Software Modules

Introduction and Overview

This document provides an overview on the currently available modules in SimulationX Version 3. The modular structure gives you the possibility to combine the modules according to your specific needs. Other modules within can be extended at any later time if required.

SimulationX Editions
... offer you tailored user profiles for applications in research, development, engineering, and sales.

Libraries
... sort model objects according to physical and application-oriented aspects. The broad collection of predefined element types in the libraries reduces your modeling efforts considerably. TypeDesigner ...by using the integrated TypeDesigner you can create and edit your own element types. Modification and extension of the fluid database can be implemented easily by the FluidDesigner.

Options
... complete the collection of tools for a holistic structural and system analysis (equilibrium computation, natural frequencies, vibration modes, input-output analysis) or for linking a simulation model to your databases considerably.

Plug-Ins
... broaden and complete SimulationX functionality by connecting External Libraries (Combustion Engines I/II, Synchronizer), the Virtual Machine, the Statechart Designer, and the Subsea Library (Hydraulics SubSea).
Co-Simulation

... provides a general interface which can be used to link SimulationX to CAE tools with predefined setups for particular realizations (MSC.Adams, Simpack, MATLAB/Simulink, ...).

Code Export

... transfers the functionality of a complete SimulationX model into C-Code. The exported source code can be used in many ways, such as Hardware-in-the-Loop Simulation (HiL), Rapid Control Prototyping (RCP), model integration into other simulation programs (e.g. Simulink S-Function, External Model) and accelerated simulation runs (Executable Model).

HiL Turnkey System

... provides a complete real time simulation environment including tailored hardware for powerful computing and signal conditioning. HiL Turnkey System enables the easy to handle integration of complex real time simulation in custom hardware environments.

Virtual Machine

... is the complete solution for virtual start-up of machines and plants. Complex SimulationX models are linked with industrial control devices via integrated interfaces in real time. Various interfaces for PLC, PLC simulators and field devices are available.

SimulationX Editions

- **Professional Edition**
  ... for design, modeling and analysis
  Full version (unrestricted functionality for all acquired SimulationX modules)

- **Analyzer Edition**
  ... for analysis and post processing
  Allows parameter studies, simulations, and post processing (for completed models this edition provides all simulation and analysis tools)

- **Viewer Edition**
  ... for presentation and demonstration
  Allows demonstrations to customers or prospects (models can be simulated, but not altered)

- **Student Edition**
  ... for education and teaching
  Version with reduced model object set and functionality (commercial usage is not permitted)

- **Evaluation Version**
  ... for evaluation and test
  Full, time-limited version (unrestricted functionality for all acquired SimulationX modules)

SimulationX Analysis Tools

- **Transient Simulation**
  Computation of linear and nonlinear models in the time domain

- **Steady State Simulation**
  Computation of models in the periodic steady state condition (nonlinear and linear) in dependence of a reference value

- **Equilibrium Calculation** (static/steady state)
  Simulation of models starting from an equilibrium state

- **Linear System Analysis**
  - Natural frequencies and Mode Shapes
    Damped and undamped natural frequencies of the complete system, time constants, eigenvectors, oscillations of all state variables at the particular eigenfrequencies
  - Input-Output-Analysis
    Linearization in the current operating point, analysis, export of the state-space matrices (ABCD or ABCDE)
SimulationX Libraries, Options, and Interfaces

Library Animation Bodies
- **Animation Bodies:** Bodies for visualization of results

Libraries Signal Blocks
- **General Signal Blocks:** Signal connection, functions, summing junction (in basic module included)
- **Signal Sources:** Signal and impulse generators (in time and frequency domain), characteristic curves, curve sets, characteristic maps (3D, 4D), noise sources
- **Linear Signal Blocks:** P-, I-, and D-, as well as combined blocks, transfer functions
- **Nonlinear Signal Blocks:** Two- and three-point functions, limiters, deadband, hysteresis
- **Time-Discrete Signal Blocks:** Integrators, differentiator, converters, filters, transfer function
- **Special Signal Blocks:** Counter, integral y over x, resettable integrator, ramp generator, flip flops
- **Switches:** pass switches, distributor switches, changeover switches, crossover switches

