MapleSim™ 2

High-Performance Multi-Domain Modeling and Simulation

Next-Generation Modeling and Simulation Tools for Stability Control Development

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Product Director

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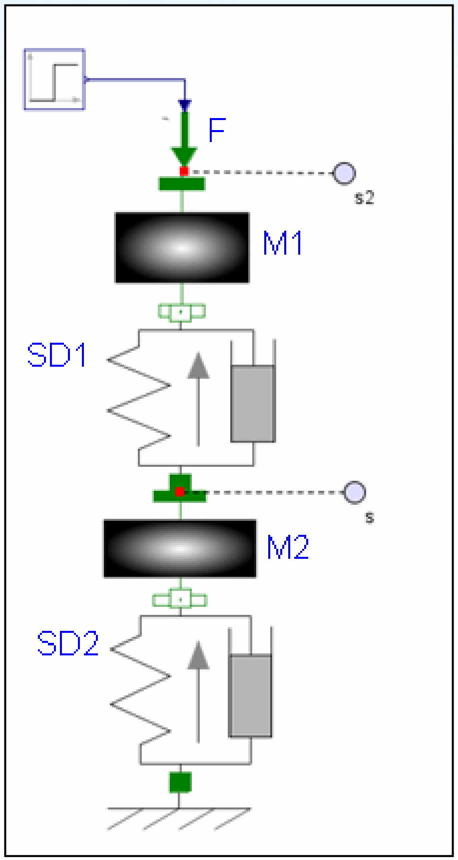
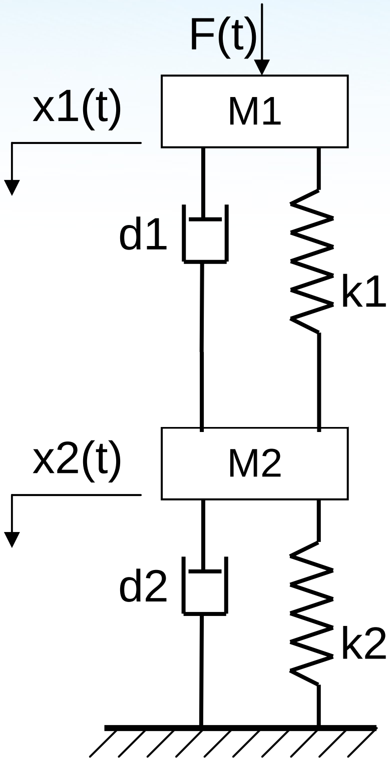
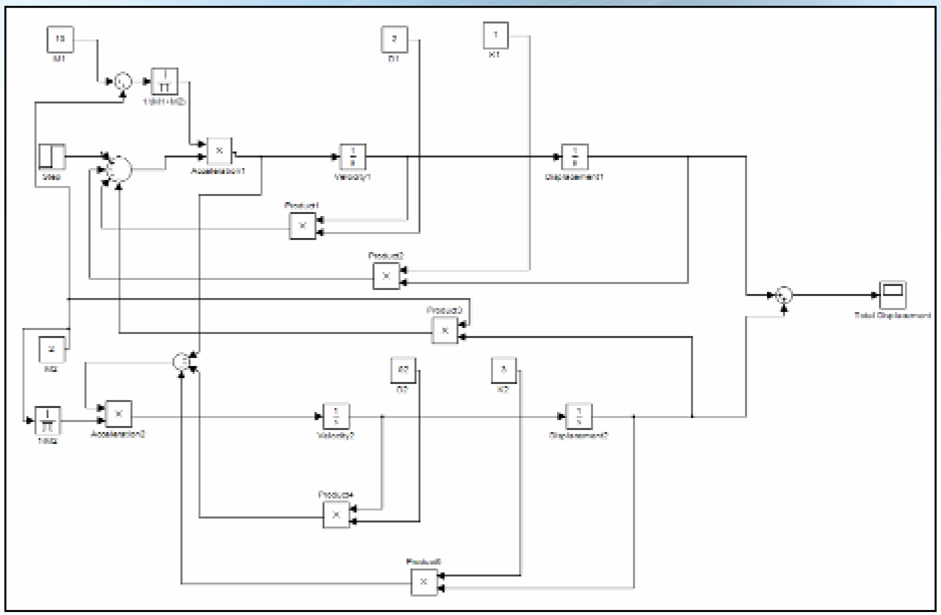
Physical Modeling – The Next Generation





