Maplesoft

Engineering Solutions

Maplesoft Engineering Solutions


Maplesoft Engineering Solutions provide you with the expertise and tools you need to meet your project requirements quickly and effectively. Offering experts in a variety of engineering fields, extensive experience in model-based design, and the superior system-level modeling and analysis tools MapleSim™ and Maple™, Maplesoft can help you reduce development risk and bring high-quality products to market faster.

Product design validation and optimization
- Multidomain model development
- Physics-based system-level simulations
- Advanced analysis and optimization

Optimized model code for in-the-loop simulations
- Lossless model simplification
- Code optimization
- Model reduction with maximal fidelity
- Model generation for a large variety of target platforms

Analysis and design calculation tools
- Powerful analysis capabilities
- Intuitive interfaces
- Meaningful presentation of results, including visualizations
- Multiple deployment options

Model predictive control
- Lossless model simplification
- Lossless order reduction of DAEs
- Model reduction specifically for model predictive control applications

Products
Develop system-level models with MapleSim and Maple, and dramatically reduce model development time, gain greater insight into system behavior, and produce fast, high-fidelity simulations.

Services
With expertise in a variety of engineering fields and extensive experience in model-based design, Maplesoft experts are available to help you solve your engineering design problems.
Past Projects and Applications

Maplesoft specializes in the modeling, simulation, and optimization of complex multidomain systems. Maplesoft Engineering Solutions have been applied to a variety of domains, such as electric and hybrid-electric vehicles, ground transportation, space systems, batteries, mining, manufacturing, and much more.

Past projects include:
- Robotic arm for drilling in mines
- Motion platform for driving simulators
- Torsional vibration analysis tool for marine drivelines
- Batteries for hybrid-electric vehicles
- Batteries for consumer electronics
- Package manufacturing machine
- Electric vehicle powertrain
- Radar gimbal actuation
- Dialysis machines
- Electromechanical personal care products
- Test platform for planetary exploration rover

Why Choose Maplesoft?

When it comes to engineering, Maplesoft tools and services have a key advantage: Maplesoft's advanced symbolic computation engine. This engine has evolved over a period of 30 years and is now considered to have the most advanced math functionality in the world. All Maplesoft tools, including MapleSim and Maple, are built on this symbolic foundation, and the experts at Maplesoft have years of experience applying this technology to engineering problems.

So why does this matter?
- For the calculations that lie at the heart of virtually every engineering project, symbolic computation allows you to obtain highly accurate results, eliminates the need to simplify problems by hand, and provides insight into your problem structure from which you can develop conjectures and conclusions about the behavior.
- By using symbolic parameters in your problem, you can defer numeric calculations until they are needed. The parameters are then carried through each stage in your analysis, making it easy to do parameter sweeps, optimize values, and study the behavior of the system.
- For modeling and simulation, symbolic computation is one of the defining technologies of next-generation modeling techniques. It provides the flexibility to develop models quickly, offers unparalleled opportunities for analysis and optimization of designs, and produces extremely fast simulation code without sacrificing fidelity.

By leveraging the power of symbolic technology when it comes to engineering design, Maplesoft Engineering Solutions give you the ability to reduce development risk, create better products, and bring those products to market faster.
Facing a tough technical problem and don’t have the skills in-house to solve it?

Are your engineers already overloaded, but the project still needs to get done?

Do you want the benefits of virtual prototyping, but aren’t sure where to start?

Need to reconcile conflicting requirements by analyzing and optimizing your design at the system level?

When you are looking for more than just great products, Maplesoft experts are available to help you solve your engineering design problems.

**Product Design Validation and Optimization**

Using high-fidelity system-level modeling and simulation, the Engineering Solutions team can help you determine how your design will behave by creating a “virtual” prototype of your system. In this way, it is possible to validate your design against specifications and correct any flaws long before investing in a physical prototype, saving significant time and money.

