VEHICLE DYNAMICS LIBRARY

Overview

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AGENDA

- ❑ About Vehicle Dynamics Library
- ❑ Key Benefits
- ❑ Key Capabilities
- ❑ Key Applications
- ❑ Library Contents
- ❑ Modelon Compatibility
- ❑ Latest Release

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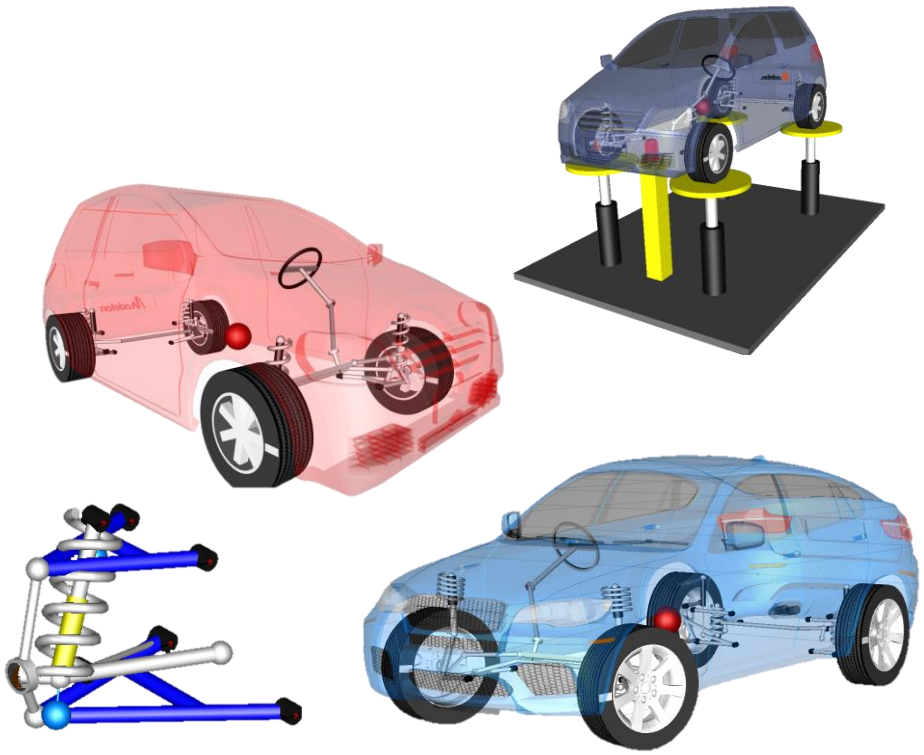
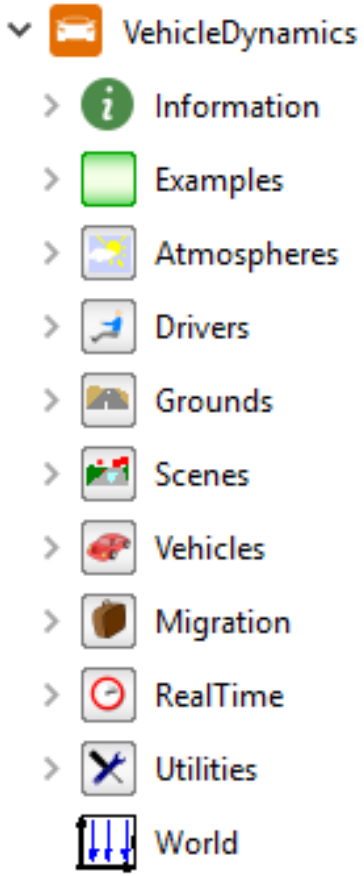
ABOUT VEHICLE DYNAMICS LIBRARY

ABOUT

An environment for the design and analysis of vehicles and vehicular components

On the market since 2004





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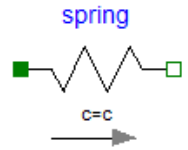
KEY BENEFITS

Open code

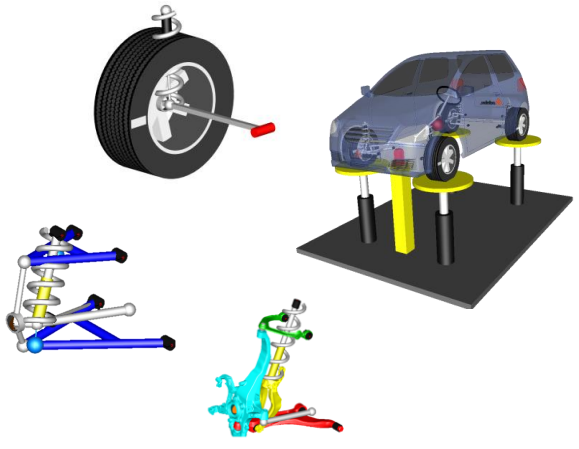



```
model Spring "Linear 1D translational spring"
  extends Translational.Interfaces.PartialCompliant;
  parameter SI.TranslationalSpringConstant c(final min=0, start=1)
    "Spring constant";
  parameter SI.Distance s_rel0=0 "Unstretched spring length";

equation
  f = c*(s_rel - s_rel0);
  a
end Spring;
```

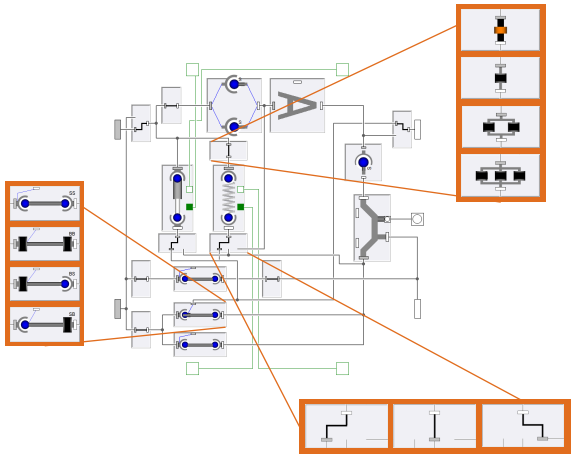
- View, extend and modify models to fit your needs
- Advantages similar to in-house tool

Scalable



- Works at both system and component level
- Adapts to your workflows
- Easily switch between different levels of fidelity

Flexible



- No limit in configurability
- Design and evaluate innovative and non-traditional concepts

