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Software development

COMSOL

COMSOL chooses Parasolid and D-Cubed to enhance multiphysics simulation

Product

PLM Components

Business challenges

Assure error-free access to geometric models designed in third-party applications

Deliver more efficient tools for parameter-driven design and geometry optimization

Create additional customer value while maintaining core research and development focus

Keys to success

Integrating Parasolid for flawless data exchange with other Parasolid-based applications and Parasolid Bodyshop for eradicating errors in imported data

Selecting D-Cubed 2D DCM for rapid parametric sketching and analysis-driven shape optimization

Outsourcing geometric modeling enhancements to a trusted supplier

Results

Enhanced interoperability of COMSOL Multiphysics software with customers' workflows

Extended proven parametric modeling with a more functional and efficient 2D sketcher

Accelerated development of COMSOL Multiphysics and helped grow market share

PLM Components provide integrated design capabilities and data interoperability in COMSOL Multiphysics

Digitalization is transforming the modern enterprise by harnessing virtual prototypes that represent real-world products and the machines and manufacturing plants used in their production. These digital twins enable businesses to cost-effectively optimize product design and manufacture by simulating real-world performance prior to investing in physical prototyping and production.

Many consumer and industrial goods, not to mention all the systems used in their automated production, are sophisticated combinations of mechanical, electrical and software components. Manufacturers use increasingly elaborate digital twins to

represent these complex systems holistically, enabling engineers to evaluate their component interactions prior to commissioning more expensive physical prototypes. Multiphysics simulation is an important development in computer-aided engineering (CAE) that leverages the increasing complexity of the digital twin. Product performance can be evaluated in the context of multiple physical phenomena, such as structural mechanics, fluid flow, heat transfer and electromagnetic fields. Solving the physical behavior in different domains simultaneously delivers more accurate results in less time by removing the need for preparing, consolidating and reconciling independent analyses.

Founded in 1986, COMSOL is a major provider of multiphysics simulation software. Its COMSOL Multiphysics® product is an integrated software environment for creating physics-based models and simulation

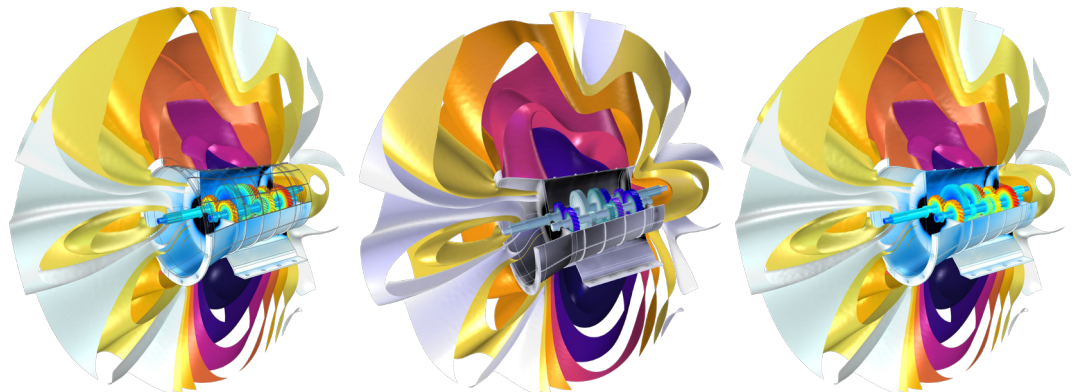


Figure 1: Multiphysics simulation in a synchro mesh gearbox.

“The fact that COMSOL software users can access Parasolid functionality in this highly integrated way is a major strength of COMSOL Multiphysics, particularly in the context of multiphysics analysis.”