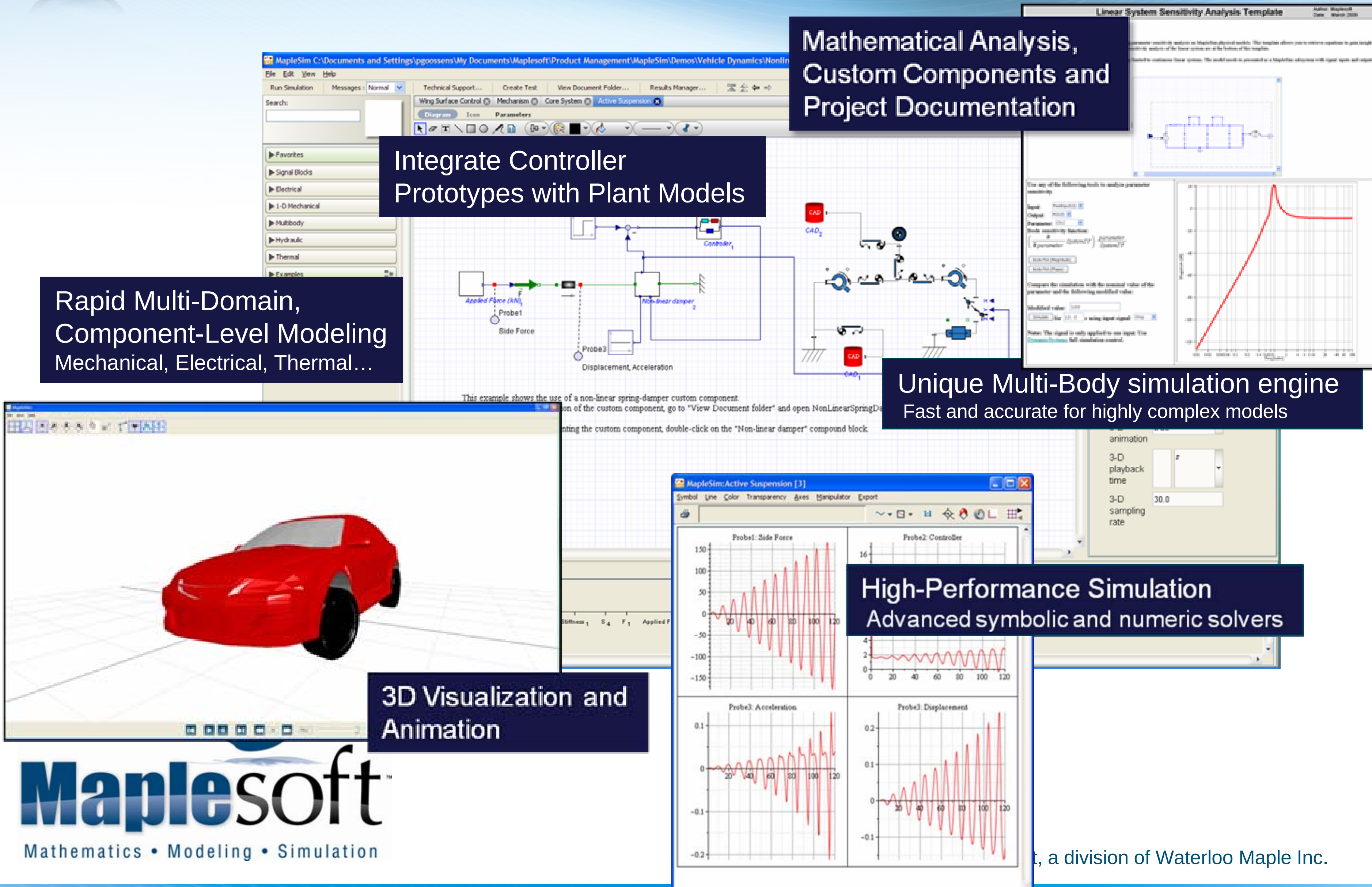
Double mass spring-damper system



Model maps directly to physical components of system

Automatically generates equations of motion

Introducing MapleSim 2



Mathematical Analysis, Custom Components and Project Documentation

Integrate Controller Prototypes with Plant Models

Rapid Multi-Domain, Component-Level Modeling
Mechanical, Electrical, Thermal…

Unique Multi-Body simulation engine
Fast and accurate for highly complex models

High-Performance Simulation
Advanced symbolic and numeric solvers

3D Visualization and Animation

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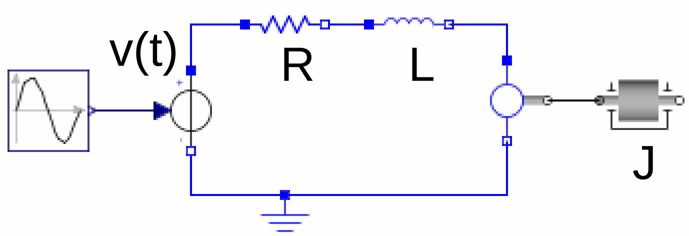
Faster model creation cuts project time and cost

- Model diagrams map directly to physical system