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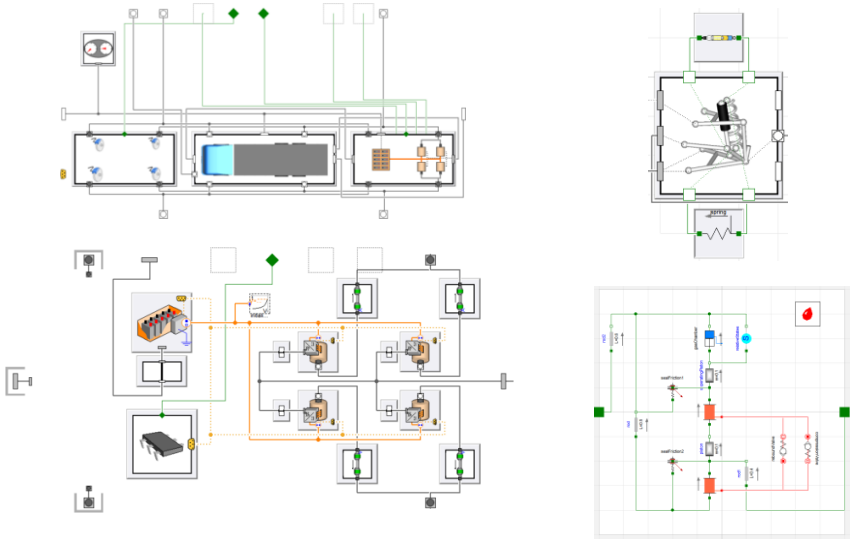
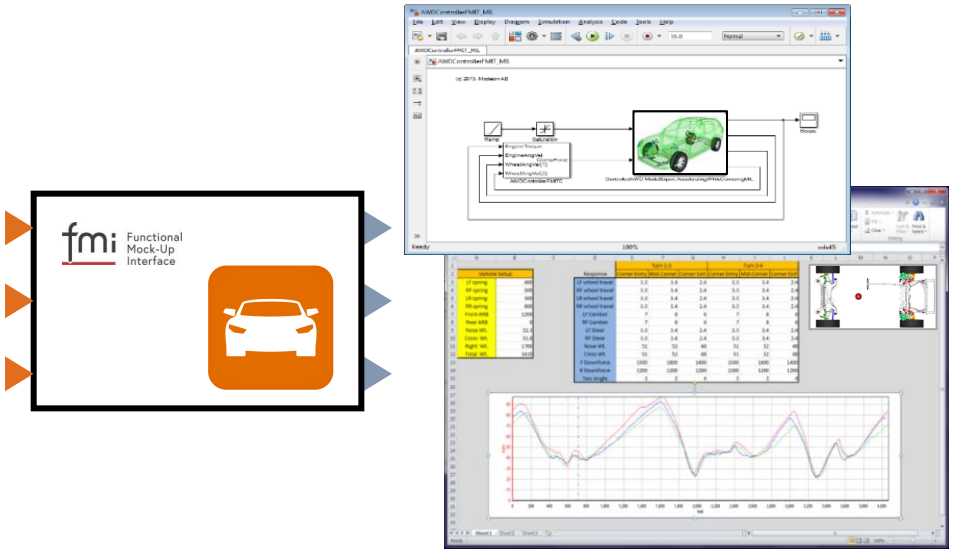
KEY CAPABILITIES

Multi-domain



- Model complete vehicle system
- Integrate electrical, hydraulic and pneumatic suspension components
- Electrified powertrains

Deployable



- Spread models and analysis capability throughout organization
- Models usable in many environments (SIL, HIL, DIL, …)
- Safely share models with suppliers

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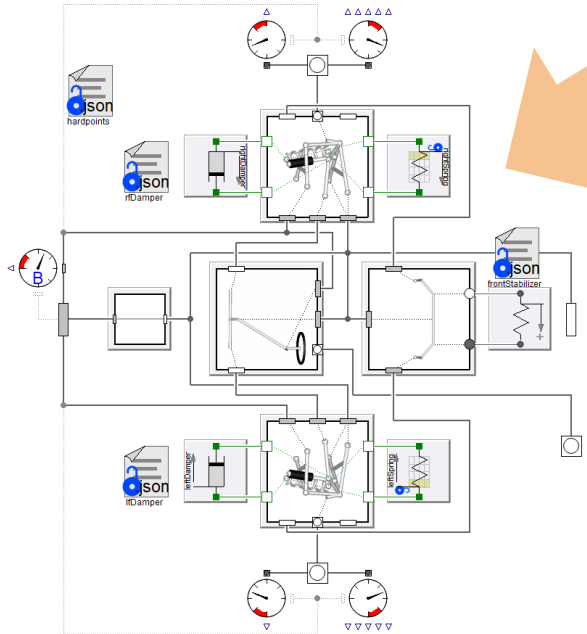
Parameterization

Model is set up to read data from files

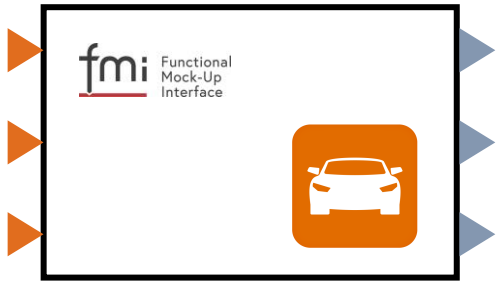


damper

spring

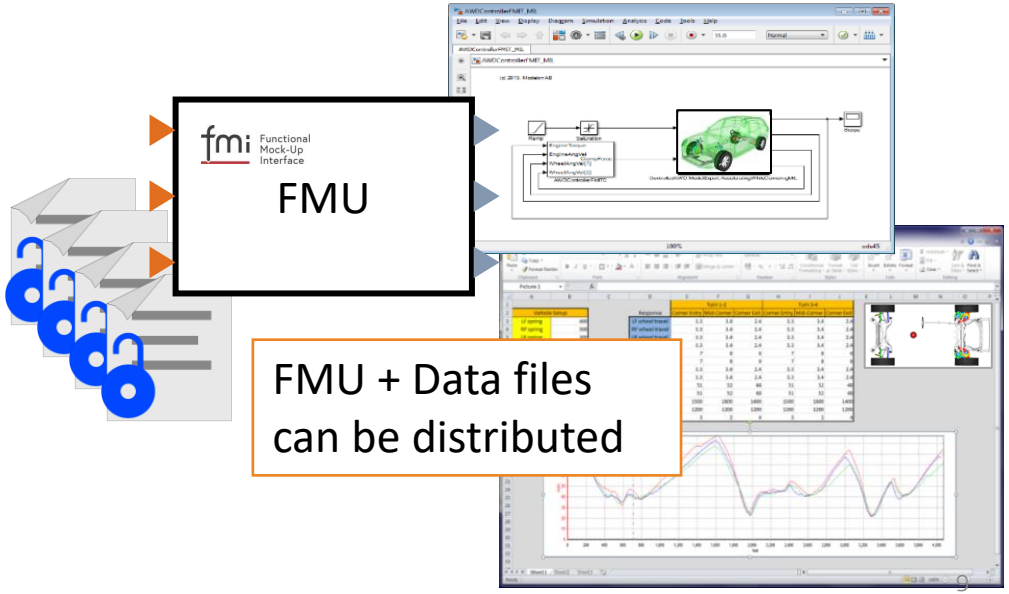
hardpoints

stabilizer



Link to data files is maintained in compiled model

Files can be changed to adjust parameterization



FMU + Data files can be distributed

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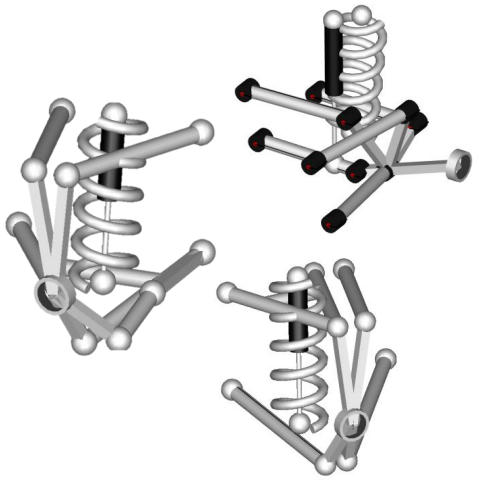
KEY APPLICATIONS

