SIMDRIVE 3D
CROSS-DOMAIN SIMULATION FOR POWERTRAIN SYSTEMS DEVELOPMENT
**SIMDRIVE 3D™**

SIMDRIVE 3D is a world-wide unique 3D cross-domain simulation platform for the development of entire powertrain systems, merging the most important methods from different engineering disciplines for predictive dynamic analysis in time and frequency domain.

**KEY FEATURES**

- Reliable and fast prediction models
- Fast model set up through an unique graphical 3D-modeling and simulation environment for all modules
- Common database for modeling, simulation and evaluation to get around co-simulation
- Convenient model/data exchange with all major automotive suppliers

**BENEFITS**

- Scaleable model depth
- Integration of subsystems into complete powertrain simulation and unmatched high accuracy of the simulation results
- Methodology approved by the VDA (German Association of the Automotive Industry) and other customers worldwide
- Can be used in cross-domain way by various development and project teams

**CONTECS PROFILE**

CONTECS engineering services GmbH is a leading technology company, which specializes in development and marketing of advanced simulation technologies, for the virtual assessment of highly-developed powertrain systems and future drive concepts. Our mission is to provide methodology, profound engineering consulting and related services to contribute to your product development success.

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**POLY-V BELT**

Part of the SIMDRIVE 3D Standard Edition is the simulation of friction belt drives (flat belts and Poly-V belts) with automatic tensioning systems containing solutions for all polymorphic designs. As an additional module the Multi Belt tool delivers the possibility of multiple layers of belt and/or chain transmission drives, which easily can be combined.

- Internationally acknowledged platform for FEAD development
- Analysis of belt flapping (transversal and torsional deflection), slippage and power loss
- Belt-Lifetime prediction model
- Integration into crank train or complete powertrain simulation

**3D ELEMENTS**

The 3D Elements module provides a powerful tool for coupled flexural and torsional vibrations of crank trains and the entire driving shafts with elastic or hydrodynamic bearings. Furthermore, it is possible to analyze the critical flexural bending rotary speed in time domain. The Eigen-modes of a complete structure can be displayed in a 6 DOF animation.

- Interactive creation of flexible bodies with spatial flexible beam structures (3D beam elements for driving shafts)
- Combination of 3D elements and 1D elements in one simulation model
- Defining transverse drives to model the differential gear unit
3D CRANKTRAIN

The Advanced Crank Train module allows the simulation of coupled flexural and torsional vibrations of the crank train. A basic version enables a reduced torsional vibration analysis of the crankshaft.

- Eigenfrequency analysis of supported cranktrain with all mounted carrying parts
- Dynamic loads and displacement paths for all bearings
- Mass forces and mass balancing
- Influence of FEAD or timing drives on the crank train through a coupled simulation

DMF

The DMF module offers detailed multi-body modeling of dual mass flywheels. This includes all common designs of the inner spring setup, which can be combined at will.

- Nonlinear and rpm dependent friction and geometry influence
- 1D torsional as well as full 3D modeling including bearings and flexplate bending

3D BEARING

The Bearing module includes the simulation and evaluation of journal bearings, ISO ball / roller bearings or basic elastic bearings for fast simulation.

JOURNAL BEARING

- Complex solution of the Reynolds equation in time domain considering drillings and tilting under dynamic load with EHD approach
- Significantly less time consuming approach available using a pre-calculated data map
- Definition of discrete bearing race for correct application of bearing forces on the housing

ISO BALL / ROLLER BEARING

- Realistic pressure conditions on the rolling bodies and dynamic behavior in dependency of geometry, load and dynamic clearance
- Service life rating according to DIN ISO 281

GEAR TRAIN

The Gear Train module allows the simulation of dynamics and vibrations of gear trains. Furthermore, simulations of rattle and dynamic transmission errors as well as load dependent deformation of shafts, gear wheels and housing can be analyzed.

- Exact geometric modeling of the tooth
- 3D contact with calculation of contact ellipse and Hertz’ Stiffness
- Diverse tooth contact consideration for fast simulations and/or high accuracy
- Static load and deformation analysis

CHASSIS AND TIRE

The Vehicle module offers a basic and advanced tire model for the consideration of the road-tire contact with realistic force feedback on the powertrain. Furthermore, the influence of driveline and wheels on chassis behavior can be analyzed.

- Dynamic change of wheel load regarding physical properties of the vehicle
- Driving resistance according to vehicle speed including rolling, air and climbing resistance
- Consideration of contact forces (braking and acceleration), lateral forces (steering) and self-aligning torque

POWERTRAIN

The holistic powertrain consideration is a valuable input for drive line development. The module allows the analysis of transient load conditions and predefined load cases in the complete power train.

- Evaluation of strains as a result of unique events and dynamic behavior for steady state
- Simulation of interaction between engine, gearbox and driven side
- Complex modeling under hybrid applications

Complete Drive Train
CHAIN DRIVE

The Advanced Chain Drive module covers the analysis and optimization of entire chain dynamics up to NVH studies of timing drives with bushings, rollers and silent chains.

- Link-to-link connection with non-linear chain stiffness including friction and damping to analyze power losses
- Detailed sprocket geometry: ISO, involute as well as a user defined outline for silent chains
- Non-circular sprockets and irregular pitch for resonance cancellation
- Physical chain tensioner model covering gap flow and dissolved air
- Dynamic model for high pressure pump
- Flexible guide rail allowing analysis of linear elastic behavior

TIMING BELT

The Timing Belt module provides the simulation and study of timing belt drives with automatic tensioning systems for NVH analysis, system load and power loss.

