Modelica® Libraries

Catalog

Version 5

AlternativeVehicles **Belts** **BG_RT**

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PowerTrain **Statistics** **Visualization**

MODELICA

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About Modelica Libraries

User Benefits

Modelica Libraries contain modeling know-how in a standardized way. They provide ready-to-use equation-based model components, as well as application-oriented parameter sets and advanced interfaces to related technologies of Modelica (e.g. FEM, real-time simulation and 3D visualization). Since Modelica source code is available in most cases, the model components are highly customizable to user needs.

Library Development and Distribution

Many Modelica Libraries were already developed or are currently under development by research labs, companies and engineering specialists. Some of these model libraries are free and can be downloaded from the Modelica homepage (www.modelica.org).

Other libraries which implement specific know-how will not be available free of charge. We distribute some of these commercial Modelica Libraries which will not be sold by the developers or via other sales channels. We offer marketing, distribution and support. Our goal is to make these libraries available for all Modelica-based simulation environments.

Are you interested in one of the Modelica Libraries?
Please do not hesitate to ask for more information, demo versions and quotations.

About Modelica

Modelica is a non-proprietary, object-oriented, equation-based language to conveniently model complex physical systems containing, e.g., mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented subcomponents.

Modelica Simulation Environments are available commercially and free of charge, such as CATIA Systems, CyModelica, Dymola, LMS AMESim, JModelica.org, MapleSim, OpenModelica, SCICOS, SimulationX, Vertex and Wolfram SystemModeler. Modelica models can be imported conveniently into Simulink through export features of Dymola, MapleSim, SimulationX and Vertex.

The Modelica Association is a non-profit organization with members from Europe, U.S.A. and Canada and Asia. Since 1996, its simulation experts have been working to develop the open standard Modelica and the open source Modelica Standard Library.

Please visit www.modelica.org for more information.

AlternativeVehicles Library

Hybrid Vehicle Power Trains, Battery-Electric and Fuel-Cell Vehicles

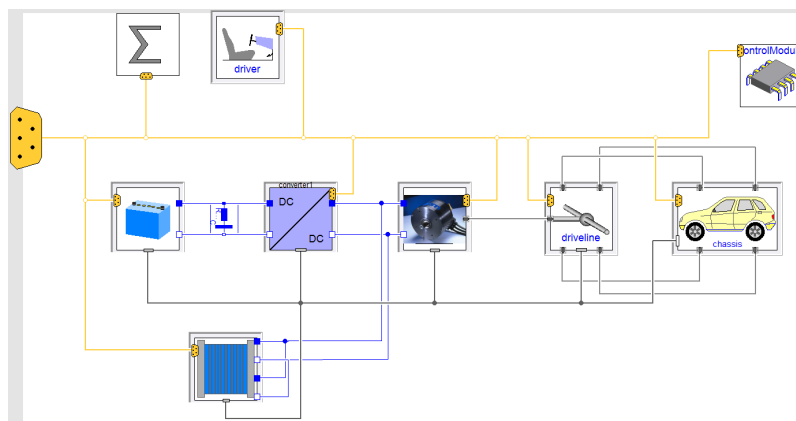The AlternativeVehicles Library provides one-dimensional mechanical and electrical components for alternative power trains. It contains ready-to-use vehicle architectures including battery-electric vehicles, range-extender vehicles and fuel-cell vehicles and component models for electric drives, energy storages, fuel cells, engines, drivers and drive cycles.

The focus of this library is on modeling of alternative power trains with emphasis on fast and simple parameterization of component models by using commonly available manufacturer datasheets and / or measured data.

New in version 1.1:

- Examples for parallel-hybrid vehicle MB S400H and conventional vehicle MB S350
- Test benches for batteries, combustion engines, transmissions and electrical drives
- Improved tutorial and documentation

The AlternativeVehicles Library was developed within the European research project EUROSYSLIB. The models are based on the VehicleInterfaces library ensuring compatibility to already existing automotive libraries.

Development

DLR, German Aerospace Center, Institute of Vehicle Concepts, Stuttgart, Germany (www.dlr.de/fk) with contributions of Institute of Robotics and Mechatronics, Oberpfaffenhofen, Germany.

Availability

Version 1.1 is available for Dymola

Tested on Dymola 2013 and Modelica Standard Library 3.2

Belts Library
## Static and Dynamic Analysis of Belt Drive Systems

The Belts Library contains elements for the static and dynamic analysis of belt drive systems.