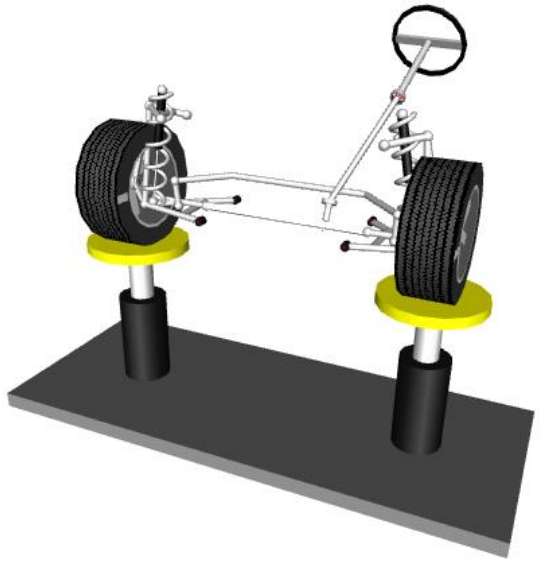
SUSPENSION DESIGN

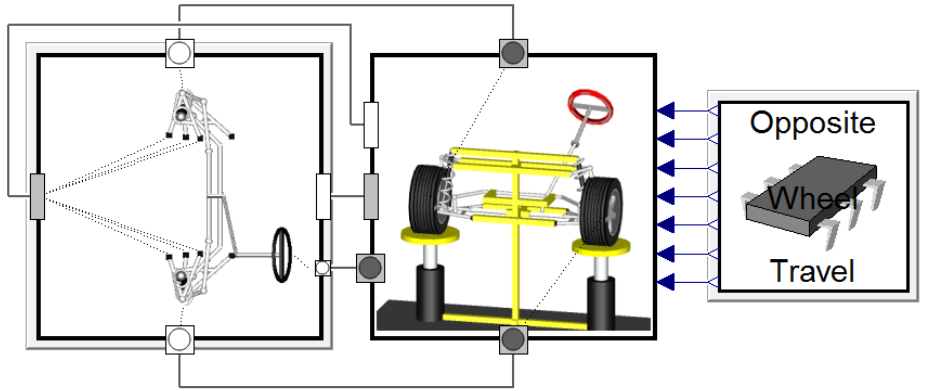
Large set of predefined configurable topologies

Easily extend to custom topologies

Different options for suspension rig tests







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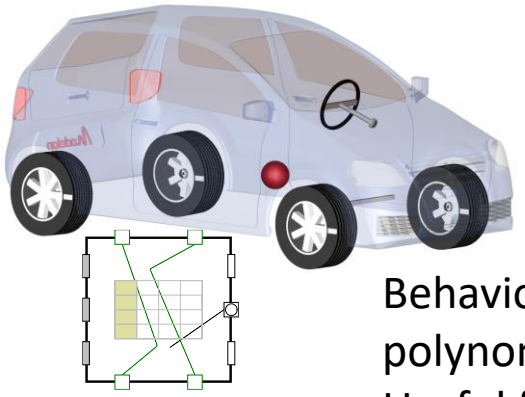
REAL TIME SIMULATION

Use VDL models for driving simulators and HIL testing



Behavioral chassis models (tabular, polynomial)
Useful for HIL testing where chassis needs to be simulated on a single processor core

Using parallel execution, also elasto-kinematic multibody models can be simulated in real time with multiple processor cores

Established workflows for several real-time environments

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CHASSIS TUNING

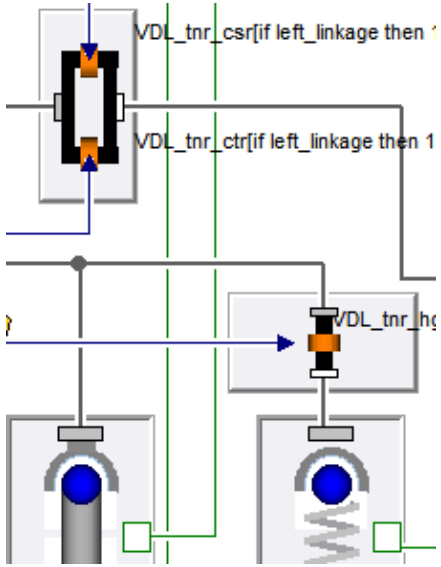
Components: tuners and tunables

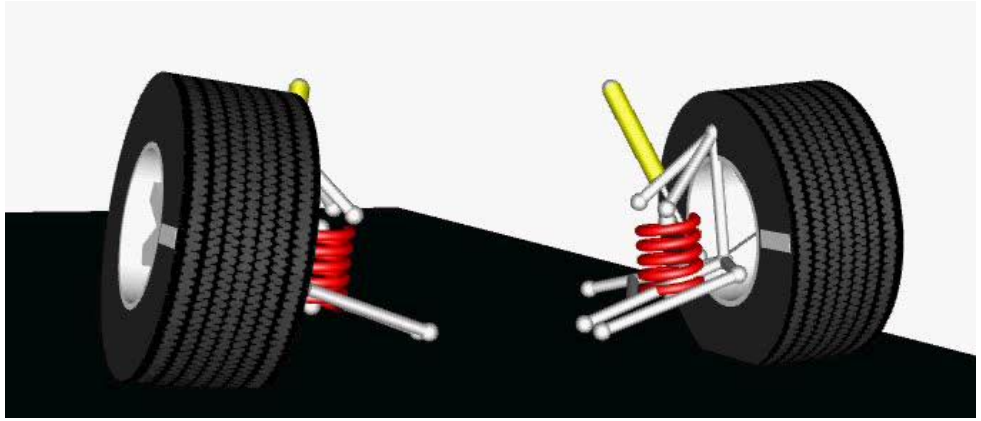
OEMs

- Automates ride height adjustment

Motorsports

- Replicate physical setup procedure such as shim adjustments, driver in/out, fuel, ballast…
- Provide setup tools to aid in physical setup