- System equations are generated automatically



$$L\left(\frac{d}{dt}\,i(t)\right) + R\,i(t) = v(t) - K\left(\frac{d}{dt}\,\theta(t)\right)$$

$$J\left(\frac{d^2}{dt^2}\,\theta(t)\right) + b\left(\frac{d}{dt}\,\theta(t)\right) = K\,i(t)$$

- Rapid, error-free model formulation
- Concise and numerically efficient
- Parametric math model

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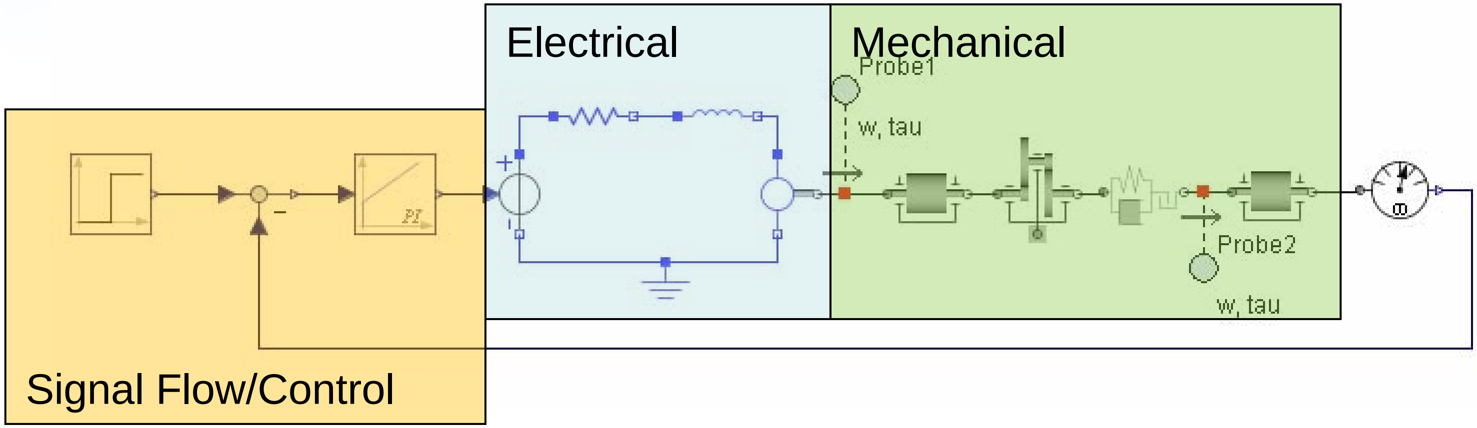
Faster model creation cuts project time and cost

- Model diagrams map directly to physical system
- System equations are generated automatically
- Natural multi-domain modeling



- Easily connect mechanical with electrical, hydraulics, thermal systems
- Mix traditional signal-flow blocks with physical components
- Design Controller and Physical Model in one environment