It is assumed that the belt drive is a planar system. The most important elements of the model library include:
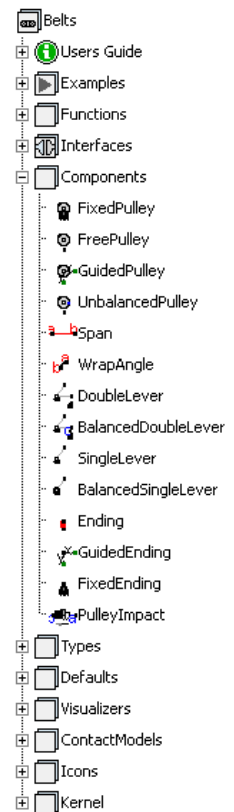
- belt pulleys with fixed axis and specified rotation

- belt spans as idealized spring/damper elements (Kelvin-Voigt model)

- belt spans capable of transversal vibrations

- belt pulleys whose axis of rotation is connected to a frame from the Multi-Body Library
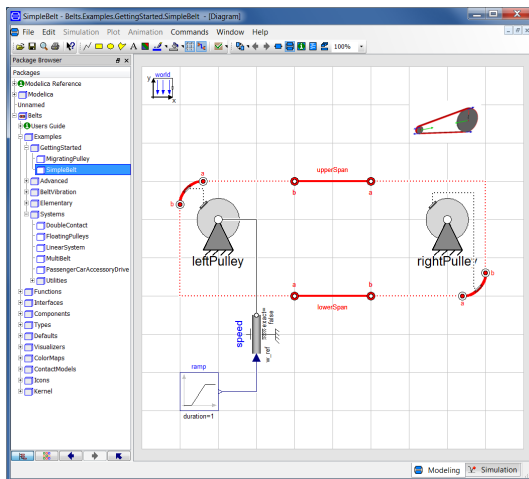
Simple belt model
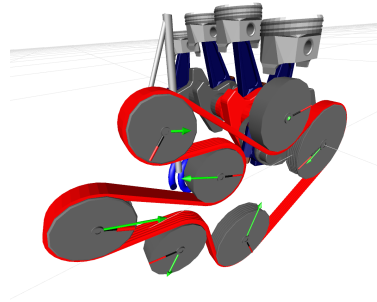
Animation of a passenger car accessory drive

The Belts Library includes components like levers, endings, wraps, contact models, functions for belt calculations and interfaces for belt drive components.

Adapted advanced animation components make it easier to understand the dynamic behaviour of the model. Visualizers for 2- and 3-dimensional visual objects are used for animation of the belt drive. Many examples are delivered to explain the usage of the Belts Library. A User's Guide completes the package.

Development

Frank Rettig, Germany

Availability

Version 3.2.1 of this library is available for Dymola
Tested on Dymola 2012 and Modelica Standard Library 3.2
We plan to make it available for SimulationX soon.

BG_RT Library
Real-Time Simulation with Standard DAQ Cards

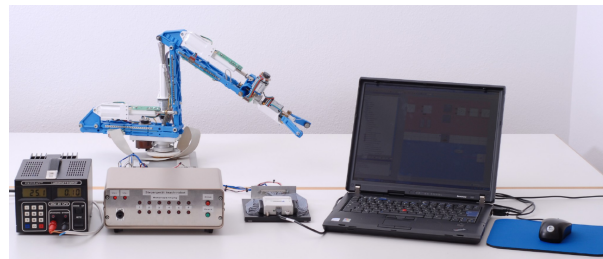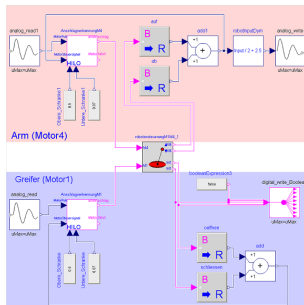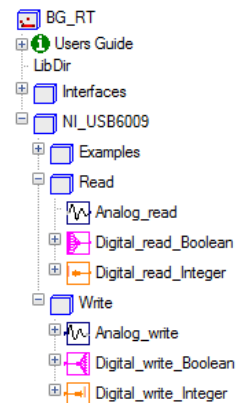The Bausch-Gall Real-Time Library (BG_RT) includes components to access data acquisition (DAQ) cards directly from a Modelica simulator.

