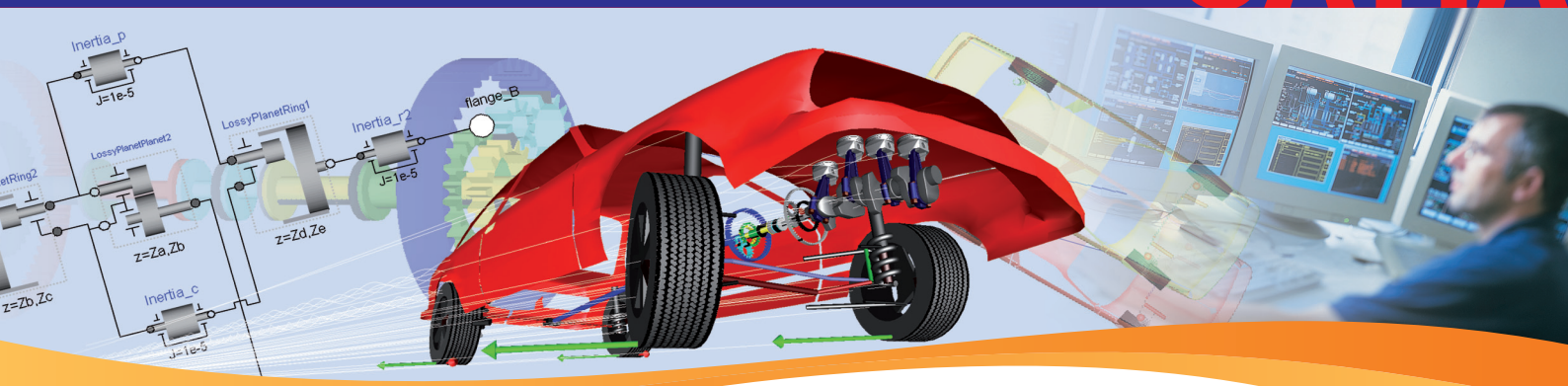


DYMOLA – PowerTrain Library

Overview:

- **Modeling and simulation of complete powertrain systems and real-time applications**

Key Features:

- **Wide range of transmission and driveline models with varying levels of detail**
- **Real-time simulation such as Hardware-in-the-Loop test of electronic control units**
- **Compatible with the other Dymola® automotive model libraries**
- **Based on Modelica® standard language for intuitive modeling**
- **Open models for full insight, easily modifiable**

Benefits:

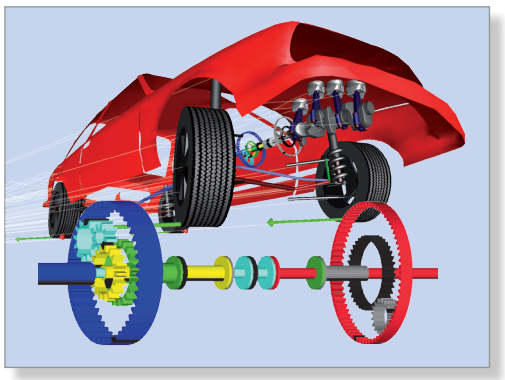
- **Single library to model complete powertrain system**
- **Higher performance, fuel economy, improved driveability and shift quality thanks to system simulation**

> Whole powertrain simulation

The PowerTrain Library contains components to enable the simulation of the whole powertrain system including the resulting motion of the vehicle. This enables the prediction of attributes such as vehicle performance, fuel economy and driveability, which in turn can aid the development of the powertrain control systems and components.

> Extensive range of components

The PowerTrain Library includes engine, transmission, driveline and vehicle models for a wide range of applications.
Map based internal combustion engine models are available along with manual and automatic transmissions that can all be coupled to front, rear or four wheel drive driveline models.
The level of detail in each of these components can be easily varied to suit different applications. Rigid elements are available for fuel-economy studies and compliant variants exist to enable the simulation of driveability.



Animation of combined model created using the Vehicle Dynamics and PowerTrain libraries

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> Handling of speed and torque dependent friction

A unique feature of the PowerTrain Library is efficient and robust handling of speed and torque dependent friction based on sound research results. Therefore, gear efficiency is easy to simulate. Many elements in the library include speed and torque dependent losses as an option.

> Considers 1D and multi-body motion

The library consists primarily of 1D rotational components for modeling the motion of the powertrain. All of the models can also be used to model the reactions into the powertrain mounting system and consider the 3D effects on a multi-body system.

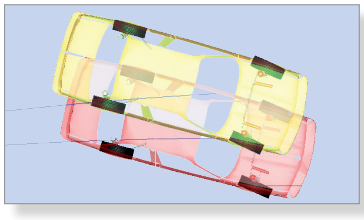
> Compatible with the VehicleInterfaces library

The VehicleInterfaces library defines an architecture for modeling the entire vehicle system. Compatibility with this library means that models built using the PowerTrain Library can be easily coupled to models from other automotive Modelica libraries such as the VehicleDynamics and SmartElectricDrives libraries.

Typical Applications

> Example 1 – Efficiency of composite gearboxes

Basic gear pairing components (planet-planet, planet-ring) are provided in order to be able to model any type of planetary gearbox. In addition, the efficiency of each pairing can be easily taken into account and used for computation of the gear's overall efficiency.



Animated comparison of a passive and active 4 wheel drive vehicle driving a slalom course

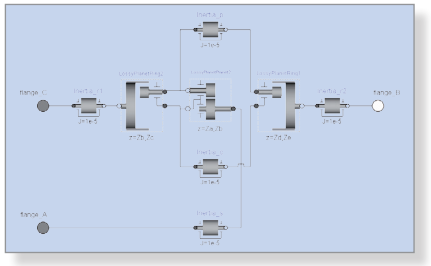
> Example 2 – Fuel consumption optimisation

The fuel consumption of a vehicle with an automatic transmission can be predicted and the shift maps optimised to minimise the fuel used. This can be done either by interactive parameter adjustments or automatically using optimisation routines. The spacing of the shift points can also be assessed and their effect on shift quality can be understood.

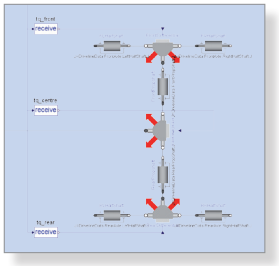
> Example 3 – Active Driveline Systems

The effect on vehicle handling of active driveline systems can be investigated by coupling the PowerTrain and VehicleDynamics libraries. The use of active differentials with a control system designed to improve the vehicle yaw rate during cornering can improve the performance of the vehicle over a slalom course. The models enable the behaviour of different passive and active differentials to be predicted and the associated control systems to be designed and calibrated.

The PowerTrain Library is designed, implemented, and maintained by DLR, the German Aerospace Center, Institute of Robotics and Mechatronics in Oberpfaffenhofen, a Dassault Systèmes technology partner.



Wolfrom type planetary gearbox with losses



Active 4 wheel-drive driveline model

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