for such complete and complex full vehicle models. SIMPACK Powertrain and Driveline component examples are:



- Kinematic and elastic gear boxes with non-linear stiffness and clearance (manual gear box, planetary gearbox, differential gearbox)
- Detailed gear wheel force element with position dependent stiffness (parameter excitation)
- Gear shift during simulation
- Gear wheel synchroniser element with contacts and friction
- Universal and constant velocity joints
- Flexible driveline shafts
- Engine torque or gas force based driveline excitations
- Driveline roller test rigs

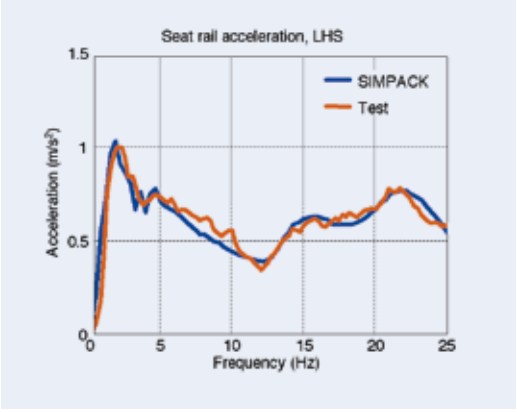
Pull Away and Gear Shift

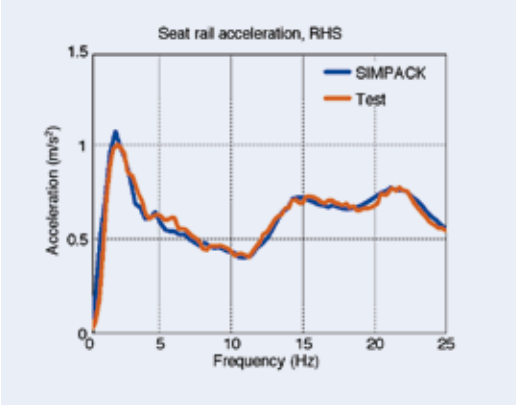




For powertrain and driveline components, SIMPACK offers a comprehensive element library and extensive functionalities.