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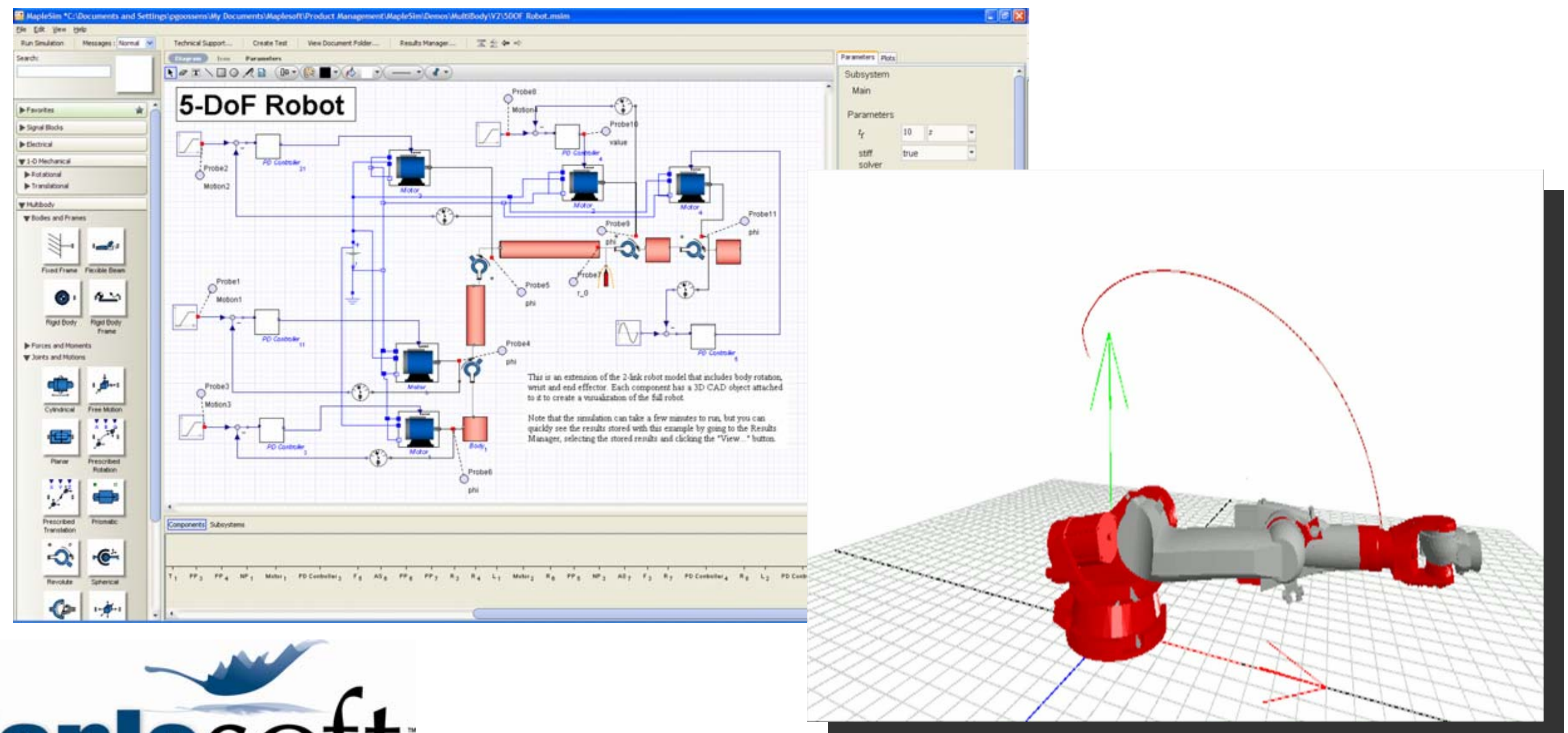
Faster model creation cuts project time and cost

- Model diagrams map directly to physical system
- System equations are generated automatically
- Natural multi-domain modeling
- **3D Visualizer** gives immediate insight into behavior of your model



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Equation generation and simplification of complex models speeds up simulations