It was designed to allow the usage of the Dymola *Realtime* option with DAQ cards without any further programming effort. Currently we support the card NI-USB6009 from National Instruments. Functions for reading and writing analog and digital data are provided.

BG_RT allows easy and low cost HiL-simulation. Only a standard Windows PC with Dymola, option Realtime and a DAQ card are needed.

The library is delivered with complete source code, including the code of all C-routines. Therefore it can be used as programming template for other DAQ cards.

- BG_RT
  - Users Guide
  - LibDir
  - Interfaces
  - NI_USB6009
    - Examples
    - Read
      - Analog_read
      - Digital_read_Boolean
      - Digital_read_Integer
    - Write
      - Analog_write
      - Digital_write_Boolean
      - Digital_write_Integer

Development
BAUSCH-GALL GmbH, Muenchen, Germany (www.bausch-gall.de)

BAUSCH-GALL GmbH

Availability
The BG_RT Library is currently available for Dymola 2014 FD01 (Modelica 3.2.1). A version for SimulationX is planned. We also assist with the adaption of other DAQ cards.

FlexibleBodies Library – *enhanced version*
Flexible Beams, Annular Plates and general FE-based Bodies

FlexibleBodies — Modelica Library

developed by DLR
distributed by BAUSCH-GALL GmbH

The FlexibleBodies Library provides Modelica models to represent flexible bodies as beams, annular plates with optional thermo-elastic properties and modal bodies. The user can define beam-like structures such as the rotor blades shown in figure 1 by simply parametrizing an analytical model of a straight and homogeneous beam considering two-dimensional bending, torsional and lengthening deformations. The same approach is also applied to model the bending behaviour of annular plates such as a helicopter swash plate in figure 1. For both model types, a graphical user interface allows the definition of a complete set of geometrical and physical properties.

Figure 2 shows an automotive brake system with a floating caliper. Due to the chosen so-called arbitrary Lagrangian-Eulerian description also non-rotating loads such as brake normal and friction forces (visualized by green arrows) and the associated heat flow may be applied in a very convenient way since the contact modelling is substantially simplified.
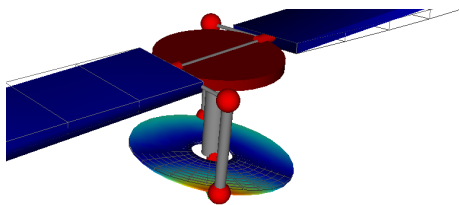

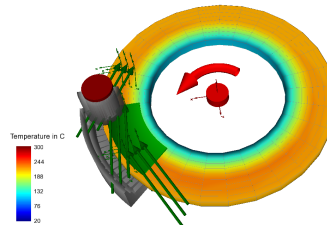Figure 1: blade pitch control

Figure 2: brake system

The component ModalBody allows to represent flexible bodies of a general geometrical shape. The geometrical and physical properties are defined by an SID (standard input data) file that is usually generated by an external program.

The SID file can be exported from Abaqus directly (as of version 6.10-EF). For users of ANSYS, Nastran, I-DEAS and PERMAS, we recommend the preprocessor FEMBS that is capable to generate an SID file from the FE programs. The user of the ModalBody model has to define which SID file is to be accessed to parametrize the body via the Modelica user interface. The SID data of a beam are completely generated by Modelica while ModalBody needs a file. For the application of ModalBody models in real-time environments the SID-data may be converted into a Modelica package so that external file access is avoided.

The motion of a flexible structure is defined by superposition of a large nonlinear motion of a reference frame with small elastic deformations. In order to consider initial buckling behavior, stress stiffening and softening effects can be described if supported by the preprocessor.
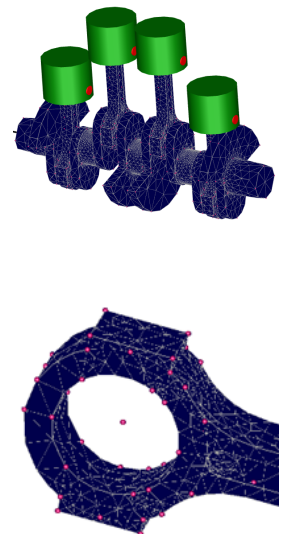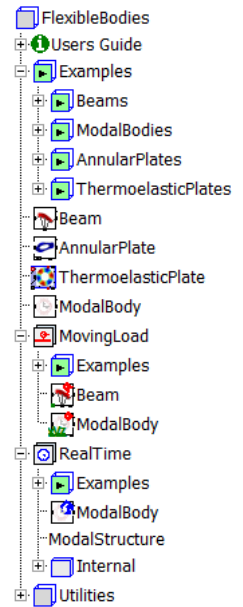
Development

DLR, German Aerospace Center, Institute for System Dynamics and Control, Oberpfaffenhofen, Germany (www.dlr.de/rm/en)

Availability

Version 2.1 is available for Dymola

Tested on Dymola 2014 FD01 and Modelica Standard Library 3.2.1

We also supply the preprocessor FEMBS from SIMPACK AG (www.simpack.com).