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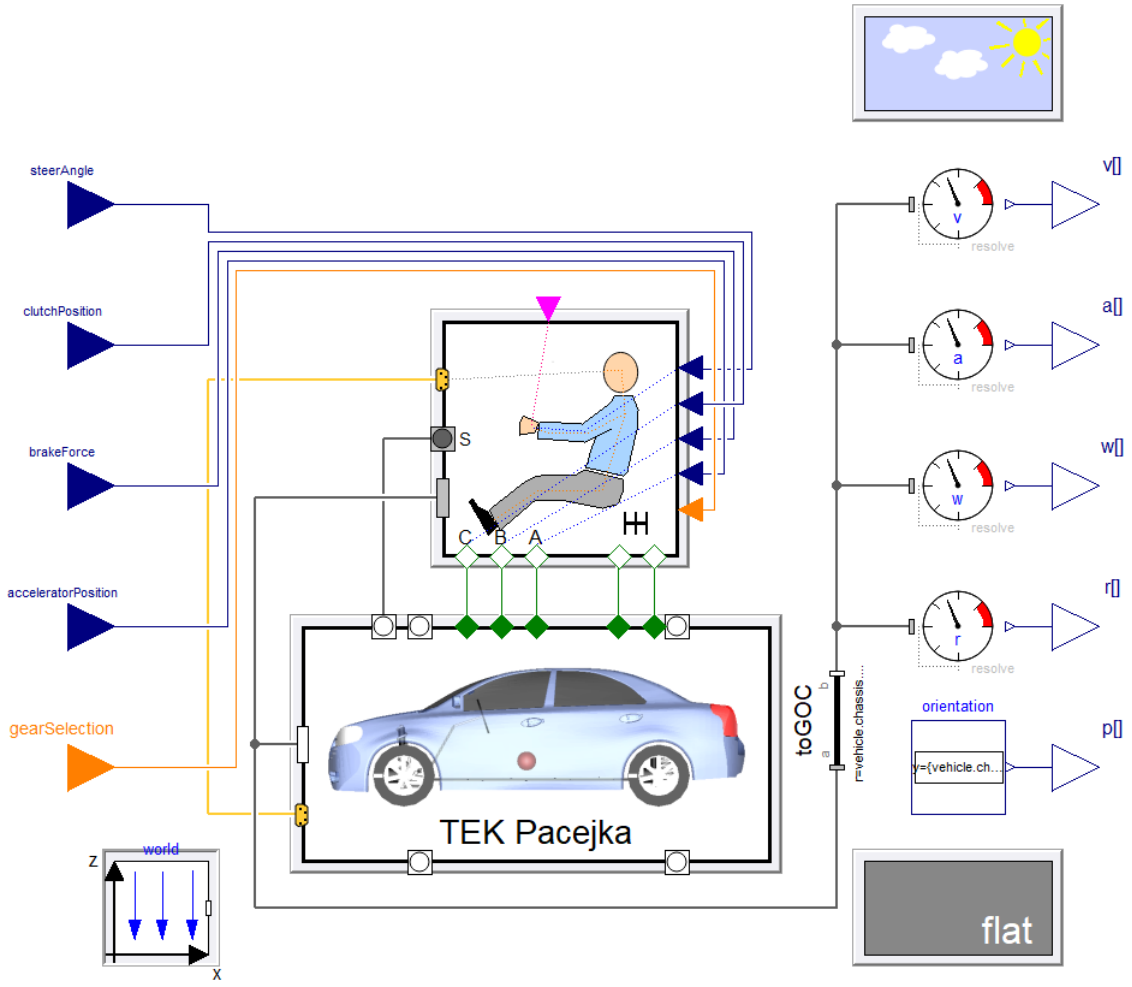
PLANT MODELS FOR CONTROLS DEVELOPMENT

Export vehicle models for use in developing control systems

Scalable fidelity allows fast execution

Interface can be tailored to the specific application

Flexible deployment using FMI



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DRIVABILITY

Challenge

To meet increasingly stringent fuel economy and emissions standards without compromising customers demands for vehicle performance

Issues

- Shift performance and feel due to increased number of vehicle shifts to optimize fuel economy
- Vehicle launch induced vibrations with both conventional and start-stop technology
- Driveline vibrations associated with dual clutch transmissions and driveline vibrations

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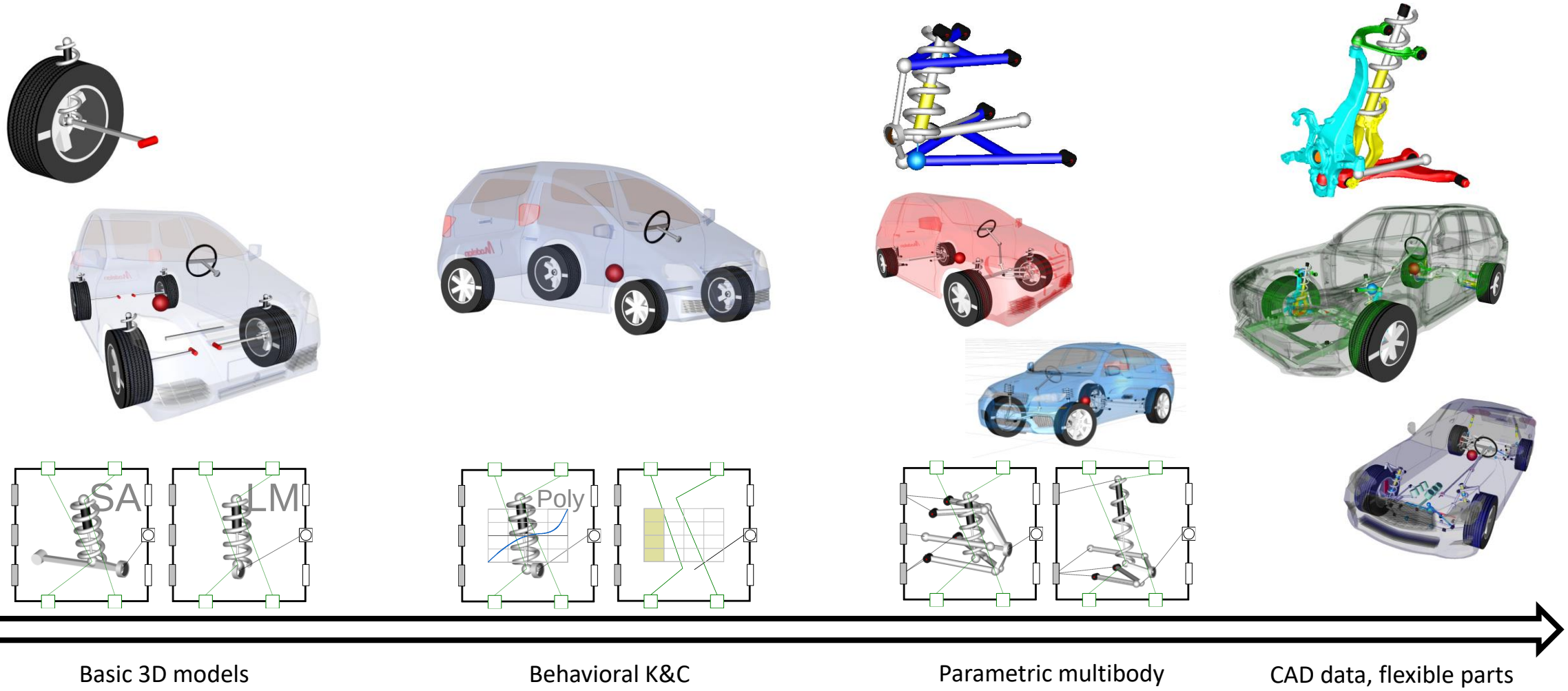
PRODUCT CONTENTS