Correspondence of Measured Data



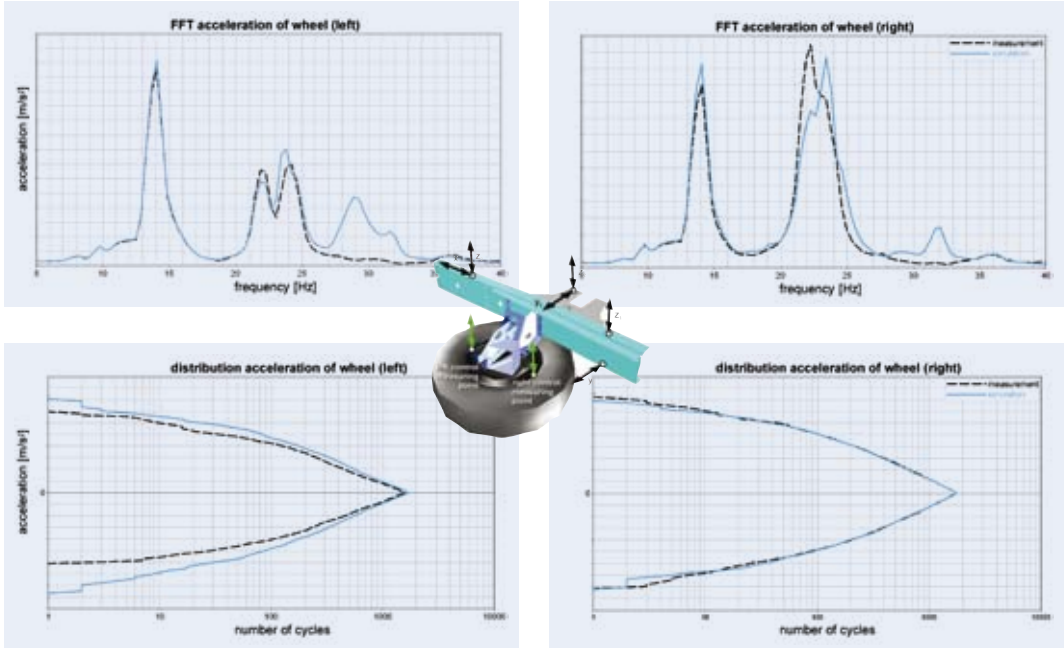


SIMPACK's solver is not only ideal for handling high frequency analyses (even into the acoustic range) but also for investigations involving extreme non-linear manoeuvres and harsh shock contact, such as "idiot-starts" (sudden clutch release), curb strikes, bridge jumping, etc. With the additional SIMPACK NVH (Noise/Vibration/Harshness) module, users may also benefit from the powerful, time saving, linear system analysis. Because SIMPACK enables easy comparisons between linear and non-linear methods, a user can always be assured of the suitability of the chosen method.

Extreme non-linear manoeuvres and harsh shock contact such as "idiot start" and bridge jumps are easily simulated using SIMPACK's reliable solver.

SIMPACK also enables fatigue life predictions of virtual prototypes. The flexible components may either be investigated as part of an entire complex vehicle model or individually analysed using virtual test rigs. Because the methods using SIMPACK incorporate both the modal coordinates and the time dependent reaction forces, dynamic loading is also considered. Using SIMPACK as the basis for durability analysis (as opposed to a transient FE-analysis) can save vast amounts of computation time and resources.

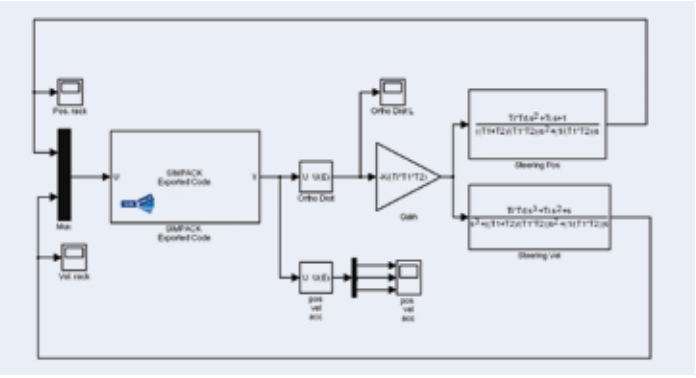
Validation of Simulation Model

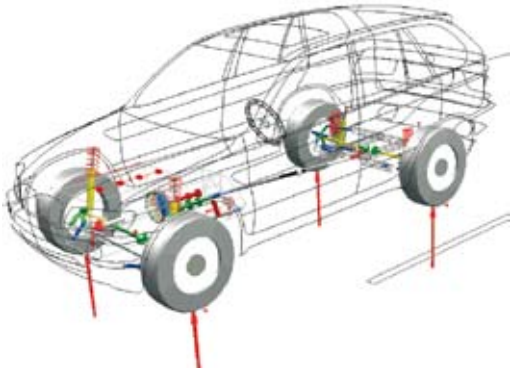


Software-in-the-Loop (SIL)

A standard Inter Process Communication (IPC) coupling enables SIMPACK users to easily interface their models with other CAE software or their own software code for advanced mechatronic investigations. In addition to co-simulation with MATLAB/Simulink®, users may also take advantage of the MATLAB Real-Time Workshop® and export entire parameterised Simulink® models directly into SIMPACK. The reverse approach may also be employed (depending on the software emphasis) with entire parameterised SIMPACK models exported as S-functions directly into Simulink® or any other simulation environment.

Complex Car Model in SIL Environment





SIMULINK Enabled

MATLAB Enabled

Several methods of interfacing SIMPACK to external programs enable users to define "best practice" processes for SIL applications.