- Detailed modeling of belt-pulley contact
- Oval sprockets for resonance cancellation
- Predictive analysis of timing error, transverse deflection, dynamic loads, etc.
- 3D tensioner for a realistic modeling of friction tensioners using CAD geometry

VALVE TRAIN

The Valve Train module is designed to make a complex analysis possible. Starting with basic torsional cam excitations, increasing the complexity with single valve elements up to a complete dynamic contact simulation.

- Kinetostatic component modeling with single elements such as cam, valve, valve spring and rocker arm
- Modeling of dynamic behavior such as lever lift-off or coil contact by using Contour and Contact elements and study of the deformation of valve and lever by using Flexible Bodies
- Structural analysis of a discrete spring using the Boundary Element Method module
- Rheologic model for hydraulic cam phaser
- Consideration of hydraulic valve lash adjustment and combustion back pressure

STRUCTURAL ANALYSIS

For the advanced structural analysis the two modules Flexible Body and Modal Calculation complete the modern methods of simulation of multi-dimensional MBSD and structural analysis. The possibility to load reduced FE structures and combine them with multibody simulation leads to an enhanced modeling process, which then combined with a modal reduced calculation method additionally reduces simulation time. The modal analysis is an independent analytical method, which is directly embedded in SIMDRIVE 3D.

- Output periphery of the modal analysis also covers the analysis of coupled structures
- Comfortable manual assignment of modal masses and 3D masses
- Possibility of additional modal degrees of freedom (nodes), which are not connected to the housing, for oscillation analysis
- Complete system with modular assembly, e.g. 3D crankshaft, FEAD, valve train, gearbox, elastic housing aggregate bearing

NVH

The NVH module enables an integrated structural analysis by applying operational loads on FEM meshes via reduced FE structures.

- Linearized structural behavior of the FEA mesh by modal analysis as preprocessing
- Application of forces and movement by connection nodes of a Flexible Body
- Tria and quad for surfaces as well as tetra, penta and hexa for solids. Mixed surface and solid elements in one structure
- Postprocessing by animation of deformation, surface velocity, surface acceleration and stress
SPRING

The BEM Spring depicts a highly accurate approach to create a structural model of a spring. Starting with an automated process to create an MBS-Model, using the displacement of a time domain simulation for the calculation of stress within the spring to predict the life cycle.

- Parametric, user defined or imported wire contour
- Geometry definition of the surface mesh using precise design parameters
- Consideration of cut ends
- Illustration of the displacement and stress on the spring surface

BOUNDARY ELEMENT METHOD

The Structure module integrates structural mechanics into MBS simulation. Stress evaluation is combined with real time results allowing the determination of coefficients of safety and weakest point in the structure. In combination with a powerful MBS simulation and a highly advanced stress analysis under realistic load condition the module simplifies the DOE process. With the included versatile elements a swift calculation of inertia and stiffness tensors of any components is featured. Any BEM mesh can be exported as a STEP file for further processing.

PARAMETRIC WEB

As a basis for a structured approach in crankshaft web design, the element enables a simple variation of specific design parameters.

- Effective modeling of complex crankshaft web geometries with high detail
- Fatigue limit assistant with material data base and consideration of construction and gradient influence
- Automatic definition of node sets for the stress analysis of notches
- Modern and revolutionary analysis algorithms for the cycle stress tensor

BODY OF REVOLUTION

The BEM Body of Revolution is applicable for the setup of shafts used in transmission or driveline and torsional vibration dampers. The automation of the transformation into an MBS-model enables a faultless setup of an accurate simulation model.

- Detailed depiction of rotary elements such as shafts through sectional calculation
- Comfortable editing of the contour using the CSketch-2D-Editor
- Import via ISO STEP file format

SURFACE MESHER

The BEM STEP File allows the import of a CAD model in STEP format and its surface meshing for BEM calculation. An automatic meshing of the complete surface and manual meshing of single faces with the Csketch-2D-Editor are offered.

- Program internal editing of STEP file, e.g. merging or splitting of two faces or cutting a body in multiple parts
- Precise mesh control and variable fineness possible
- Tri and quad meshing
- Combining manual meshing of single faces and automatic meshing of remaining surface

THERMO CALCULATION

The Temperature module allows the coupling of thermal and mechanical real time simulation for components with high temperature dependency, e.g. rubber dampers. It calculates the 2D heat flow within rotationally symmetric structures. This module also comprises the features of the SIMDRIVE 3D sketcher tool, which facilitates a fast and easy way to set up models / assemblies for thermal analysis.

- Prediction of damper heating and temperature distribution
- Consideration of thermal influence on rubber parameters in mechanical model
- Dissipated energy as heat source
- Different boundary conditions for heat flow on the outside borders of the analyzed structure
- Reference points for temperature comparison to measurement results
The Controller module allows the setup of controlled systems, thus giving the possibility to assemble control structures comparable to real engines. A library with E-components for synchronous and asynchronous motor, inverter and battery completes the functionality.

- Setup of controlled systems, e.g. idle speed control, gearbox control, active tensioner and even full NEDC
- All simulation parameters can be defined as a controlled reference variable
- Incremental and continuous sensing and actuating
- Consideration of influence of the control unit on the drive lines dynamic behavior
- Integration of dynamic link libraries for external processing

E-Simulation

Displacement due to magnetic force
Calculation of magnetic field

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