HumanComfort Library® – *enhanced version*
Human Comfort within Air-Conditioned Zones

HumanComfort Modelica Library

developed by XRG Simulation GmbH
distributed by BAUSCH-GALL GmbH

Humans feel comfortable within certain limits defined by thermal and personal factors, but energy systems are often optimized with regard to economical rules.
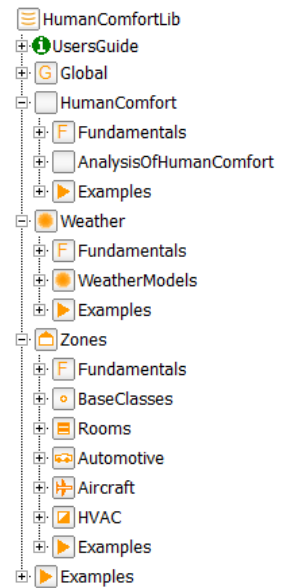
The Library contains basic models to estimate the thermal comfort of occupants or a group of occupants within an air-conditioned zone. The comfort results are provided in form of mathematical criteria and graphical visualizations.
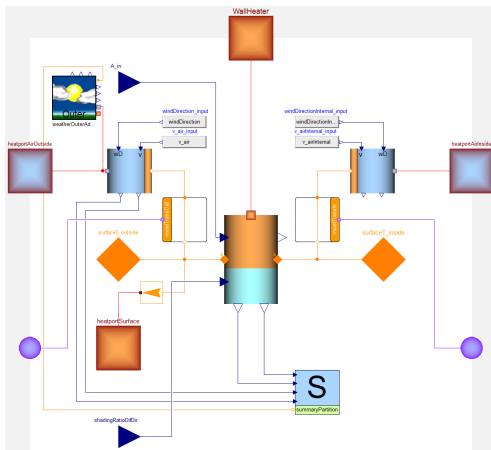
Multi-layer partition (wall or window)
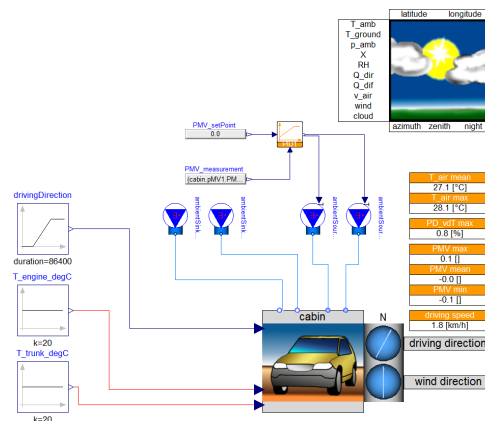
Automotive cabin (pulldown simulation)

The HumanComfort Library was initially developed within the research project EUROSYSLIB and has been extended by modeling details like shading, 3D heat conduction for thermal bridges, condensation at cold surfaces (cooling ceilings, windows), more pressure loss models and CO_2 emission of occupants. The library has a modular approach consisting of three packages:

- HumanComfort: thermal comfort analysis
- Weather: weather model for annual simulation
- Zones: buildings, aircrafts and automotive models

The use of standardized interfaces enables an easy coupling to existing Modelica libraries (e.g. combination of automotive cabin models with AC models using Modelica.Fluid connectors). The user may also combine existing building simulation models with the HumanComfort module.

Highlights of version 1.3:

- Multi-layer walls can be simplified to one capacitive mass without changing parametrization.
- A new weather model allows changes of latitude and longitude during simulation. This enables long flight or driving scenarios.
- All parts of an automotive or aircraft zone have a common frame of reference. This allows turning cabins in all directions, dynamically.