CHASSIS AND SUSPENSIONS



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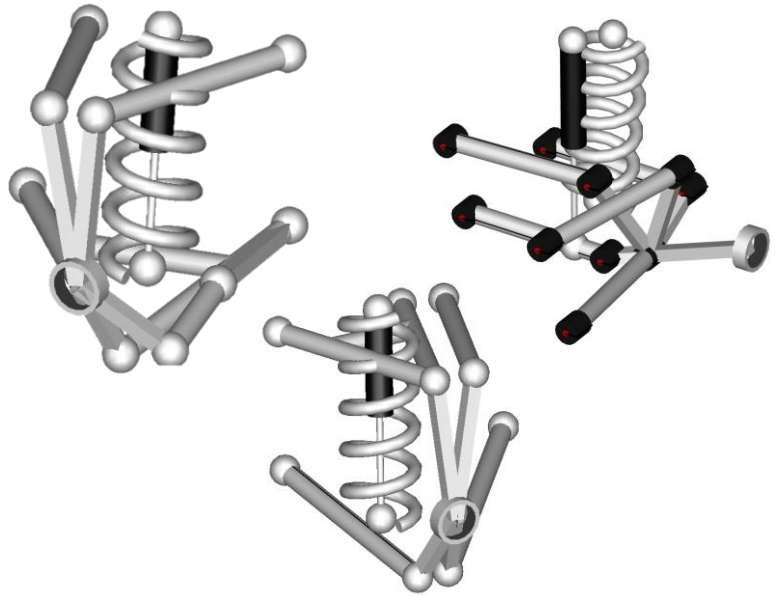
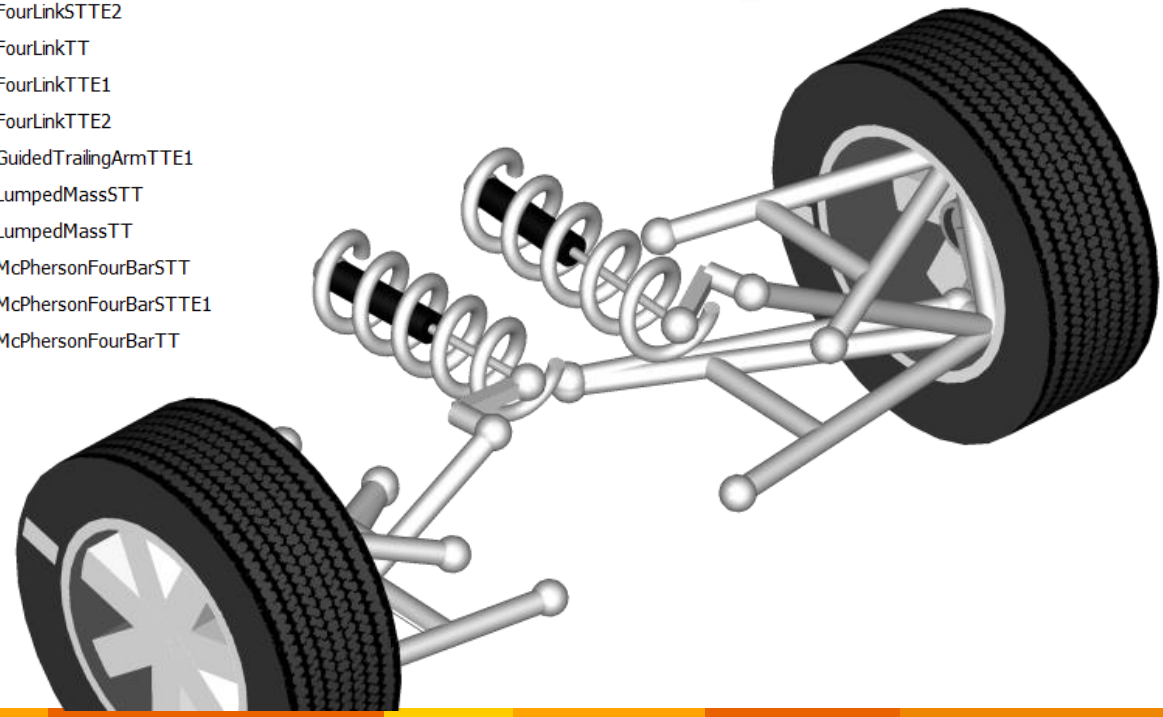
SUSPENSIONS

Contains all the Components necessary for detailed analysis of suspension and steering systems

- Extensive library of suspension components
  - Ride elements (springs/dampers/stabilizer bars)
  - Steering systems
- Over 30 different suspension topologies
  - Varying level of detail: planar, tabular, multibody
  - Kinematic and compliant (lumped/bushings)
  - Switchable attachments/mounts means 100s of configurations