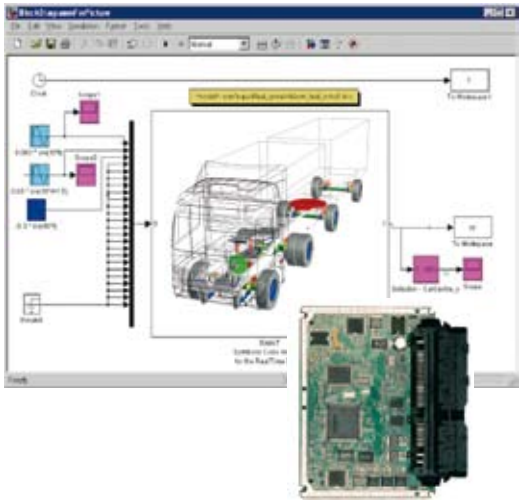
Real-time Applications (MIL, HIL)

Code Export enables SIMPACK models to be exported to external platforms for SIL, MIL (Man-in-the-Loop) and HIL (Hardware-in-the-Loop) applications. Complex models created for dynamic, ride and durability investigations can also be used as the basis for real-time applications. Therefore new SIMPACK elements and methods have been specifically developed for real-time applications in order to achieve the required computation speeds.

SIMPACK offers the unique approach to use one common data source in order to parameterise offline and online (real-time) MBS models simultaneously. This saves vast amounts of modelling and verification time.

Driving Simulator – Courtesy of DaimlerChrysler AG

Complex Truck Model in HIL Environment

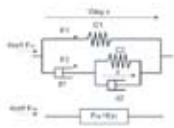


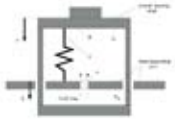
Entire parameterised SIMPACK models can be exported as code for MIL/HIL use.

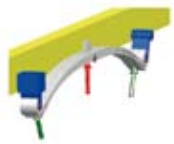
Specialised MBS Modelling Elements

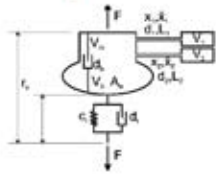
In order to simulate high-end 3D MBS models (with frequency and amplitude dependent behaviours for example) numerous specialised MBS modelling elements are available within the SIMPACK Automotive product family. These include:

- Physical parameter based frequency and amplitude dependent force (bushing) elements
- Measurement based (transfer function) force element description
- Stick Slip friction force elements
- High frequency comfort and durability tire force elements
- Detailed air spring models
- Beam based leaf springs with contact and friction
- User routines