Development
XRG Simulation GmbH, Hamburg, Germany (www.xrg-simulation.de)

Availability
HumanComfort Library 1.3 is available for Dymola
Tested on Dymola 2014 FD01 and Modelica Standard Library 3.2.1

Hydronics Library® – *enhanced version*
Incompressible Thermo-Hydraulic Fluid Systems

Hydronics — Modelica Library
developed by XRG Simulation GmbH
distributed by BAUSCH-GALL GmbH

The Hydronics Library allows detailed modeling of thermo-hydraulic systems including heat exchangers for humid air and liquids. All components like pipes, bends, pumps and valves can be insulated, non-insulated or adiabatic. Joints, orifices, sudden expansions, contractions and expansion vessels complete the range of model components.

The example in the figure below shows the cooling of two different air flows in two heat exchangers. Control valves distribute the coolant mass flow. Model diagrams get animated according to fluid temperature and visualizers for model outputs like pressure, heat flow and electric power can be added.
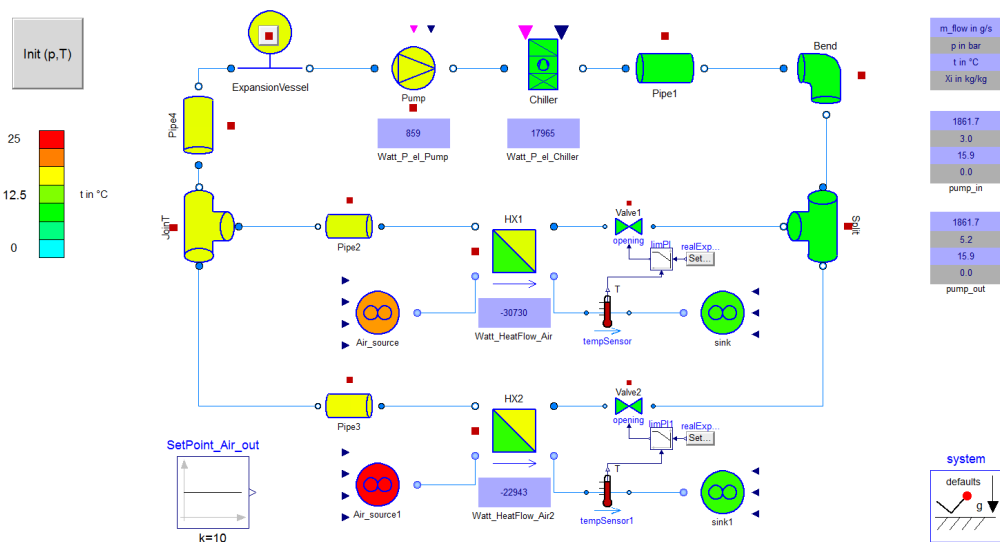
This library is used for cooling and heating applications in automotive, aircraft and shipbuilding industries as well as for building services engineering. Modern heat distribution networks require detailed analysis of the ratio of mechanical effort to thermal performance of heat exchangers.

By design, this library is limited to incompressible media. In return, systems with more than 100 sub-components are supported with robust initialization. User specific media data can be easily added in a table-based way.

Another benefit is the support of both dynamic and steady-state simulations. Dynamic simulations allow the optimization of pump and valve controls, while steady-state simulations allow rapid calculation of pressure loss or performance in arbitrary operating points.

The library uses XRG's free FluidDissipation Library for pressure loss and heat transfer calculation. The fluid ports and the air side of heat exchangers can be easily combined with libraries using stream connectors like AirConditioning, HumanComfort or Modelica.Fluid.

Development

XRG Simulation GmbH, Hamburg, Germany (www.xrg-simulation.de)

Availability

Hydronics Library 2.0.1 is available for Dymola
Tested on Dymola 2014 FD01 and Modelica Standard Library 3.2.1