- Multiple stages of model optimization
  - Symbolic preprocessing gives optimal formulation
  - Built-in compilation speeds up numeric computation
  - Model caching delivers high-speed simulation for multiple runs

Example: 2,300 equations simplified to 150

Speedup: 10 x

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Equation generation and simplification of complex models speeds up simulations

- Multiple stages of model optimization
    - Symbolic preprocessing gives optimal formulation
    - Built-in compilation speeds up numeric computation
    - Model caching delivers high-speed simulation for multiple runs
- Unique technology gives highly efficient models for multi-body mechanical systems
- Optimized generated code for export to real-time and other applications
    - Very efficient, simplified code runs 10 – 100x faster for complex models

Simulation cycle time = 10ms	SimMechanics (μs)	MapleSim> S-Function> Simulink (μs)	Speed advantage
Double Pendulum	137	14	9.9x
Four Bar Linkage	288	70	4.1x
Stewart Platform	710	74	9.6x

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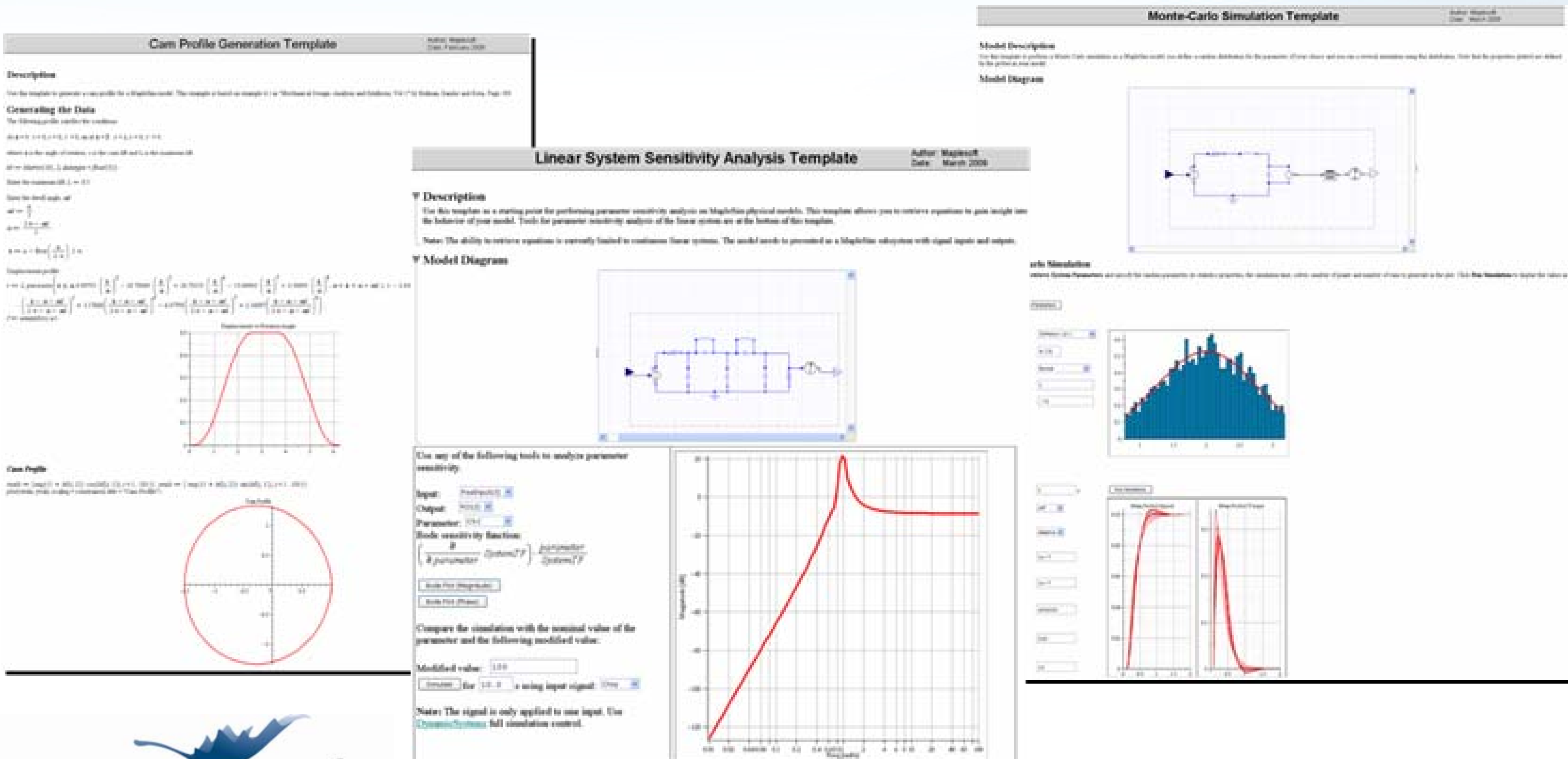
Powerful tools for model design and analysis reduce development time