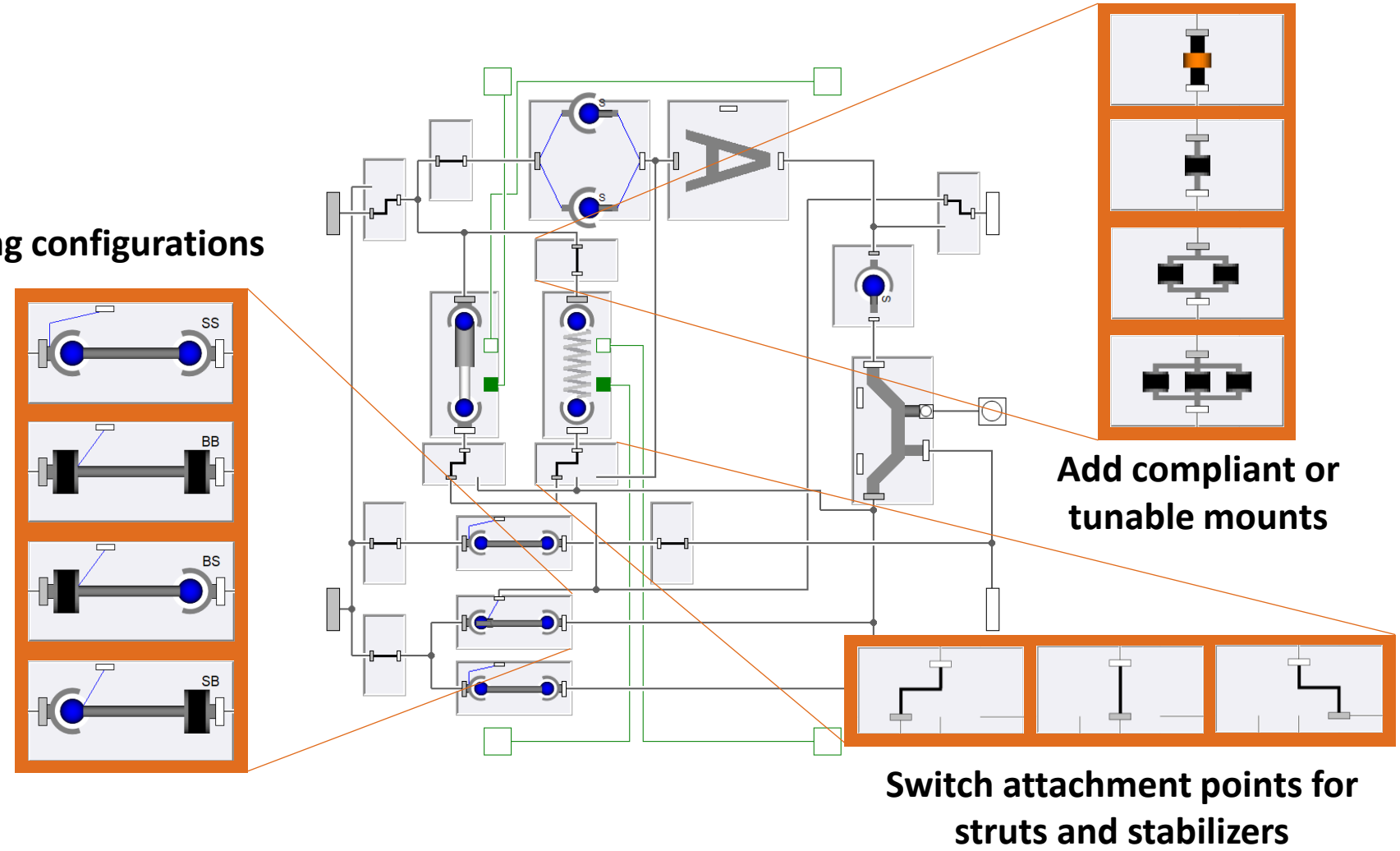
DoubleWishboneSTTE1
DoubleWishboneSTTE2
DoubleWishboneSTTE3
DoubleWishboneTT
DoubleWishboneTTE1
DoubleWishboneTTE2
DoubleWishboneTTE3
FiveLinkSTT
FiveLinkSTTE1
FiveLinkSTTE2
FiveLinkTT
FiveLinkTTE1
FormulaDoubleWishbone
FormulaDoubleWishboneS
FourLinkSTT
FourLinkSTTE1
FourLinkSTTE2
FourLinkTT
FourLinkTTE1
FourLinkTTE2
GuidedTrailingArmTTE1
LumpedMassSTT
LumpedMassTT
McPhersonFourBarSTT
McPhersonFourBarSTTE1
McPhersonFourBarTT





CONFIGURABLE TOPOLOGIES

Change bushing configurations



Add compliant or tunable mounts

Switch attachment points for struts and stabilizers

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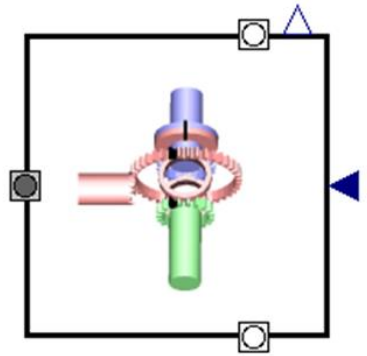
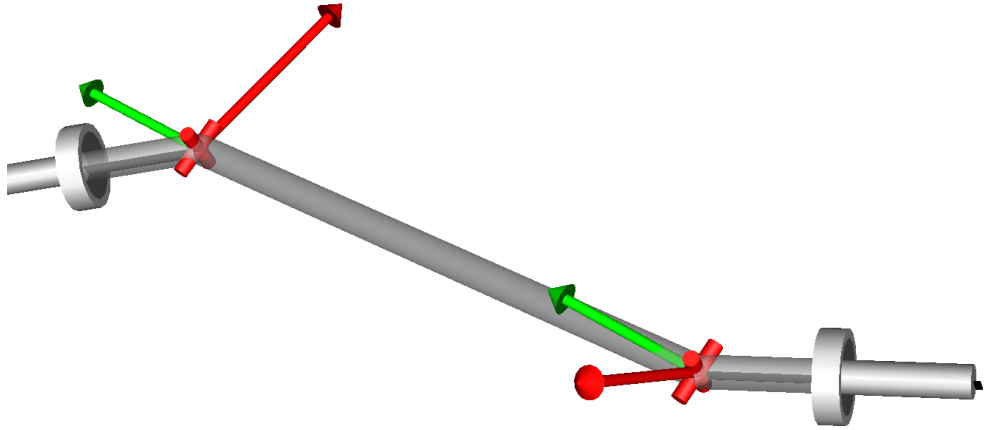
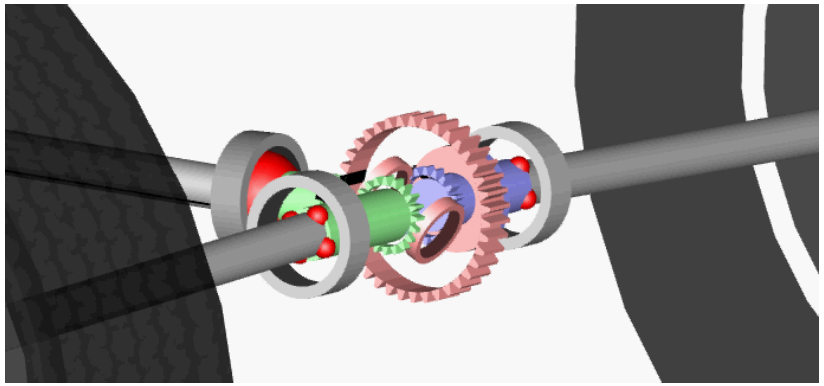
POWERTRAIN - DRIVELINES

Contains components and assembled subsystems to model various driveline implementations: front-, rear-, all-wheel drive



- Targeted to the development of vehicle drivelines
  - 3D effects in joints, shafts and gears
  - Geometry and kinematic effects
  - Reaction torques and forces
- Bridges the gap to very detailed subsystem models