PowerTrain Library

Vehicle Power Trains and Planetary Gearboxes with Losses

The PowerTrain Library provides primarily one-dimensional rotational mechanical components for vehicle power trains. Optionally, all three-dimensional mechanical effects can be taken into account, e.g. when mounting a power train on a multi-body vehicle dynamics model.
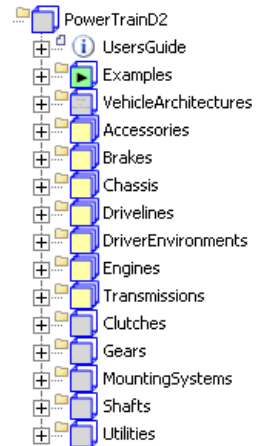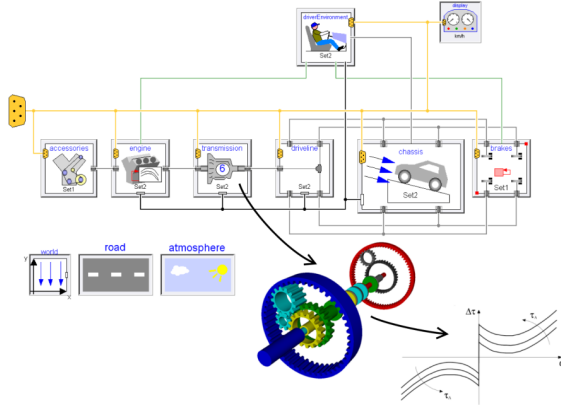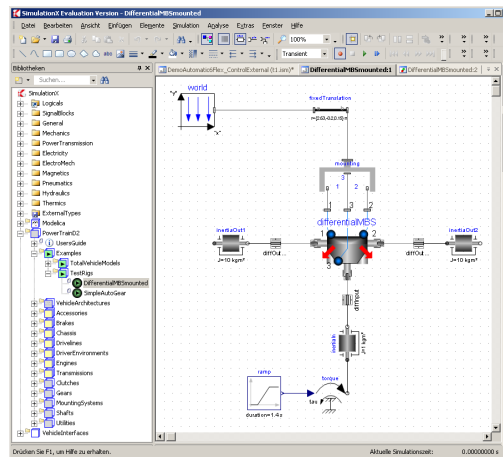

In addition, basic components for modeling the longitudinal dynamics of a whole car are available. The focus however is on power train modeling with emphasis on standard and planetary gears with losses and flexible driveline models.

Examples in SimulationX
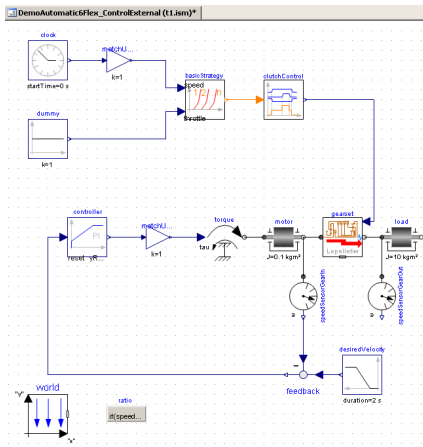
Automatic transmission

Differential

Development

DLR, German Aerospace Center, Institute of Robotics and Mechatronics, Oberpfaffenhofen, Germany (www.dlr.de/rm/en)

Availability

The PowerTrain Library will be soon available for SimulationX.
Dymola users please contact your Dassault Systèmes Value Added Resellers.
Dymola users in D, A, CH please contact our partner company CENIT.

Statistics Library
Definition of Statistical Variations of Parameters and Variables

The Statistics Library is designed to handle statistical analysis tasks using Modelica functions by variation of parameters and variables. In order to analyze the performance and robustness of system models, there are two main applications of the library:

1. Monte Carlo analysis, where the model parameters are calculated by statistical distribution functions. Repeated simulation varies the parameters according to the chosen distribution.

C = Statistics.SAEStandard.Uniform(50e-6, 0.1, 0)
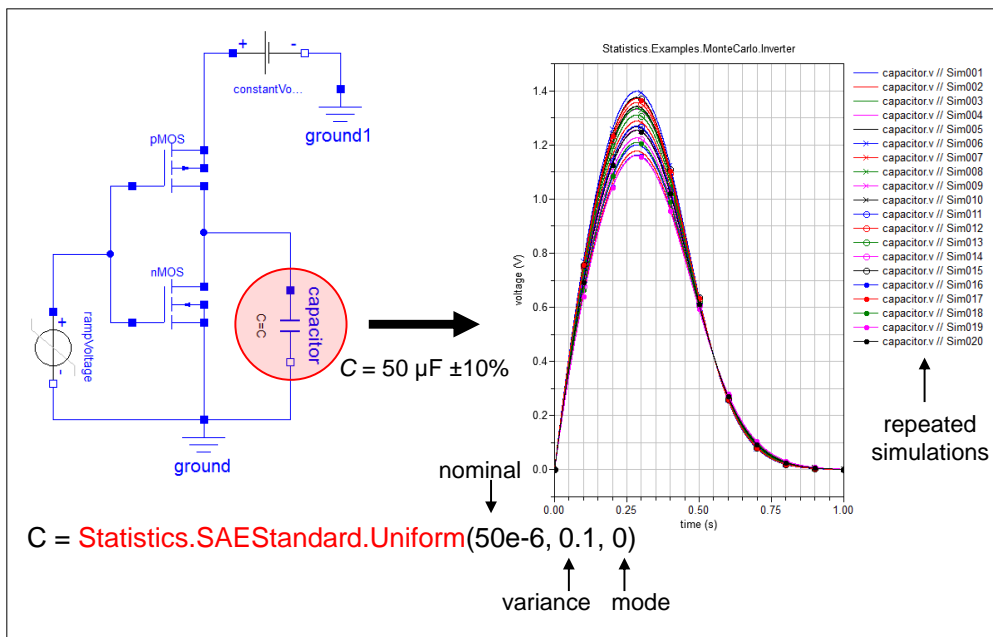
2. Noise Generation: The sampled call of a statistical distribution function generates noise during transient simulation.

