

Mathematical modelling and simulation with MapleSim

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Abstract

There is introduced the new product of Maplesoft called MapleSim. This product will address many problems that engineers are struggling with when using traditional mathematical modelling and simulation tools.

The MapleSim approach treats components as mathematical functions that have to be broken down into basic math elements and entered into a block diagram that looks nothing like the original representation (in this case, an electric circuit). This approach is often called causal: “a block responds to signals coming into it and sends out signals as a result”. Most physical system representations, however, are typically acausal: “blocks and lines represent components that have some relationship through some connection (usually a line)”.

To address these problems, Maplesoft is developing MapleSim: a high-performance, multi-domain modelling and simulation tool that use the power of Maple to automatically generate the model equations from an acausal model representation that looks more like the real engineering system representation.

By using extensive math solvers and simplification technologies, MapleSim will be able to produce highly concise models for efficient numeric computation. This will deliver much faster simulations than can be produced with traditional simulation software that needs to run a numeric iteration at each time step. MapleSim simulations will run faster because the equations for the overall model are generated once and then solved using a very efficient numeric DAE solver.

Maple technology automatically performs the following modeling tasks:

- Elimination of redundant equations and algebraic loops.
- Separate independent systems.
- Large-scale Symbolic Simplification.
- Efficient management of large equations.
- Hybrid Numeric-Symbolic Algorithms.
- Advanced High-Index DAE Solving.

The core underlying technology lies in Maple’s symbolic computation. Physical system representations such electric circuits and free body diagrams are automatically converted to mathematical expressions, just like an engineer would do manually. Maple’s technology performs many tasks to ultimately deliver highly efficient numeric models. With Maple’s built-in automatic code generation you produce simulations that are capable of running in real time. The above properties of Maple technology enable to integrate this technology with MapleSim is fully integrated with Maple so users can switch between the two environments, depending on the task they need to perform. Users can use MapleSim to define and simulate the model, and then use Maple to visualize and validate the mathematical representation. Since the model in this form is fully parameterized, you can use it to perform detailed analysis of the system such as optimization, sensitivity analysis, validation, linearization and

simplification, and approximations.

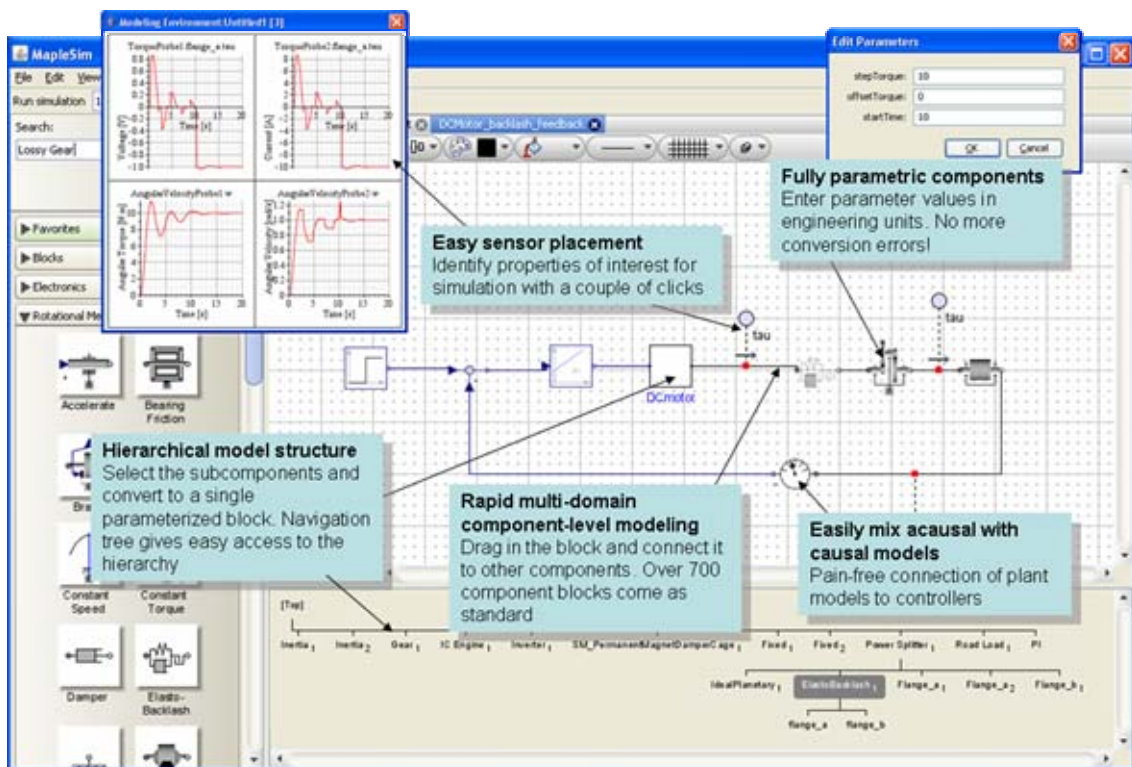


Figure 1: MapleSim GUI environment

Finally, users can use the Maple interface to fully document their work and attach it to the model for future reuse. NB: stress knowledge capture, reuse, etc. – the technical document interface is one of the key competitive advantages of using Maple and MapleSim system. MapleSim key features will be, see Fig. 1:

- *Click, drag, collapse, expand and connect* operations that support hierarchical top-down and bottom-up development to maximize productivity.
- Seamlessly mix mechanical with, for example, electrical, thermal, hydraulic and chemical components in one environment.
- Provides both *causal* and *acausal* modelling as well as math and code entry in a combined single environment to reduce your software costs.
- Unique symbolic technology delivers system equations for efficient numeric computation and advanced analysis.
- “As-fast-as-possible” one-shot execution and real-time simulation for interactive use.
- Support for Modelica libraries, and includes tools for creating your own component blocks.
- Remove conversion errors.
- Export to real-time platforms for HIL testing applications.
- Attach live design documents to your system models to minimize rework.

References

- <http://www.maplesoft.com>
- <http://www.maplesoft.cz>