Maplesoft experts can also help you investigate ways to further improve your design. Because our tools provide access to the underlying equations that represent the physical behavior of your design, we can develop customized parametric analysis tools even for complex, multidomain systems. These tools will give your engineers significant insight into the effect of parameter changes on the overall system, enabling them to optimize their design. We can also perform automated parameter sweeps, Monte Carlo analysis, sensitivity studies, design of experiments, and multi-objective optimization, so that you can improve your products and feel confident in your design choices.

**Optimized Model Code for In-the-Loop Testing**

Whether you are working on hardware-, software- or operator-in-the-loop applications, it is critical that your system models run on a real-time platform within the simulation time step. The symbolic model formulation and optimized code generation techniques used by the Engineering Solutions team guarantees you the fastest possible execution time for your model. However, with large systems, even the fastest possible time may not be fast enough. When that happens, our team has extensive experience in rigorous model reduction and code optimization techniques that maximize fidelity within the constraints of working on a real-time platform.
Analysis and Design Calculation Tools
Many projects require the creation of specialized analysis and calculation tools to support informed decision making, such as tools for vibration analysis and attenuation, thermal analysis, and component sizing, among many others. The Engineering Solutions team can develop powerful analytical tools to provide your team with the answers they will need for years to come. Depending on your needs, these tools can be specialized applications intended for use by experts or easy Depending on your needs, these tools can be specialized applications intended for use by experts or easy-to-use turnkey solutions suitable for wider deployment throughout your organization.

Model Predictive Control
Model predictive control is an advanced technique used to represent the behavior of complex systems. However, this very complexity is what makes it challenging to create a model of the system that is of sufficient fidelity to accurately reflect the behavior but still efficient enough to run within stringent time and size constraints of the controller code. The symbolic model formulation and optimized code generation techniques used by the Engineering Solutions team guarantee you the fastest possible execution time for your model. When that isn't fast enough, our team has extensive experience in rigorous model reduction and simplification techniques that maximize fidelity while staying within the constraints of the controller.

Training
There is no substitute for your engineers spending time with a seasoned expert in the use of any software tool to maximize productivity, competence, and confidence in the tool. If you choose to purchase Maplesoft products for use by your own engineers, we have training to help them become productive quickly. We offer standard 3-day courses for MapleSim and Maple that can be customized to suit your specific needs, and other topics can be arranged.
MapleSim™

The modern approach to physical modeling

MapleSim is an advanced physical modeling and simulation tool that applies modern techniques to dramatically reduce model development time, provide greater insight into system behavior, and produce fast, high-fidelity simulations.

Reduce Development Time

- Easily construct and validate models using a model diagram that closely resembles the system diagram.
- Create multidomain system-level models by seamlessly combining components from different domains into a single model.
- Take advantage of revolutionary multibody technology that gives you unparalleled flexibility and control of your multibody models, making complex multibody models easier to develop and analyze.
- Create custom components easily, without programming, simply by specifying their representative equations.
- Customize and expand MapleSim’s modeling capabilities through the open standard Modelica® modeling language. Modify existing component definitions, create new components using the Modelica language, and leverage the growing collection of industry-tested Modelica components in your own projects.

Develop Better Designs

- Take advantage of an extensive library of built-in analysis tools for sensitivity analysis, Monte Carlo simulation, optimization, and more.
- Leverage automatically generated model equations in full parametric form for open access to your models for advanced applications and analysis.
- Perform complicated operations at the click of a button or with a single command, including symbolic differentiation, symbolic integration, order reduction, variable isolation, and analytical solving of sets of equations.
- Easily script custom analyses using a powerful programming language designed for working with mathematical concepts.
- Access the underlying equations or Modelica code for components for deeper insight into the behavior, and modify them if desired.
- Capture all your project information into a single project file, including models, simulation results, analyses, and reports, combining your reasoning with your results and fully capturing the engineering knowledge that goes into each project.