The Statistics Library was developed in the Fraunhofer research project CAROD. It includes a set of statistical functions based on standard SAE J2748 and supports:

- Usage of the same model for nominal and Monte Carlo analysis
- Possibility to assign different statistical distributions to one parameter
- Continuous and discrete distributions which may be user-defined
- Possibility to specify correlation between parameters and variables
- Independent random number generation for each parameter and variable
- Reproducibility of a Monte-Carlo simulation

Development

Fraunhofer Institute for Integrated Circuits IIS, Design Automation Division EAS, Dresden, Germany (www.eas.iis.fraunhofer.de)

Availability

Statistics Library 1.3 is available for Dymola

Tested on Dymola 2014 and Modelica Standard Library 3.2

Please ask for availability for SimulationX and OpenModelica.

Visualization Library – *enhanced version*
Advanced, Model Integrated, Offline and Real-Time Visualization

Visualization — Modelica Library

developed by DLR
distributed by BAUSCH-GALL GmbH

The Visualization Library provides an advanced, model-integrated and vendor-unspecific visualization tool for Modelica models. It is especially useful in the mechanical, fluid and electrical area. Many components are available for off-line, online and real-time animation. Most components are attached to a Modelica model with a Frame connector of the Modelica.Mechanics.MultiBody library.

The library contains visualizers for basic shapes, CAD files (.3ds, .obj, .dxf, .stl, .vrml and more), flexible bodies and surfaces, text, light, energy-/mass-flow visualizers, analogue instruments and weather effects. A camera system can be used to define the point of view manually or controlled by simulation.

Components like Buttons, Checkboxes and Sliders are available for the creation of graphical user interfaces for the visualization software. These elements can be used to control the simulation interactively during the simulation run.

The components are visualized in an integrated system providing support for multi-camera scenes, a fullscreen mode, several monitors, replays and stereo/wireframe modes. It is based on the OpenSceneGraph framework.

The integrated video-export function allows the export of the animation replays as MPEG4, Windows Media Video, Flash Video and Lossless HUFF video.

The standard Modelica visualization for multi-body models can be replaced by this Visualization tool, if the Shape component in the ModelicaServices Library is replaced by the user.
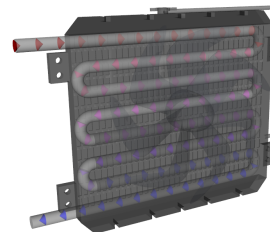
Examples
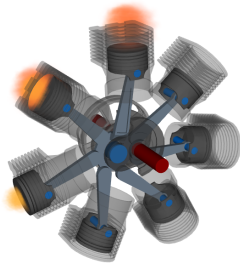
Radial Engine with visualization of combustion
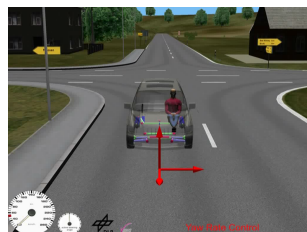
Vehicle dynamics visualization with a landscape from Vires

Flow visualization of a cooling system

Highlights of version 1.3:

- Support for Oculus Rift (head-mounted display)
- Vehicle example connecting the collision detector to the contact model of a tire.
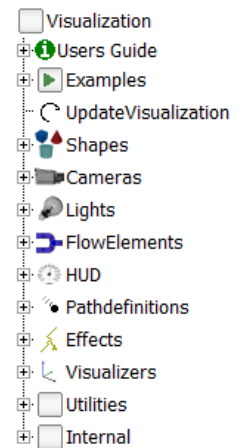
Development

DLR, German Aerospace Center, Institute for System Dynamics and Control, Oberpfaffenhofen, Germany (www.dlr.de/rm/en)

Availability

Visualization Library 1.3 is available for Dymola on Windows and Linux.

