COMSOL

NEW FEATURE HIGHLIGHTS

VERSION 3.4

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COMSOL New Feature Highlights

Version: October 2007 COMSOL 3.4

New Feature Highlights

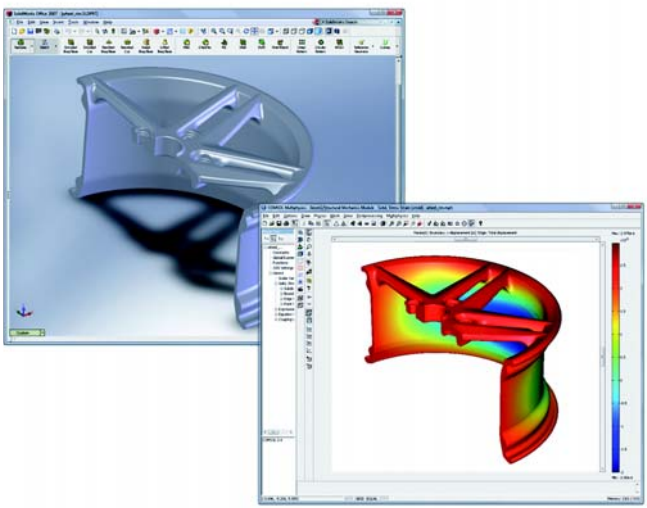
COMSOL Multiphysics® 3.4 introduces exciting new features for all steps of the modeling process—importing of CAD-files, drawing, setting the physics, meshing, solving, and postprocessing. This guide introduces you to the new features in version 3.4 following the order you would use when modeling.

We hope that you will find this release to be even more helpful for your creativity in the modeling process.

CAD Import Module and Draw Mode

The CAD Import Module can now save repaired and defeatured CAD files in the Parasolid format. This allows for the loading of files into your preferred CAD package after manipulation in COMSOL Multiphysics. You can also use the CAD Import Module to convert CAD-files of the supported formats to Parasolid format.

In addition, the performance and robustness of COMSOL Multiphysics' built-in geometry engine is greatly improved in version 3.4.



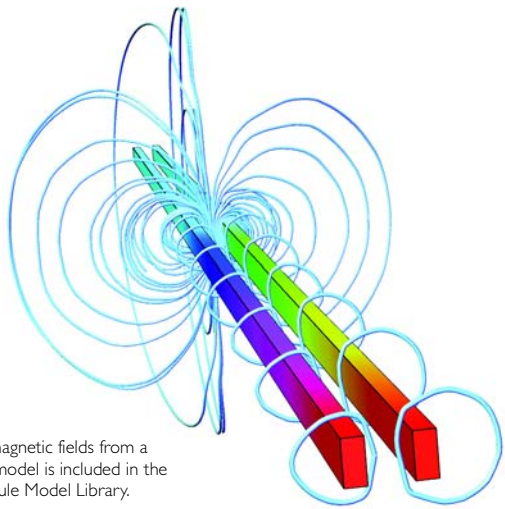
Structural analysis of a wheel rim imported from SolidWorks® into COMSOL Multiphysics 3.4. The model is included in the Structural Mechanics Module Model Library.

Application Modes, Physics Settings, and Modeling Features

The new version of the *AC/DC Module* is able to define models using SPICE import directly in a user interface.

The module further introduces interfaces for small-signal analysis, easy set-up of periodic boundary conditions, and direct use of BH-curves in simulations.

The new features are exemplified in a number of new models, see the section “New Models”.