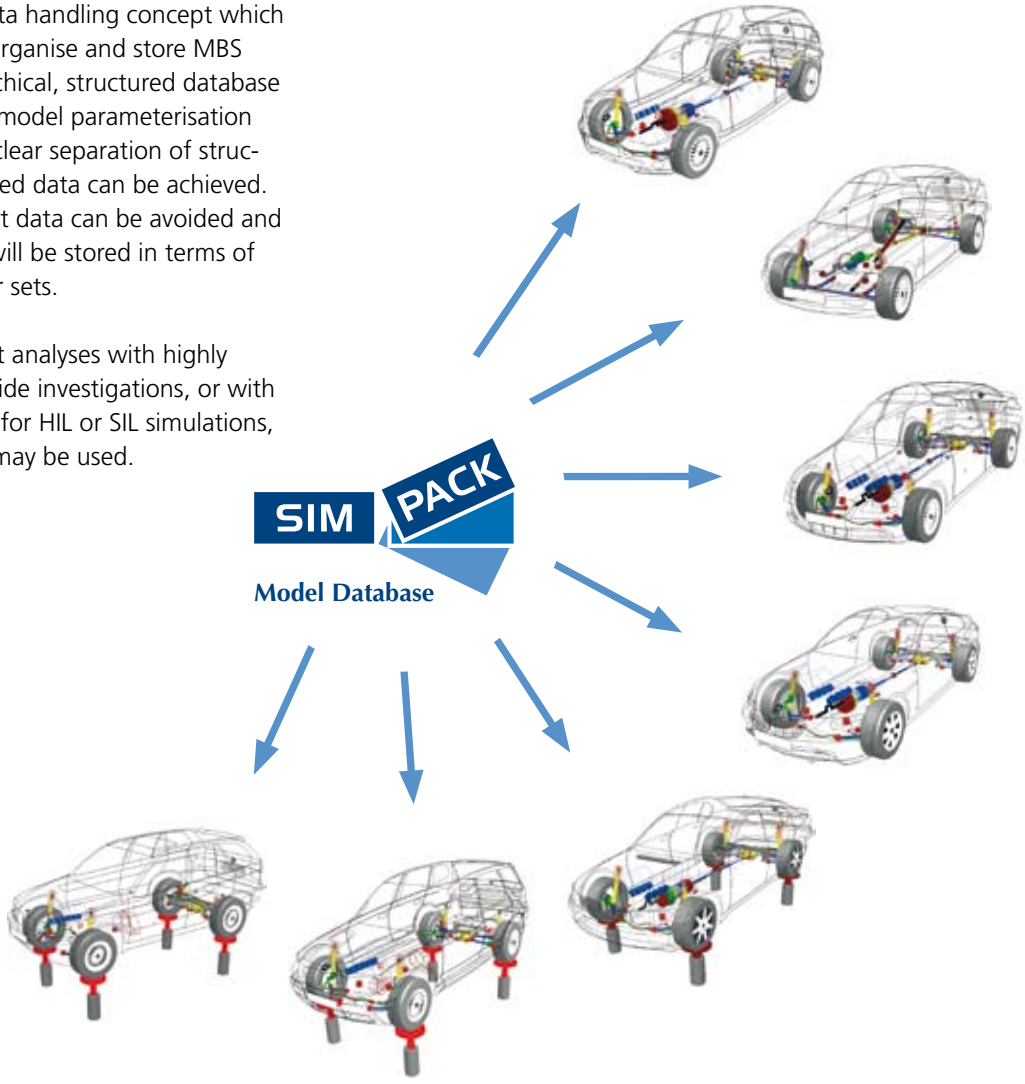


An extensive range of modelling elements in SIMPACK enables high-end simulation.

MBS Data Handling

SIMPACK offers a data handling concept which enables the user to organise and store MBS model data in hierarchical, structured database directories. By using model parameterisation and substructures a clear separation of structure and parameterised data can be achieved. In this way redundant data can be avoided and development levels will be stored in terms of associated parameter sets.

Whether carrying out analyses with highly detailed models for ride investigations, or with less complex models for HIL or SIL simulations, common databases may be used.



Model variants may be easily generated and investigated by using the SIMPACK database structure.

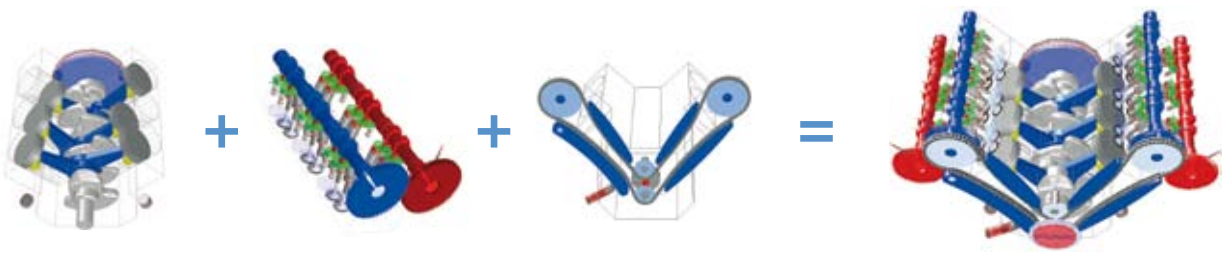
SIMPACK Engine

The SIMPACK Engine product suite may also be easily used together with SIMPACK Automotive.

SIMPACK Engine includes modelling elements specifically implemented for detailed engine simulations covering single component analysis to complete dynamically coupled engine investigations. All engine components ranging from valve trains (dynamic valve springs, elastic contacts, etc.) and timing mechanisms (chain, gearwheels, etc.) to crank trains (flexible crank shafts, hydro-dynamic bearing, etc.) may be easily incorporated. The use of SIMPACK parameterisation and substructures enables efficient and secure model creation. Due to SIMPACK's common database structure and modelling elements all SIMPACK models, e.g. Automotive or Engine models, are completely compatible and therefore may be easily interconnected and exchanged.

For more detailed information please refer to the SIMPACK Engine brochure.