Jean-Francois Hiller
VP of Business Development
COMSOL

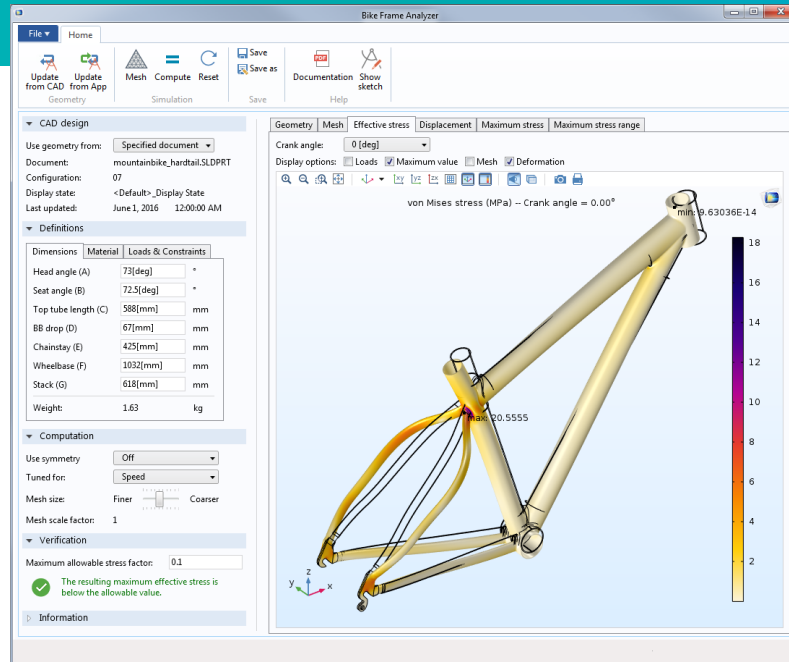


Figure 2: Seamlessly importing a Parasolid-based 3D CAD model to evaluate structural stress for varying dimensions, materials, and loading conditions.

applications for multiphysics phenomena. A consistent user interface means anyone working with structural mechanics can easily transfer their knowledge of working with the software to other application areas such as fluid flow or electromagnetics. Furthermore, simulations can be combined to assess the coupled impact of one physical behavior on another. For example, figure 1 illustrates a 5-speed synchromesh gearbox. Structural vibrations in the gearbox are modeled for a given engine speed and external load. Resultant accelerations are converted to the frequency domain and used as a noise source. A simultaneous acoustics analysis computes the sound pressure levels in the near, far, and exterior fields. By simulating and predicting the vibration and noise radiation

from a gearbox, designers gain valuable insights early in the design process.

Multiphysics simulation and the importance of interoperability

CAE applications typically facilitate the simulation of virtual products that are initially conceived in third-party computer-aided design (CAD) software. COMSOL supports this workflow by offering dedicated interfaces for leading CAD applications, in addition to a CAD import module that supports a wide range of 3D data formats.

Seeking to deliver exceptional interoperability with third party CAD models, COMSOL licensed Parasolid® software. Parasolid is a part of Xcelerator, the comprehensive and integrated portfolio from Siemens Digital Industries Software.

“Our Parasolid integration has dramatically enhanced the interoperability of COMSOL Multiphysics software with our customers’ workflows.”

Lorant Olasz
Technical Product Manager
COMSOL

More than 350 product design, manufacturing and simulation applications are based on the Parasolid geometric modeling kernel, which is part of Siemens' PLM Components product suite. As a result, more than 4 million end-users are creating 3D digital products that offer 100 percent translation-free interoperability with COMSOL Multiphysics.

To support customers working with alternative 3D file formats, COMSOL also licensed Parasolid Bodyshop, which creates high quality Parasolid models from imported data. Some 3D file formats may be less accurate compared with the high-resolution models created in Parasolid. As a result, errors may arise in the imported model; for example, gaps arising between edges. Parasolid Bodyshop includes functions for addressing these problems, such as healing gaps, repairing self-intersecting curves and surfaces and removing coincident curves.