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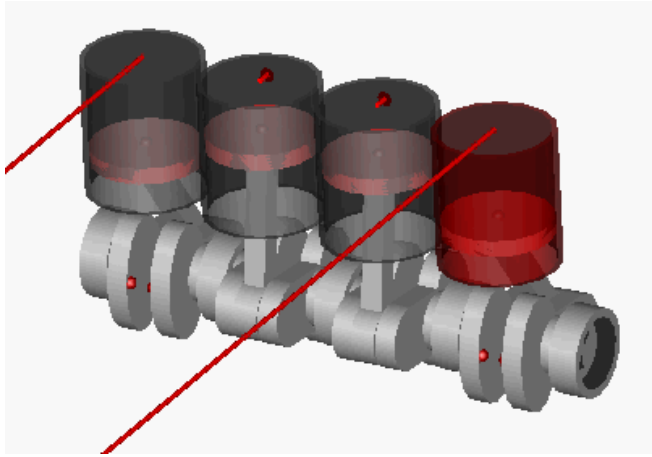
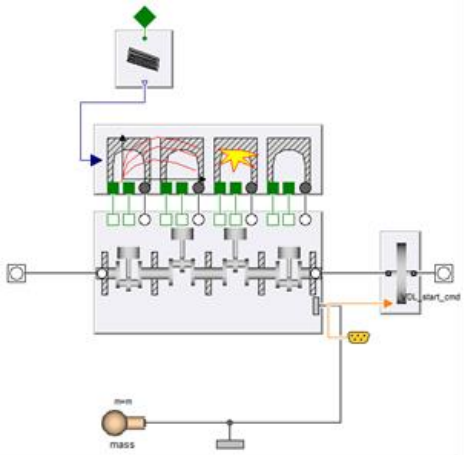
POWERTRAIN - ENGINES

- Pure torque map: torque as a function of throttle and engine speed
  - Applications: vehicle handling, drivability
- Pressure map (cycle resolved): cylinder pressure as a function of crank angle, throttle, engine control settings, and engine speed
  - Applications: engine, powertrain and driveline vibrations; and drivability
- More detailed (Engine Dynamics Library) engine models can be used to study gas exchange and mean value torque production





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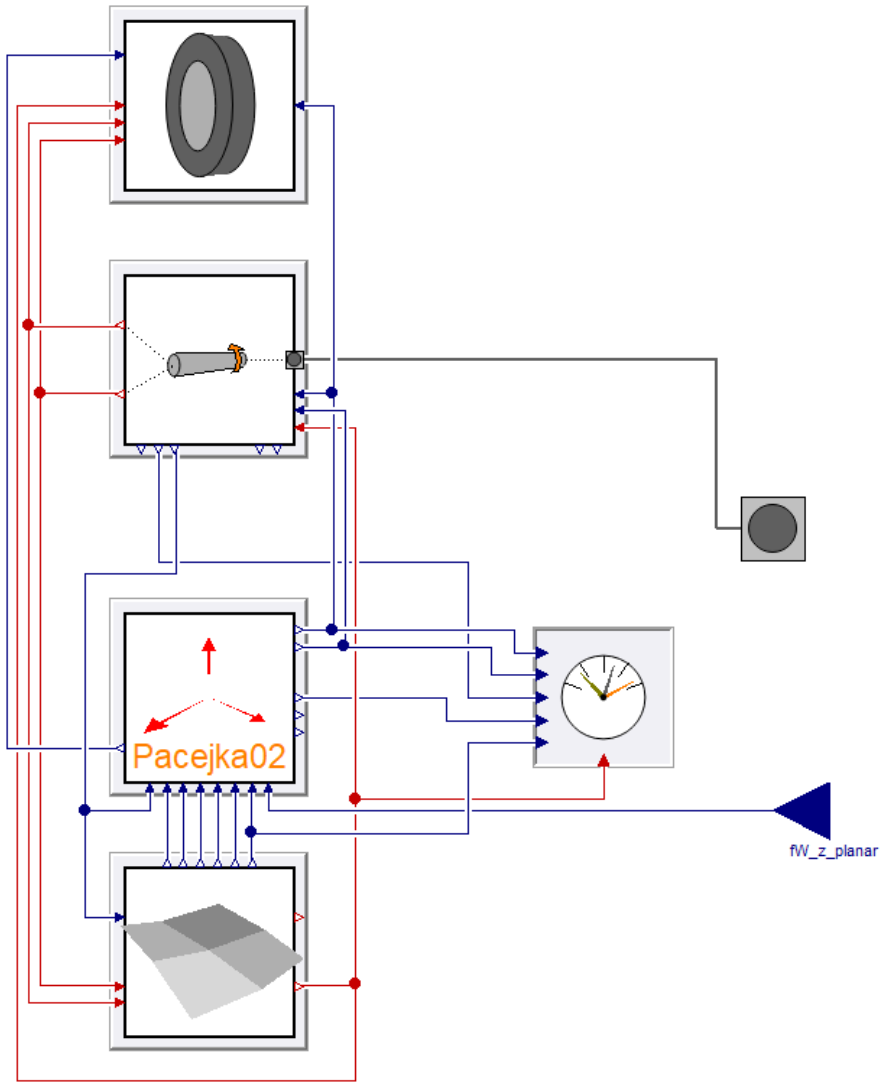
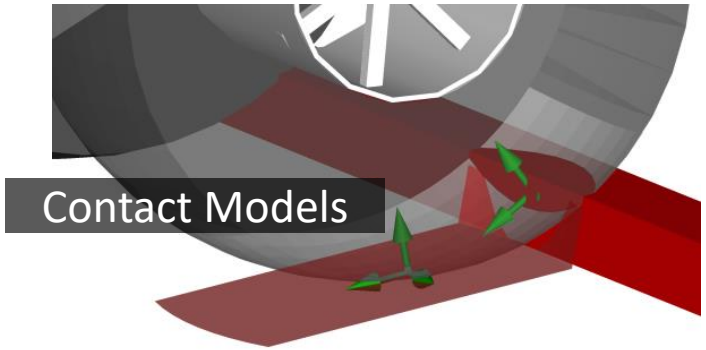
TIRES/ROADS

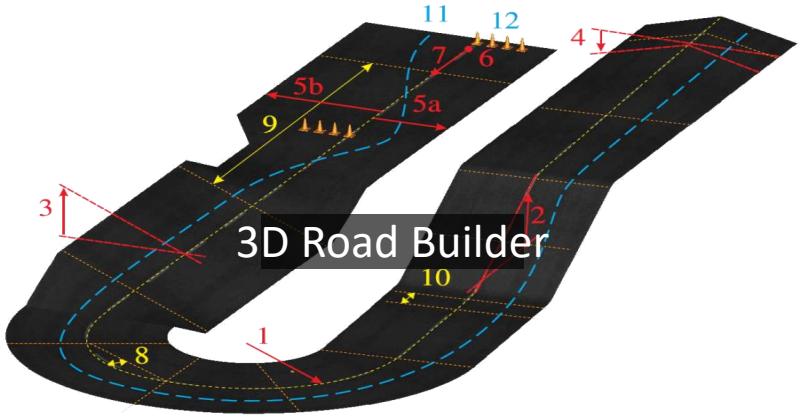
- Native tire models
  - Pacejka ‘94
  - Pacejka ‘02
  - Pacejka ‘12
  - Bakker ‘89
  - GSTBakker ‘87
  - Rill ‘05
  - Linear
- 3rd party interfaces
  - Delft Tire: MF-Tyre, MF-Swift
  - FTire
- User extensible
  - Modelica
  - External code (.dll)