SIMPACK Crank Train | SIMPACK Valve Train | SIMPACK Chain Drive | SIMPACK Engine

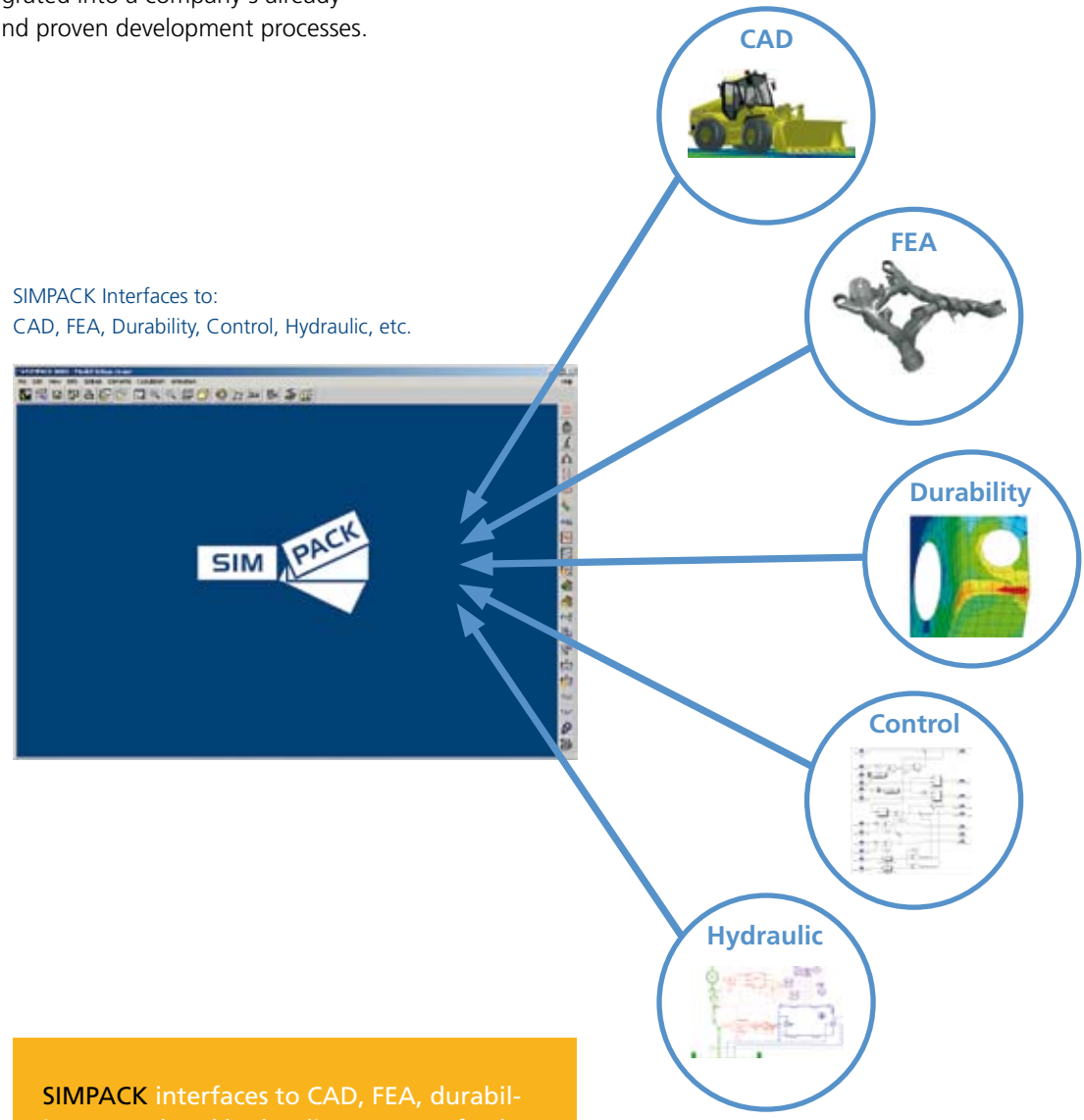


SIMPACK Automotive functionalities may be further enhanced by **SIMPACK** Engine which enables the simulation of complete coupled engines.