Libraries Mechanics
- **Mechanics 1D (rotary):** Inertia, external torque, spring, damper, spring-damper-backlash, preset, constraint, transmission, planetary transmission, rigid friction, elastic friction, rotational-linear transformer, sensor and end stop
- **Mechanics 1D (linear):** Mass, external force, spring, damper, spring-damper-backlash, preset, constraint, lever, plane transformer, rigid friction, elastic friction, sensor and end stop
- **MBS Mechanics (3D):** Rigid Bodies, joints, constraints, force elements, sensors, animation bodies, CAD import via STL, beam element (option), contact element (option), cameras
- **CAD Import for Autodesk Inventor®**
- **Modal System:** Modal system incl. ANSYS interface

Libraries Power Transmission (mech.)
- **Motors and Engines:** Asynchronous induction motor, combustion engine, servo motor
- **Couplings and Clutches:** Disc clutch, elastic coupling, fluid coupling, friction clutch, dog clutch, dual-mass flywheel,
- **Transmission Components:** Bevel gear, worm gear, Ball screw drive, belt drive, crank mechanism, differential gearbox, planetary gearbox, cardan shaft, wheel ground contact, torque converter, tooth contact
- **Planetary Gears:** Base structures for spur gear wheels
- **Actuating Elements:** Gear selection
- **Combustion Engines I:** Cylinder structures, cylinder and motor models
- **Combustion Engines II:** All elements of Combustion Engines I, additional elements with VIBE combustion function, EDC (Electronic diesel control)
- **Synchronizers with friction and tooth contact:** Dog clutch, Borg-Warner synchronizer (simple and duplex)
- **Drive Accessory:** Incl. element mount and shaft segment

Libraries Power Transmission MBS
- **Wheels and Tires:** Tire plane contact (Prerequisite: MBS Mechanics)

Libraries Electrical Engineering and Electronics
- **Electronics (Analog):** Resistors, capacitances, coils, transformers, bipolar and field effect transistors, diodes
- **Magnetics:** Eddy currents, ground, electromagnetic transformer, iron elements, air
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- Electric Motors
  - Asynchronous, synchronous, and DC motors
  - Continuous Space Vector Modulation, Ideal Unswitched Three-Phase Inverter, Field-Oriented Torque Control of Synchronous and Asynchronous Motors

- Stepping Motors
  - 3 and 5 phase motors with controllers

- Converters
  - Prerequisite: Electronics (Analog) and Mechanics 1D (linear)

Libraries Fluid Power and Thermodynamics
- Hydraulics I (Base Package for Plant Modeling)
  - Pressure source, tank, volume, differential cylinder, throttle, valves

- Hydraulics II (Standard Package for Plant Modeling)
  - Pressure sources, tanks, valves, pressure gauges, temperature sensors

- Hydraulics III (Complete Package for Plant and Component Modeling)
  - Pressure source, tank, volume, differential cylinder, throttle, valves

- Hydraulics Lines
  - Pressure source, tank, volume, differential cylinder, throttle, valves

- FluidDesigner Hydraulics
  - tool for definition of new fluids and mixtures

- Subsea Hydraulics
  - Subsea Accumulator

- Pneumatics I (Gases)
  - Pressure sources, volumes, exhaust, cylinder, throttle, valves, pipes, pressure and temperature sensors

- Pneumatics II (Gases & Mixtures)
  - as Pneumatics I (but also for gas mixtures)

- FluidDesigner Pneumatics/gases
  - as FluidDesigner Hydraulics

- FluidDesigner Pneumatics/mixtures
  - as FluidDesigner Hydraulics

- Thermics
  - heat conduction, convection, and radiation, heat flow, heat capacity, heat and temperature sources