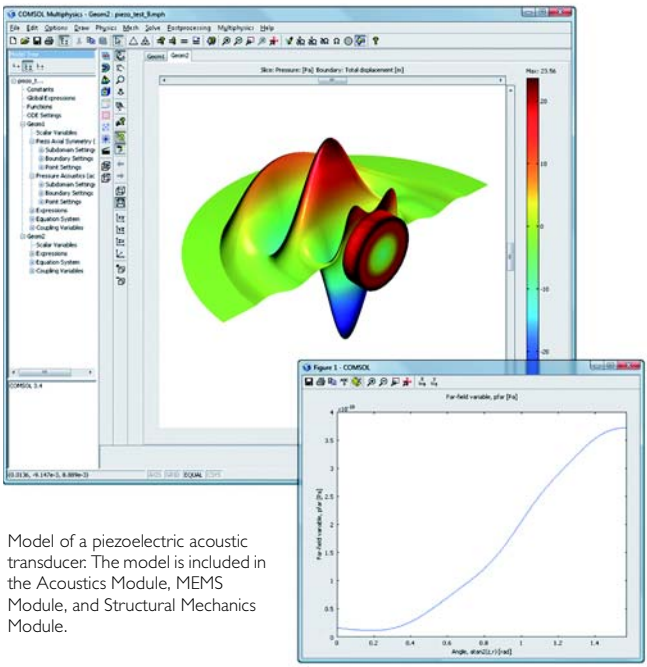


The electromagnetic fields from a railgun. The model is included in the AC/DC Module Model Library.

The *Acoustics Module* includes new application modes for piezoelectric modeling. This new, easy-to-use interface provides the

ability to model piezoelectric devices with piezoelectric, dielectric, and structural parts. The interface also makes it simple to model materials with piezoelectric, decoupled isotropic, and anisotropic properties. It comes with a new material properties library containing 23 of the most common piezoelectric materials.

The new ultraweak variational formulation for pressure acoustics allows you to solve large models with pinpoint accuracy on a comparably coarse mesh.



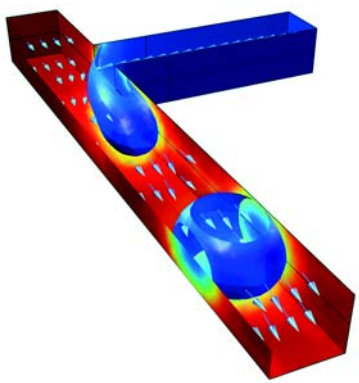
Model of a piezoelectric acoustic transducer. The model is included in the Acoustics Module, MEMS Module, and Structural Mechanics Module.

The *Chemical Engineering Module* is upgraded with two new application modes for multiphase flow. The Bubbly Flow and

Mixture Model application modes are suitable for modeling of gas dispersions in liquids, liquid-liquid mixtures, and flow of solid particles in liquids.

Compared to previous versions, the application modes for non-isothermal flow in the Chemical Engineering Module yield increased performance, robustness, and usability for problems involving free convection and weakly compressible flow.

The new boundary conditions available in all fluid flow application modes further increase the ease-of-use of the Chemical Engineering Module.Furthermore, the *Earth Science Module* takes advantage of the performance and robustness provided by the new stabilization methods for fluid flow. You can also make use of the new COMSOL Reaction Engineering Lab® interface to the Earth Science Module to set up solute transport problems directly from complex reaction schemes.

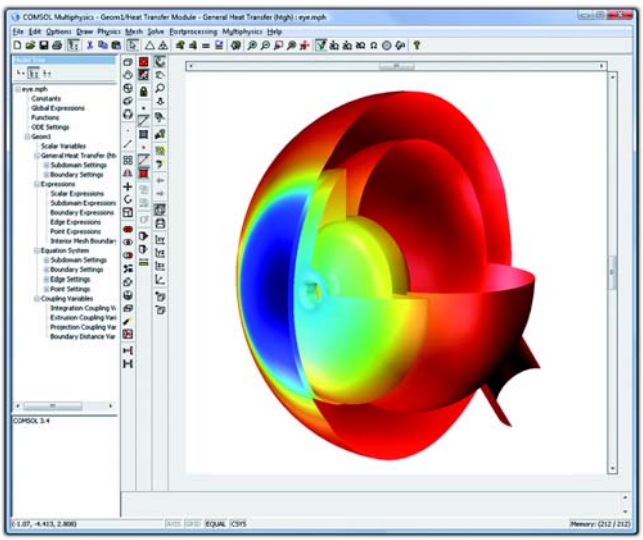


Droplet break-up in a T-junction for the generation of aerosols and emulsions. The model is included in the Chemical Engineering Module Model Library.

The *Heat Transfer Module* can now handle surface-to-surface radiation in axisymmetric models.

The improved performance and stability in the Non-Isothermal Flow application modes also provide for a greatly improved usability for free convection problems in, for example, electronics cooling.