Get Extremely Fast Simulation Code

- Achieve a computationally simpler set of system equations without loss of fidelity through symbolic simplification, including DAE index reduction, removing redundant operations, and eliminating algebraic loops.
- Dramatically speed up execution times with symbolic optimizations of generated code.
- Take advantage of automatically generated simulation code that is always royalty-free.
- Easily integrate code into popular real-time toolchains and other applications, including Simulink®.
The Essential Tool for Mathematics and Modeling

Mathematics plays a critical role in our modern world, which is why mathematicians, engineers, and scientists everywhere rely on Maple software. Maple helps you analyze, explore, visualize, and solve mathematical problems quickly, easily, and accurately. With over 5000 functions covering virtually every area of mathematics, Maple has the depth, breadth, and performance to meet all your mathematical challenges.

Most Powerful Math Engine

Whether you need to do quick calculations, develop design sheets, or produce sophisticated high-fidelity simulation models, the world-leading Maple computation engine provides the necessary technology to dramatically increase your analytical productivity.

- Over 5000 functions covering virtually every area of mathematics, including calculus, algebra, differential equations, statistics, linear algebra, geometry, and transforms
- Symbolic, numeric, and hybrid computation algorithms
- World-leading algorithms for solving problems that are beyond the reach of any other software system
- Efficient algorithms and tools for high performance computing and large-scale problem solving

Smart Document Interface

Maple’s intuitive interface supports multiple styles of interaction, from interactive tools to a sophisticated programming language. Using the smart document environment provided by Maple, you can automatically capture all of your technical knowledge in an electronic form that combines calculations, explanatory text and math, graphics, images, sound, and diagrams.

- Easy-to-use math equation editor, interactive assistants, task templates, and self-documenting context-sensitive menus
- Sophisticated programming language
- 2-D and 3-D plotting and animation, with extensive annotation tools
- Extensive document creation and word-processing tools

Extensive Connectivity

Extensive connectivity features ensure Maple can be integrated seamlessly into your toolchain. Maple connects to standard engineering tools and custom solutions in a variety of ways.

- Code generation (C, C#, Fortran, Visual Basic®, Java®, MATLAB®)
- Connectivity to Excel®, MATLAB, MapleSim, Java, Fortran, CAD systems, C, databases, web sites, and more
- Extensive import and export capabilities for data, documents, math, and plots
- Web deployment through MapleNet™ and the free Maple Player™
Customer Stories

**High-speed robot, DeltaBot™, designed with the help of Maplesoft Engineering Solutions**

AEMK Systems is a company specializing in the design and distribution of high-speed, cable and vision-based robotics systems for use in a variety of industrial applications. The AEMK DeltaBot robots use cables instead of rigid arms to reduce moving inertia and mechanical equipment costs. The simple design and scalability of the DeltaBot means that it can easily integrate into existing automation environments. The DeltaBot is capable of over 120 pick-and-place cycles per minute. One of the distinctive features of the DeltaBot over other delta robots is its high payload capacity. While other delta robots are limited to payloads under 3 kg, the DeltaBot is capable of handling up to 20 kg. Its high speed, low maintenance costs, and high payload capacity make it a very attractive industry alternative in many automation applications.

Dr. Amir Khajepour, founder of AEMK, chose Maplesoft Engineering Solutions to develop key elements of the initial design, and continues to leverage Maple, MapleSim, and the experts at Maplesoft to make further improvements. “Maplesoft technology was an integral part of the design process of the DeltaBot system, and is now an integral part of the robot’s ongoing development,” says Dr. Khajepour. “With the use of Maplesoft technology, the initial development time for the robot was significantly reduced, and we continue to benefit from shorter development cycles as we make enhancements to our products.”

**From Months to Days With Maplesoft Engineering Solutions**

<table>
<thead>
<tr>
<th>Project</th>
<th>Time Reduction</th>
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<tbody>
<tr>
<td>Power-Split Hybrid Electric Vehicle</td>
<td>3 months to <strong>15 days</strong></td>
</tr>
<tr>
<td>Planetary Rover</td>
<td>3 months to <strong>10 days</strong></td>
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A complex, multidomain model that covers all aspects of a hybrid electric vehicle, including a mean value internal combustion engine.

A complex multidomain model that simulates planetary rover motion, wheel/soil interaction, energy consumption, and more.
Maple and MapleNet Streamline the Development of Solar Panel Foil Systems

As a technology consultant, Dr. Peter Waegli works with a wide range of companies to bring the latest and most efficient technology to his clients. His firm, Dr. P. Waegli-Research, provides technology-based strategies and solutions to clients.