"Many of our users are standardized on CAD software that is either based on Parasolid, or can export to the Parasolid format," says Lorant Olasz, technical product manager, COMSOL. "Our Parasolid integration has dramatically enhanced the interoperability of COMSOL Multiphysics software with our customers' workflows."

CAE model preparation and integrated design capabilities

CAE users often need an integrated design capability to prepare models for analysis or perform some conceptual design. COMSOL needed to satisfy this customer demand and implemented Parasolid geometric modeling functionality in its Design Module. Since many customers use Parasolid-based CAD applications in their early design process, choosing Parasolid meant the company could offer users a

familiar 3D modeling experience while delivering a range of benefits to customers, including:

- Making design modifications to imported 3D models for optimal analysis. For example, by removing design features that are not required in the simulation. Defeaturing accelerates the simulation by eliminating the time to mesh and analyze redundant features
- Tweaking the model with 3D modeling operations such as filleting, thickening, midplaning, lofting and chamfering to make required unanticipated modifications
- Providing users with an integrated conceptual design capability that doesn't require them to license an independent CAD application

"The fact that COMSOL software users can access Parasolid functionality in this highly integrated way is a major strength of COMSOL Multiphysics, particularly in the context of multiphysics analysis," says Jean-Francois Hiller, VP of business development, COMSOL.

Parametric 2D sketching

More recently, COMSOL decided to further enhance its integrated design capability by developing a new set of 2D sketching tools based on Siemens' geometric constraint solver, D-Cubed™ 2D DCM software. Like Parasolid, D-Cubed 2D DCM is a part of the PLM Components product suite. This technology enables the creation of parametric sketches using dimensions (distance, angle, curve length, etc.) and constraints (parallel, tangent, symmetric, etc.). D-Cubed 2D DCM solves these geometric rules to specify and preserve relationships in the sketch geometry. Sketch modifications can be made quickly and intuitively by modifying dimension values.

"Licensing Parasolid and D-Cubed 2D DCM made it possible for COMSOL to focus on simulation technology while outsourcing geometric modeling to the leading experts."

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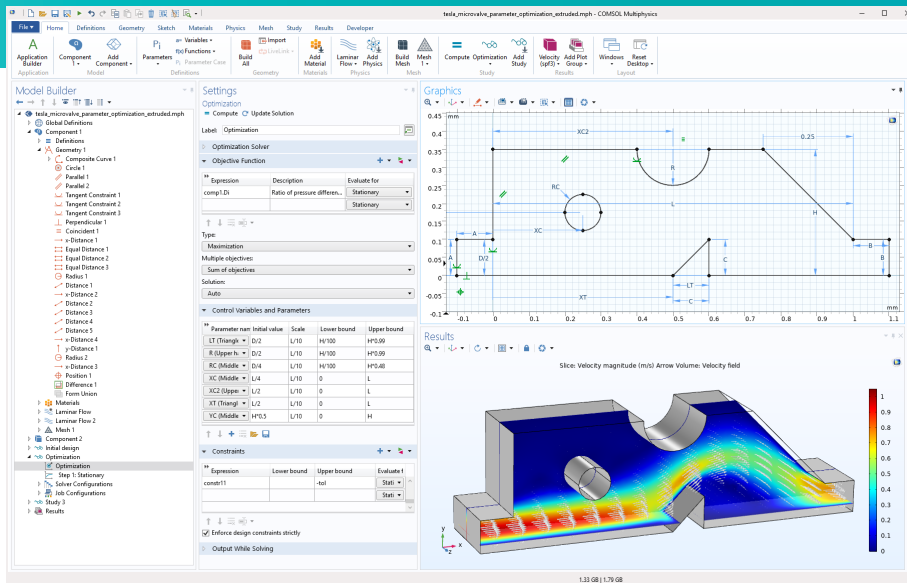


Figure 3: Parametric optimization of fluid flow in a microvalve; geometry is modified using the D-Cubed 2D DCM-based sketcher.