- Dynamic analysis, control design and optimization tools
- Easy creation of custom components



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MapleSim™ 2

High-Performance Multi-Domain Modeling and Simulation

Demonstration

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Real-time Simulation

Motivation: Real-time simulation and control of engineering models of arbitrary topology

- **Real-time simulation**
  MapleSim is built on top of Maple's symbolic engine. All models are generated symbolically, yielding efficient simulation code.

- **Arbitrary topology**
  MapleSim is a general systems modeling tool. The user is not restricted to predefined topologies when generating simulation code.

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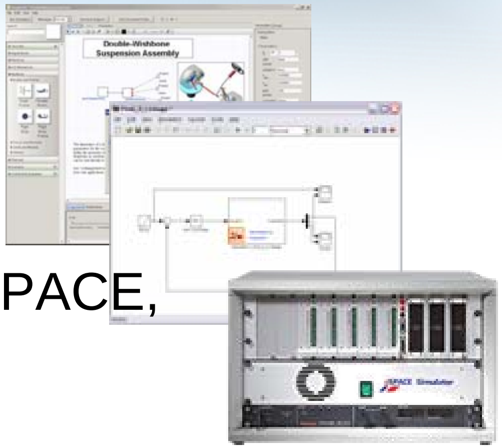
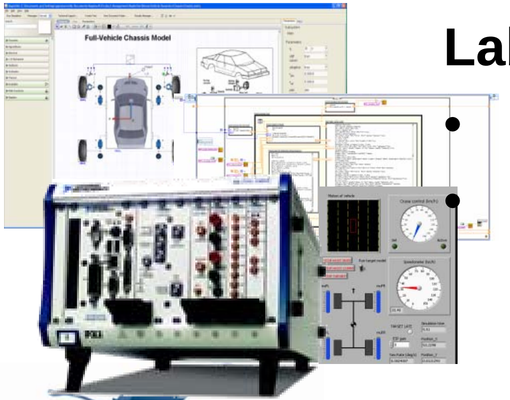
MapleSim Connectivity Toolbox

Rapid deployment of MapleSim models into your simulation and HIL tool chain



Simulink: C-based S-Functions

- Compatible with Real-Time Workshop
- High-fidelity, high-performance models for dSPACE, xPC Target, ETAS LabCar, RT-LAB etc…



LabVIEW: C code VI for Simulation Module

- Compatible with LabVIEW/RT
- High-fidelity, high-performance models for all hardware platforms from National Instruments: PXI, FPGA…

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Example: MapleSim/LabVIEW HIL Demo

Host PC with…

- MapleSim
- Full-chassis model
- Connectivity Toolbox
- LabVIEW
- Simulation Module