SIMPACK Interfaces

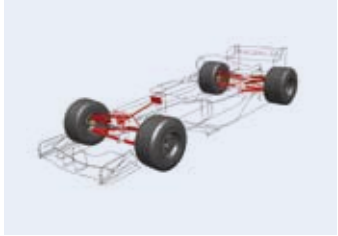
SIMPACK's versatility and excellent interfaces enable users to combine the core competence of different software tools for optimum usage. The strong interfaces also enable SIMPACK to be easily integrated into a company's already established and proven development processes.

SIMPACK Interfaces to:
CAD, FEA, Durability, Control, Hydraulic, etc.



SIMPACK interfaces to CAD, FEA, durability, control and hydraulic programs further increase the range of **SIMPACK's** application areas.

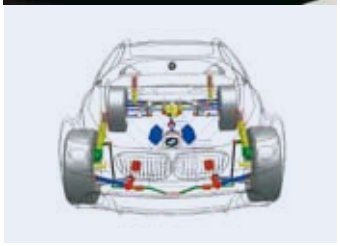
Customers working with SIMPACK Automotive



SIMPACK is now the world leading multibody simulation software for commercial vehicles and the number one choice of leading automobile manufacturers for ride and comfort analyses.

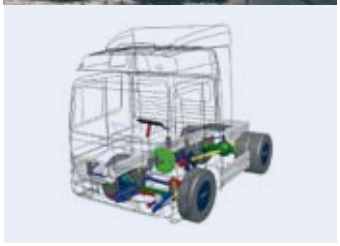
"SIMPACK has enabled us to rapidly enhance our dynamic simulation capabilities with a level of versatility which enables the use of fewer core models. This, in turn, leads to a more efficient design support process and reduced response time for track support tasks."

Richard Frith, Midland F1 Racing Ltd., United Kingdom



"For almost ten years, SIMPACK has been used at BMW Acoustics and Vibrations Development. A modularised database has been achieved, which includes the whole range of vehicles with all the different subsystems, e.g. engines, powertrains and suspensions. The SIMPACK vehicle model is part of the virtual car process for design and evaluation of vibration characteristics, such as ride comfort, powertrain, chassis and body vibrations."

Andreas Raith, BMW Group, Germany



"Over the past few years, SIMPACK has become an important tool in the development process of our Mercedes-Benz vans and trucks. With SIMPACK, we have the ability to design vehicle models based on a master model database for different applications, for example for vehicle driving dynamics, ride comfort, drive train vibrations, durability, braking system layout, and the layout of active systems."

Joachim Pressel, DaimlerChrysler Commercial Vehicles Division, Germany

"MAN has been using SIMPACK since the very first version. Since then SIMPACK has matured into an indispensable tool for handling, NVH, active control, and durability investigations of both trucks and buses.

We consider both INTEC's nearby location and its outstanding competence in simulation technology to be invaluable for productive cooperation."

Thomas Ille, MAN Nutzfahrzeuge AG, Germany

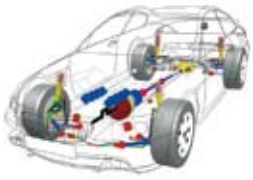
SIMPACK Compatibility

SIMPACK Automotive offers users the power and versatility to carry out an almost infinite range of analyses. Because all modules within SIMPACK are 100% compatible, automotive users can also benefit from SIMPACK developments originating out of other engineering disciplines.

From mounting configurations of single components to entire mechatronic vehicle analyses, from handling manoeuvres to high frequency durability studies, from linear system analysis to non-linear shock contact, from co-simulation to hardware-in-the-loop, SIMPACK Automotive offers the complete, harmonised solution.

Tires
Powertrain
Transmission
Steering
Engine
Hydraulics
Chassis
Environment
Exhaust System
Controlled Systems
Suspensions
Brakes





If you would like additional information or brochures please contact us or visit our website at **www.simpack.com**.

INTEC GmbH
Argelsrieder Feld 13
82234 Wessling
Germany
Tel. +49 8153 9288-0
Fax +49 8153 9288-11
intec@simpack.de
www.simpack.com