The Heat Transfer Module also takes advantage of the new boundary conditions settings in the application modes for fluid flow.

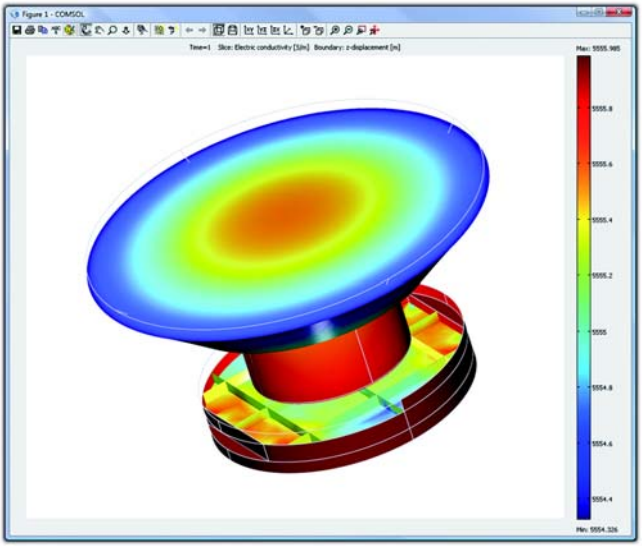


Simulation of the temperature distribution on the different parts of the human eye. Model courtesy of Prof. Eddie Y. K. Ng, Nanyang Technological University, Singapore.

The *MEMS Module* features the application modes for piezoelectric modeling described above for the Acoustics Module.

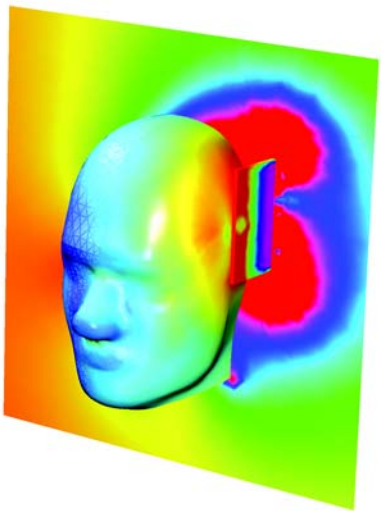
Several new dialogs in the user interface facilitate the definition of mechanical heating and slide-film damping in the MEMS Module.

The MEMS Module also benefits from a new interface to COMSOL Reaction Engineering Lab that makes it easy to set up reacting-flow models in the microfluidics application modes.



Model of a piezoresistive device incorporated in an elevator button. The model is available in the model libraries of the MEMS Module and the Structural Mechanics Module.

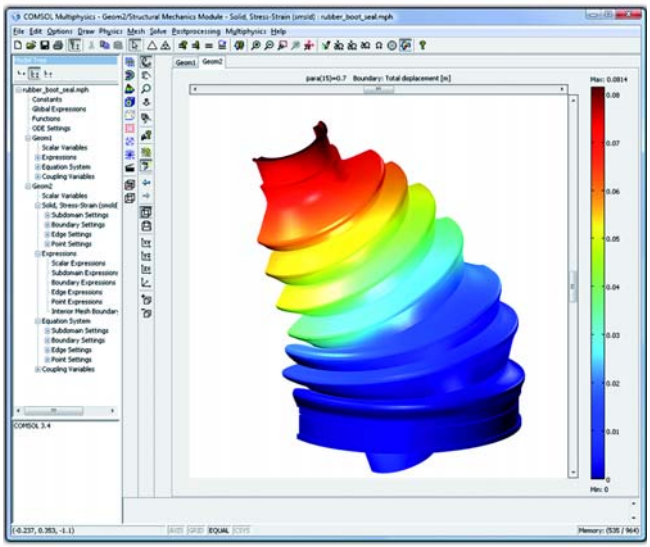
A new modeling interface makes it easy for you to define periodic boundary conditions in the *RF Module*. The RF Module also greatly facilitates the modeling of wave propagation in transmission lines and circuit boards through its new lumped-port boundary conditions. The new fast far-field analysis feature further increases its usability.



SAR simulation based on the radiation coming from a mobile phone in the RF Module. The model is available in the RF Module Model Library.

