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VALDYN

MULTI-BODY SYSTEMS ANALYSIS FOR POWERTRAIN SYSTEMS

www.realis-simulation.com/products/valdyn

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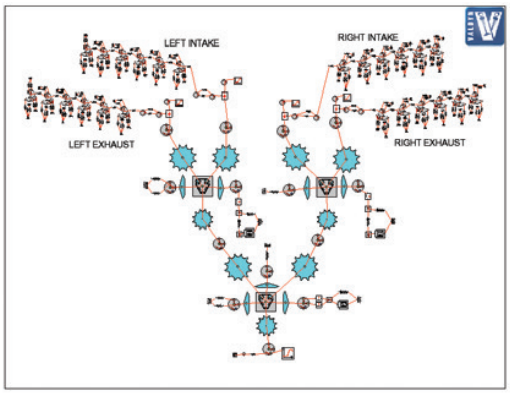
What is VALDYN ?

VALDYN is a multi-body dynamic and kinematic simulation package that has been specifically developed for valvetrain and drive system analysis and cam and spring pack design. With its detailed "building block" models of engine components, it is significantly quicker to build models with VALDYN than with general purpose dynamics tools; and quicker to run because model refinement is focussed on the critical aspects related to engines.

Key Features

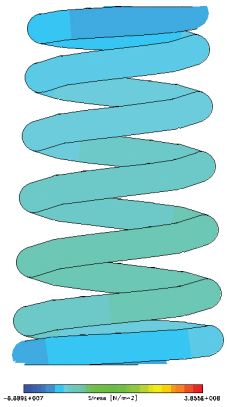
- "Building block" structure allows modelling of virtually any valvetrain, from individual valvelines to complete systems with crankshaft and camshafts
- Modelling of drive systems, including gears, belts and chains
- Data input using expressions involving case-varying parameters
- Frequency domain solver with forced-damped solution of linear models
- Dynamic and kinematic analysis of valvetrains
- Modelling of VVT and VVA mechanisms
- Animated output in the time and frequency domains
- Automatic plotting of results
- 3D frequency response plots
- Plotting of mathematical expressions involving several outputs
- Run distribution using network computing resources to speed up multi-case simulations
- Links to ENGDYN and FEARCE for engine structural analysis
- Co-simulation with other Realis and 3rd party programmes, such as Simulink

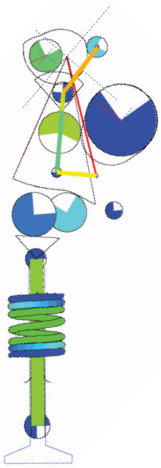


Valvetrain design

VALDYN-Kinematics caters for the design and kinematic analysis of valvetrain systems. Using a building-block approach, VALDYN provides users with a library of select standard and unconventional valvetrains. All valvetrain types can be analysed, including linearly translating and swinging followers with or without a push rod and rocker systems. VALDYN-Kinematics can be used assess an existing cam design or to generate a cam profile using either the Realis 'Multipol' method or a general spline method. A number of methods of spring pack design are available to allow combined optimisation with cam profile design.

VALDYN-Kinematics produces comprehensive outputs to enable assessment of spring and cam design, including cam contact Hertzian stress, oilfilm thickness, cam wear, spring cover, spring stress and spring natural frequency. Data can easily be transferred to VALDYN for assessment of the design in the context of the timing drive and to assess dynamic aspects such as spring surge and valve bounce.





- Building-block approach to model construction
- Caters for novel systems
- Tribological analysis from kinematic and dynamic standpoints
- Detailed spring model including coil clash
- Dynamic analysis in context of complete engine
- Advanced spline methods for cam design
- Arbitrary shaped swinging cam follower
- Spring pack natural frequency

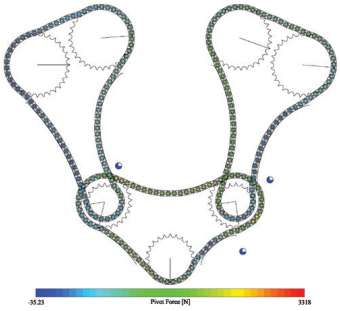
Chain dynamics

VALDYN can be used to model most types of chain including roller and inverted tooth chains. Generation of chain models is fast and simple with minimal data input and automated wrapping of the chain around the sprockets. Sprocket tooth, link and guide shapes can be built from lines, arcs and involutes or defined by B-splines which can be fitted to measured data.
The behaviour of the chain can be viewed as an animation, both in the time domain and as mode shapes in the frequency domain. Comprehensive plotted output of force, friction and power loss is available. The time variation of forces on individual components or at given points in the chain run, and spatial variation of forces around the chain run can also be plotted.