“It was important from a user perspective that the new sketching functionality aligned with the well-established user experience in COMSOL Multiphysics,” says Daniel Bertilsson, technology manager, COMSOL. “By integrating D-Cubed 2D DCM, we were able to extend proven history-based, parametric modeling with a more functional and efficient 2D sketcher.”

Parameter-driven geometry optimization enabled by Parasolid and D-Cubed

All aspects of a COMSOL Multiphysics model are defined parametrically. Users seek to optimize the performance of their product design by systematically and/or simultaneously modifying geometry, material properties, boundary conditions and loads, etc.,

prior to meshing, solving and analyzing the corresponding physical behaviors. During such optimization cycles, COMSOL can drive geometric variations using Parasolid to modify parameters such as wall thickness or the extrusion depth of a 3D part.

In addition, 3D solids are often created by extruding or revolving a 2D sketch into a 3D part. This makes it possible to redefine the shape of a part by modifying the underlying sketch and rebuilding the part. D-Cubed 2D DCM enables such design variations by rapidly solving changes to the sketch parameters (geometric dimensions), further supporting product design optimization.

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Technology Manager
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Solutions/Services

Parasolid
siemens.com/parasolid

D-Cubed 2D DCM
siemens.com/d-cubed

Customer's primary business

COMSOL is a global provider of simulation software for product design and research to technical enterprises, research labs, and universities. Its COMSOL Multiphysics product is an integrated software environment for creating physics-based models and simulation applications.
www.comsol.com

Customer location

Stockholm
Sweden

Enabling simulation across the enterprise

Across the digital enterprise, a diverse range of disciplines can benefit from multiphysics simulation, including product design, manufacturing and testing teams as well as the business' partners, suppliers and customers. Restricting the simulation process to a small team of experts that must serve the wider needs of various, less-experienced users is inefficient. For example, a manufacturing expert doesn't need to understand or control all the possible inputs and settings available in general simulation. Conversely, a simulation expert can't be expected to understand the manufacturing engineer's detailed simulation objectives.

COMSOL's solution is to empower simulation experts to create custom applications that serve a specific team or process.

These applications benefit from a carefully tailored interface that delivers only the subset of simulation parameters, options and outputs that the user needs to get their specific job done. These applications can be deployed on a server for company-wide use on desktop and mobile devices or compiled for distribution in standalone applications. Any multiphysics model that benefits from Parasolid and D-Cubed 2D DCM design functionality can easily be ported to a COMSOL application, bringing the power of these geometry editing technologies to users in all areas of physics across a wide range of disciplines, including design teams, manufacturing departments, process operators, test laboratories, customers and clients worldwide.

The benefits of an open ecosystem

Parasolid and D-Cubed components are at the heart of Siemens' open and flexible

ecosystem. They are standardized enabling technologies across the company's range of products. They are also licensed on a level-playing field basis to many global independent software vendors like COMSOL, bringing benefits such as data interoperability to users of various computer-aided manufacturing (CAM), CAD and CAE applications.

"COMSOL licensed Parasolid and D-Cubed 2D DCM in order to deliver advanced CAD functionality which would not be commercially viable to develop in-house," says Lorant Olasz, Technical Product Manager, COMSOL, "Reviewing the market for CAD software components, it became clear that Parasolid and D-Cubed 2D DCM dominated the industry and were the natural choice for our 'buy versus make' decision."

COMSOL recognized that licensing software components from a trusted supplier to deliver solutions for design and interoperability would be far more cost-effective than re-inventing the wheel and developing the required capabilities themselves. This buy versus make strategy also enabled COMSOL to continue focusing its resources on innovating in its established area of expertise – multiphysics simulation.

"Licensing Parasolid and D-Cubed 2D DCM made it possible for COMSOL to focus on simulation technology while outsourcing geometric modeling to the leading experts," says Jean-Francois Hiller, VP of business development, COMSOL, "This strategy accelerated the development of our innovative multiphysics simulation software for the CAE market and helped grow our market share."

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