Control Output Display

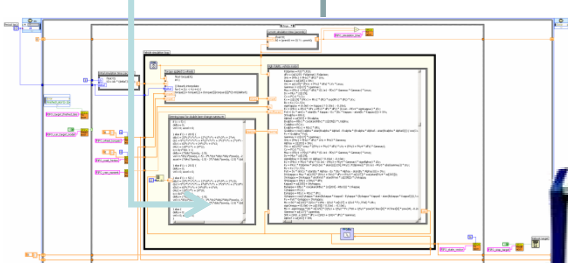
PXI Chassis

- LabVIEW/RT

Controller Module

Digital Out

CAN bus Interface



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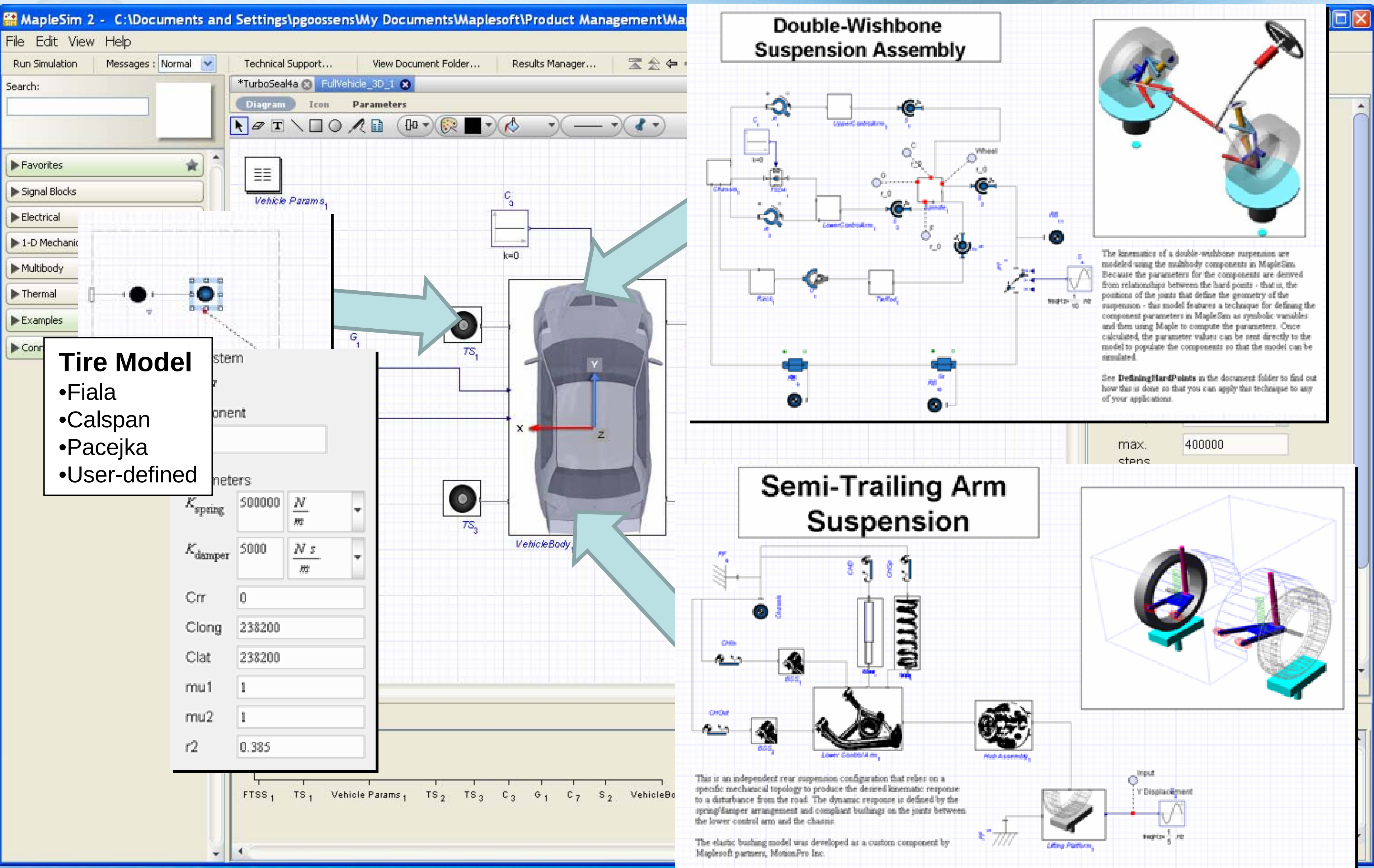
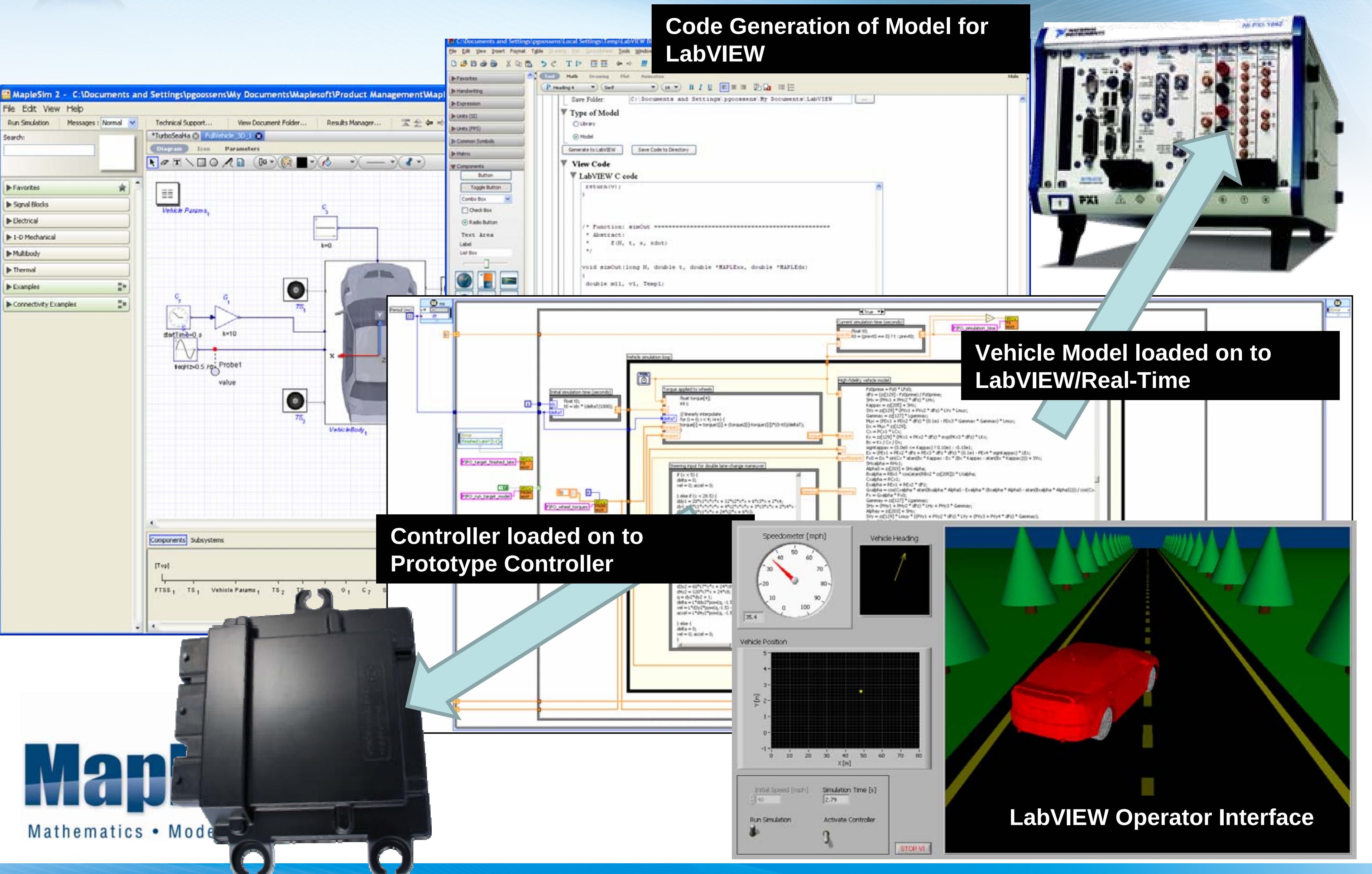
Vehicle Model



Model Code Generation to LabVIEW



Without Stability Controller

With Stability Controller

High-Performance Multi-Domain Modeling and Simulation

- Faster plant model creation cuts project time and cost
- Equation generation and simplification of complex models speeds up simulations
- Powerful tools for model analysis and control design reduce development time

Shorten the product development cycle

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High-Performance Multi-Domain Modeling and Simulation

Questions?