- Simple model generation
- Class-leading simulation speed
- Full capability for modelling tensioner systems
- Ability to model non-circular sprockets and pulleys
- Interaction of chain with camshaft and crankshaft
- Span flap and system modes by perturbation at any time step
- Automatic model simplification for linear frequency domain analysis
- Results animation
- Comprehensive plotted output
- Automated tensioner initial positioning
- Ability to model wet belt guides

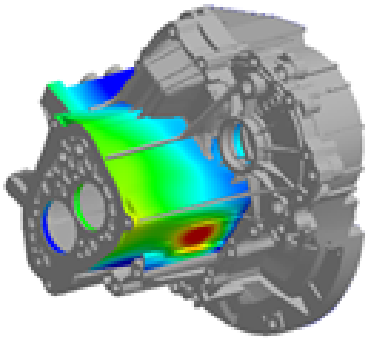
Belt dynamics

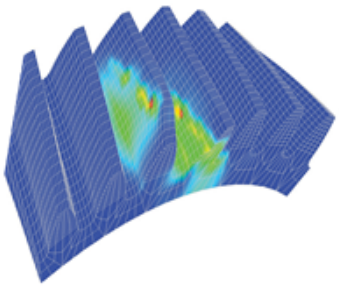
VALDYN can model both timing (toothed) belts and auxiliary drive belts. Timing belts with non-circular pulleys can be modelled, as can “wet” belts using guides. Generation of belt models is fast and simple with minimal data input and automated wrapping of the belt around the pulleys and automatic positioning of the tensioner to achieve a required initial belt tension. Pulley and belt tooth shapes can be built from lines, arcs and involutes or defined by B-splines which can be fitted to measured data. The behaviour of the belt can be viewed as an animation both in the time domain and as mode shapes in the frequency domain. Comprehensive plotted output of belt/pulley forces, belt internal forces and span flap is available. The time variation of forces on individual pulleys and belt teeth, or at given points in the belt run, and spatial variation of forces around the belt run can be plotted.

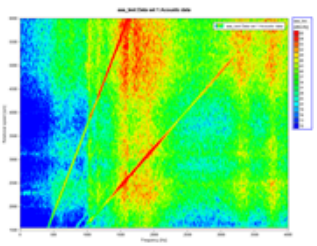


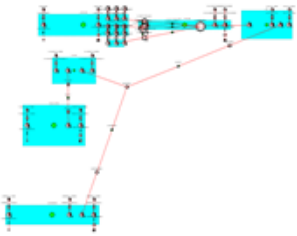
Transmission solution

VALDYN is ideal simulation tool for design an analysis of a transmission. Together with Realis SABR and SABR-Gear it offers a complex solution from design and concept studies up to advanced stress, vibration and NVH analysis. It offers a quick and automatic translation of SABR models which shortens model set-up significantly. Using of SABR-Gear transmission error calculation enables accurate prediction of contact stiffness in a gear pair. VALDYN offers a fast and accurate solver, which enables to run a time-domain, non-linear transient analysis very quickly with class leading simulation time and accuracy. Flexibility of VALDYN enables user to join the transmission model with an engine model or E-Motor to simulate the complete powertrain.