TIRES/ROADS

- Tire contact routines
  - Single point contact
  - Geometric/Enveloping
- 3D Road Builder
  - Closed loop/circuit from centerline
  - ISO3888-2 double lane change
  - NHTSA Fishhook
  - NHTSA J-turn
- Support for OpenCRG roads
- User extensible
  - Contact filtering
  - Ground lookup routines





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MODELON COMPATIBILITY

RECOMMENDED MODELON LIBRARY COMPATIBILITY

- Vehicle Dynamic Library integrates with the Modelon Library Suite
  - Electrification Library
    - Electric drivelines, effects on vehicle dynamics
  - Hydraulics Library
    - Detailed hydraulic dampers
    - Hydraulic brake systems
  - Pneumatics Library
    - Air springs
    - Pneumatic brake systems

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LATEST RELEASE

RELEASE: 2021.2

New Features

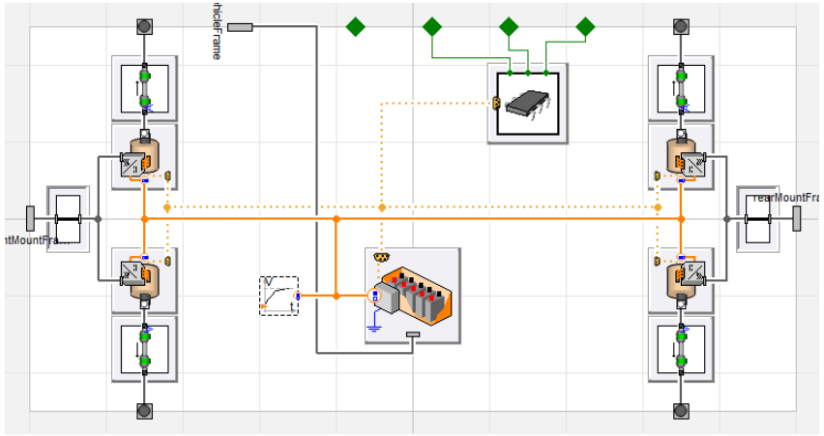
Electrified powertrains
VDL is now dependent on the Electrification Library, which is now available to all VDL users starting with the 2021.2 release

There are two new electric vehicle examples, a Pickup with a quad-motor powertrain and a Coupe with either a dual-motor, or single-motor powertrain

There is also a range of new electric powertrain examples, including Quad-, dual- and single motor configurations based on components from Electrification library

Finally, there are three example experiments, a **Range** estimation, **Acceleration** test and a **Torque Vectoring** test with the quad motor pickup vehicle.

New electric Pickup and Coupe vehicle examples



Quad motor powertrain example

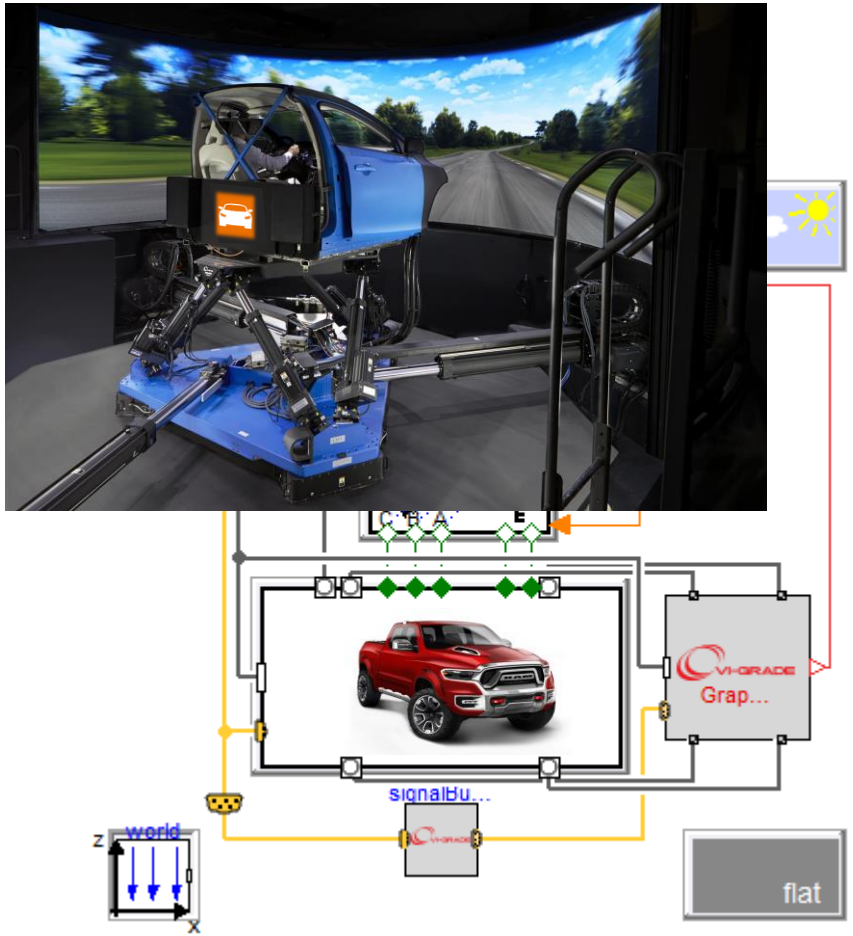
RELEASE: 2021.2

New Features

VDL models are now VI-Certified®
Vehicle models generated by VDL are now VI-Certified®.

VI-Certified is an elevated partner program aimed at validating 3rd party software operation on VI-grade® simulators. VI-grade develops and optimizes its Driving Simulators with a complete software suite for vehicle modeling, graphics, sound & vibration, and motion cueing, thus enabling an off-the-shelf, turn-key solution.

VI-Certified, that enables customers to use their established products, knowing that these products have been fully tested by partners and assured by VI-grade. This reduces cost and time of deployment for their Driving Simulators.



RELEASE: 2021.2

Enhancements

- Automatic transmission improvements, shift tables updated to improve shift logic in example transmissions
- New set of predefined drive cycles for DriveCycle driver
- Additional templates for trucks and trailers
- Scale and offset parameters eliminated
- SimCenterTire updated to 2021.2

- Fixed bug in windup angle output of WheelAngles sensor
- FormulaSAE chassis updated to use newer suspension topologies and added to a new FormulaSAE vehicle model including brakes and powertrain

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