- Thermal-Fluid I (single phase: liquids and gases)
  - Flow source, volume, sensors, throttles, flow inertia, piston surface, transformers, heat exchanger, evaporator, condenser

- Thermal-Fluid IIA (two-phase: coolants, refrigerants, NIST)
  - as Thermal-Fluid I + Two phase heat exchanger, liquid-gas interface, phase separation tank

- Thermal-Fluid IIB (two-phase: water, wet air)
  - as Thermal-Fluid IIA (for water and wet air)

- Thermal-Fluid III (gas mixtures)
  - as Thermal-Fluid I (for gas mixtures)

- Thermal-Fluid Lines
  - TJunction 90°, transition, bend, elbow, orifice, phase splitter

Options
- Variant Wizard
  - Execution of parameter variation studies

- Order Analysis
  - Frequency analysis of power transmission systems

- Statechart Designer
  - Modeling and simulate time-discrete and state-discrete control algorithms inside SimulationX in the TypeDesigner as a special kind of behavior description.

Interfaces
- Optimization Tool (OptiY, iSight, modelFRONTIER)
  - Search for best-fitting parameters for a model according to a user-defined cost function (software which can be acquired separately)

- Database Link
  - Parameterization of components from existing databases (OLEDB data sources)
SafetyDesigner (FMEA Interface) — A new developed interface for the analysis of modeling errors and their influences.

COM Interface — Access to parameters and results and controlling of the simulation, as well as communication with the MS-Office world.
   (in basic module included)

PrintEngine — Preparation of the print output of models.
   (in basic module included)

Code Export
- Code Export (without solver) — export C-code without solver
- Executable Model — export C-code with solver
- Export S-function (ML/SL)
- Option Export SIMPACK®
- Option Export ScaleRT
- Option External Modell — export as DLL (User DLL)
- Option Saturius
- Option dSPACE DS1006

Co-Simulation
- Co-Simulation Interface (Sockets) — The base functionality for linking SimulationX to other simulators and CAE tools (required for *)
  - with MSC.ADAMS® *
  - with SIMPACK® *
  - with MSC.visualNastran® *
  - with MATLAB®/Simulink® *

Virtual Machines
- Co-Simulation with S7-PLCSim — Connection to SIEMENS PLC simulator S7-PLCSim
- OPC client to synchron interface — SimulationX acts as OPC client and enables connectivity to all OPC servers.
- NI 24V Interface — Direct connection to control and field devices.

AddOn's
- ITI EdgeDesigner — CAE Tool for automated determination geometrical and flow technically relevant parameters from geometry data with the development of fluid, primarily hydraulic valves.

For performing your “first steps” in SimulationX ITI developed a collection of tutorials, which guide you through the tool and its capabilities (available on the SimulationX CD or for download at: http://www.iti.de/simulation/simx_tutorials_e.htm)
SimulationX Tutorials

Getting Started

Fluid Power
... Hydraulic cylinder drive with position control

Automotive

Thermal Fluid

Multi body Mechanics

Virtual Machine

External Model Interface (DLL)

- Model assembly for a simple example, parameterization, simulation and result display and analysis
- Modeling of a cylinder drive, which is controlled by a proportional directional control valve: step by step from an open-loop to an closed system with cylinder position feedback
- Modeling of a vehicle powertrain system with varying complexity:
  - simple engine model
  - complete powertrain model
  - model for observation of NVH phenomena
- Modeling of a simple two phase heat exchanger:
  - simple model for demonstration of physical system behavior
  - extended model for some tests
- Modeling a simple robot with MBS structure and integration of 1D kinematic drives
- Controlling of Virtual Machines with external PLC’s; demonstration of the different controllers
- Creation and Using of External Models (DLL)

Please ask for your individual SimulationX Evaluation Version (Test Version) by sending an email to info@iti.de. You will receive a CD-ROM with the software, online help, and the manuals as PDF or use the download http://www.iti.de (program and Online-Help).