- Automated SABR model import
- Optional FE tooth model
- Integration of a transmission with ICE and/or E-Motor
- Non-linear bearing stiffness and gear contact
- Time domain or frequency domain simulation
- Perturbation analysis
- Results animation
- Speed sweep or transient simulation
- Comprehensive plotted output

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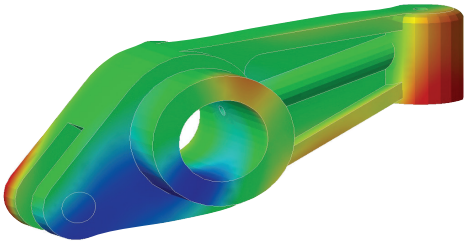
Finite Element (FE) flexible components

VALDYN has an advanced DYNAMICBODY element that allows FE models to be connected to other modelling elements to form a fully coupled system that can be simulated directly in VALDYN. This is a powerful technique for representing complex component stiffnesses, which would otherwise be difficult to define in a lumped-mass model. It uses a reduced FE model which is derived from a full FE model using the Craig-Bampton method for Component Mode Synthesis (CMS). In the FE model, connection nodes are defined, which are either normal 6-DOF FE nodes or "constrained" nodes representing the average motion of groups of normal FE nodes. Nodes not contributing to the motion of connection nodes are reduced out. Results can be back-substituted to obtain component displacement and stress can be lined to FEARCE.

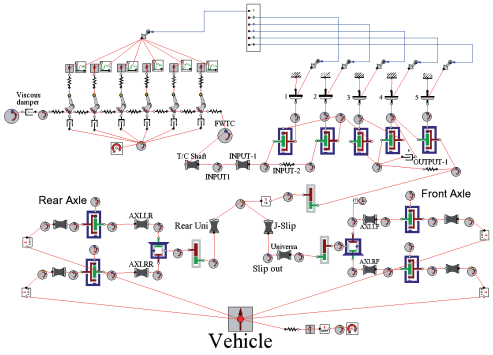
- Simple incorporation of complex geometry
- Can be used in linear frequency domain analysis
- Back-substitution for displacements and stresses
- Animation of results



Engine system modelling

VALDYN is ideal for simulating complete engine systems using its wide range of modelling elements. The ease of model construction and high simulation speed mean that models can be assembled and solved quickly. Common engine and driveline components, such as cam followers, hydraulic lash adjusters, cam phasers, chains, belts, gears, gear sets, clutches, brakes and control elements, are provided by VALDYN, and other mechanisms can be assembled from over 30 basic building block elements.

Co-simulation with other Realis Simulation tools, ENGDYN, IGNITE and WAVE, or other third-party programmes, such as Simulink, allows the VALDYN model to be included in a system model so complex interdependencies can be examined.

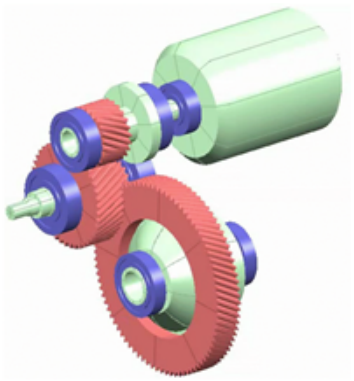


- Rapid generation of complete engine models
- Parametric input for case-to-case variation
- Run distribution for fast multi-case analysis
- Co-simulation with ENGDYN, IGNITE and WAVE
- Linear frequency domain analysis including automatic model simplification of non-linear components
- Perturbation analysis to allow frequency domain analysis at a given instant in time

E-motor simulation

VALDYN enables a simulation of an E-Motor dynamic simulation integrated with a transmission or/and combustion engine. That offers a possibility of quick and accurate simulation of the entire hybrid vehicle powertrain. VALDYN offers a hierarchy of solution from the simplest 1D models, through including the torque ripple up to fully dynamic model with flexible bodies which includes the effect of the rotor eccentricity. The E-Motor element also supports multiple slices to allow modelling of a skew angle of stator slots. VALDYN imports models from EM simulation tools such as Maxwell, MotorCAD and JMAG to create a 5D lookup table and interpolates the forces from that. This is much faster approach than a co-similation with an EM simulation while not compromising accuracy.

- E-Motor dynamic simulation
- Import from major EM simulation packages
- 5D lookup table for torque ripple, speed, load and eccentricity
- Easy integration with a transmission or ICE engine
- Prediction of stator and transmission vibrations
- Time domain, non-linear transient analysis
- Fast and accurate simulation



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