Dr. Waegli recently advocated the use of Maple in a project related to solar panels. Solar panels are composed of a collection of connected photovoltaic cells, and the type of cell interconnection technology affects the performance of the solar panel. Eppstein Technologies, a subsidiary of EppsteinFOILS, is a developer of innovative foil systems for interconnecting and encapsulating photovoltaic cells. In a recent project with Eppstein Technologies, Dr. Waegli used Maple and MapleNet to help the company streamline the development process of their foil systems.

A simulation model for a module tester, which illuminates the test modules to measure their power conversion performance, was built in Maple. This model simulates the light distribution and intensity for various arrangements and specifications of the LED-sources. These results were then used to optimize LED positions, properties of the LEDs, and the collimation optics and distance of the LED assembly from the measuring plane. Based on the results of this optimization during the modeling phase, the tester light source was built and performed correctly on the very first try. Maple was then used to create simulation models of the modules. With virtual models of both the modules and the test platform, the company was able to optimize their designs early in the process, reducing the number of expensive physical prototypes they need to create and test.

The model and the results were fully described in interactive Maple documents and shared using MapleNet. As a result, every design engineer on the project has access to the information and can run simulations with their own parameters online.
Customer Stories

NASA’s Jet Propulsion Laboratory begins widespread adoption of Maplesoft technology

NASA’s Jet Propulsion Laboratory (JPL) is implementing Maple, MapleSim, and MapleNet in its various projects. Whether creating America’s first satellite, Explorer 1, sending the first robotic craft to the moon, or exploring the edges of the solar system, JPL has been at the forefront of pushing the limits of exploration. Curiosity, JPL’s latest space rover, aims to explore Mars to investigate whether the planet could have ever supported microbial life. Other JPL projects include spacecraft missions to comets, asteroids and the edge of the solar system, as well as satellites that monitor the land, oceans, and atmosphere of our own planet.

Maplesoft products are expected to help JPL save time and reduce cost by providing more efficient and smarter methods for mathematical analysis, modeling, and simulation. In addition to using Maple for advanced mathematical analysis, JPL will use MapleSim, Maplesoft’s high-performance physical modeling and simulation platform, as a key tool in its engineering workflow.

Game Changing Hockey Sticks with Help from MapleSim

Hockey Robotics is a company that has pioneered the concept of robotic testing for the hockey industry. It specializes in hockey stick design, performance, and durability testing using an advanced hockey stick testing robot. Hockey sticks most often break during a slap shot; therefore the company’s goal was to produce a robot capable of properly mimicking the professional hockey slap shot. The Hockey Robotics team, with support from Maplesoft Engineering Solutions experts and industry partnerships, manufactured the SlapShot XT, a dynamic hockey stick robot capable of delivering a slap shot at speeds up to 110 mph. Hockey stick manufacturers are now using the robot to test their designs in a highly repeatable and controlled manner, providing evaluation data never before available.

MapleSim played a critical role in the design and development of the SlapShot XT. It allowed Hockey Robotics to efficiently and accurately simulate the coupled dynamic electrical and mechanical behavior of the equipment. MapleSim enabled the concurrent study of the flexible body deformation and rigid body motion of the machines, which is a very difficult, time-consuming, and error-prone task when done by hand. It also allowed them to quickly prototype the designs and investigate the coupled motion of the mechanisms very easily.

The result was definitive: The robot provides repeatable, unbiased test data on the performance and durability of hockey sticks, a first in the industry.

“MapleSim is the engine driving our development,” said Dr. John McPhee, Chief Scientist at Hockey Robotics. “It has been crucial in our development and testing, resulting in tremendous savings in design and prototyping. In addition, MapleSim allows us to perform engineering analysis that was previously too challenging and computationally intensive for our industry to undertake.”
Selected Customers

Talk to a Maplesoft Engineering Solutions expert to learn how we can help you with your design projects.

www.maplesoft.com