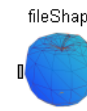Tested on Dymola 2014 FD01 and Modelica Standard Library 3.2.1
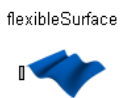We plan to make it available for SimulationX soon.

□ Visualization
⊞ ❶ Users Guide
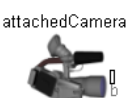⊞ ▶ Examples
 ↻ UpdateVisualization
⊞ ♠ Shapes
⊞ ▭ Cameras
⊞ ⬤ Lights
⊞ ⤙ FlowElements
⊞ ◷ HUD
⊞ ⬩ Pathdefinitions
⊞ ⚡ Effects
⊞ ∟ Visualizers
⊞ □ Utilities
⊞ □ Internal

elementaryShape

box

fileShape

flexibleBody
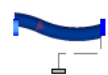
flexibleSurface

text

abc

Text

attachedCamera

light

analogueInstru...

HUD

weatherEffect

WeatherType....

collisionDetector

dist ▷
n ▷
collision ▷
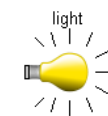
About us

BAUSCH-GALL GmbH is an engineering company based in Munich, Germany. We sell simulation software, organize training courses (for Dymola, SimulationX, PSpice, LTSpice) and do consulting based on our specific technical know-how. We also offer special design services, devices and products for radio frequency (RF) applications. BAUSCH-GALL GmbH was founded in 1987 by Dr. Ingrid Bausch-Gall and Hans Gall who started as independant consultants in 1983 and 1981. Today, the company is owned and operated by Leo Gall and Hans Gall. Based on a broad range of expertise in the solution of practical problems by effective computer application, BAUSCH-GALL GmbH serves the market for high-quality simulation and computer-aided engineering.

Please visit www.bausch-gall.de for more information.

Further Libraries

Please contact us if you are looking for a company to market your commercial Modelica library. We plan to distribute Modelica libraries for all Modelica simulators. We help you to make your libraries ready for the market, e.g. by testing the libraries under several Modelica simulators. We provide marketing material and we perform the complete selling process.
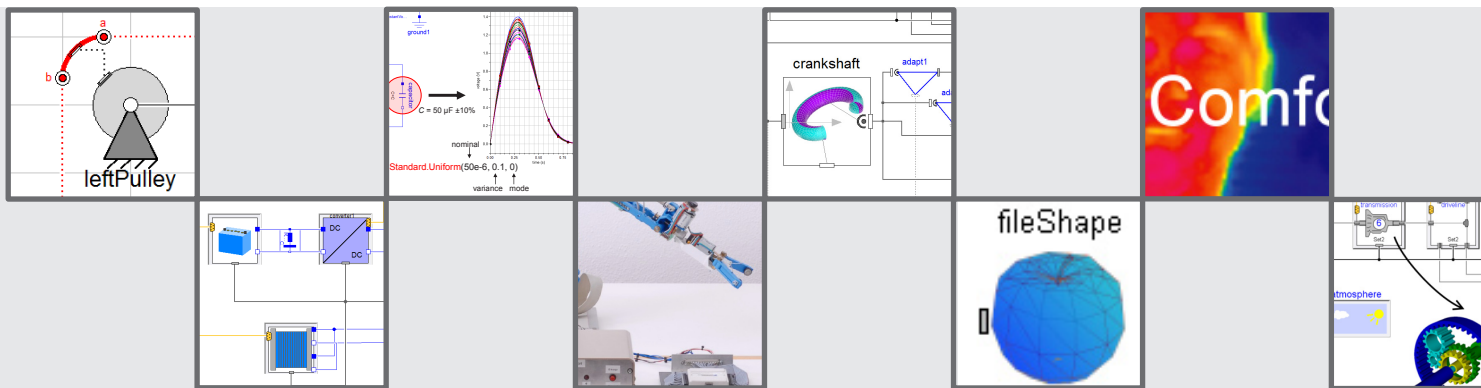
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Web: www.bausch-gall.de/molib

Please check our website for local resellers.

Date: 2014-02-19