This new release extends the usability of the *Structural Mechanics Module* with tools for high-cycle and low-cycle fatigue analyses. In addition, an interface for follower loads further facilitates the model set-up for structural analysis.

The Structural Mechanics Module also includes the new interface for piezoelectric modeling, which comes with a material properties library containing 23 common piezoelectric materials.

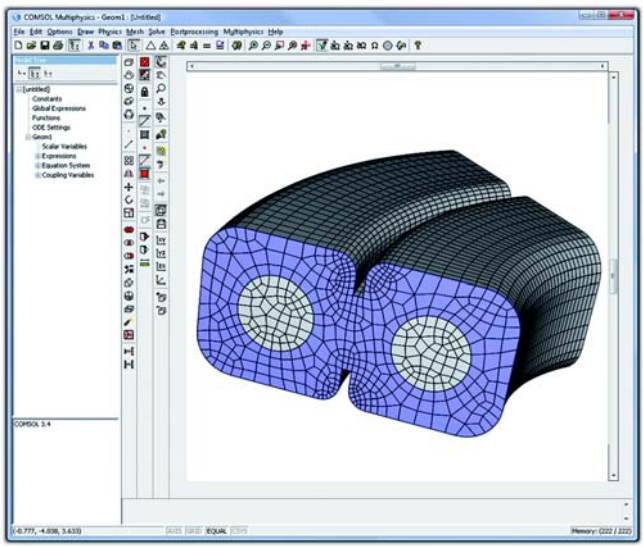


Deformation in the rubber boot-seal of a gear stick.

Meshing

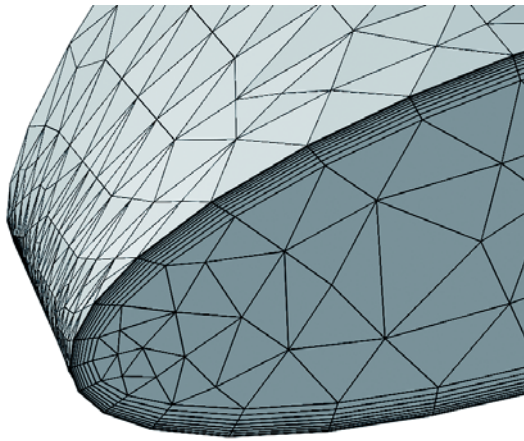
The meshing of complex geometries requires free mesh also for quad elements, a functionality that you can use for curved and flat surfaces in COMSOL Multiphysics 3.4.

In order to obtain high accuracy for fluxes perpendicular to a boundary, you can use the new boundary layer meshing feature. This enables you to reduce the number of elements, while still maintaining superior accuracy, when dealing with boundary layers in fluid flow, mass and heat transfer, and for resolving charged double layers in electromagnetic applications.



Unstructured quad-mesh on a surface generating a brick mesh through the swept-mesh features.

The meshing algorithms in version 3.4 are parallelized for parts and assemblies, which yields a substantial boost in performance for multicore processors.

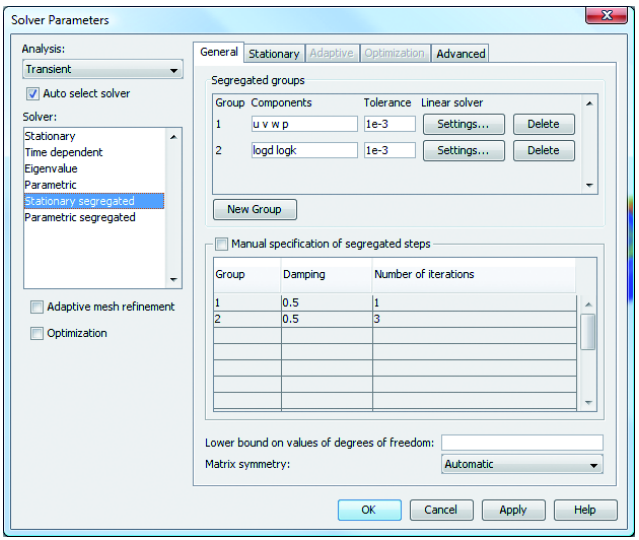


Prism elements used in the automatic boundary layer meshing feature in version 3.4.

Solving the Model

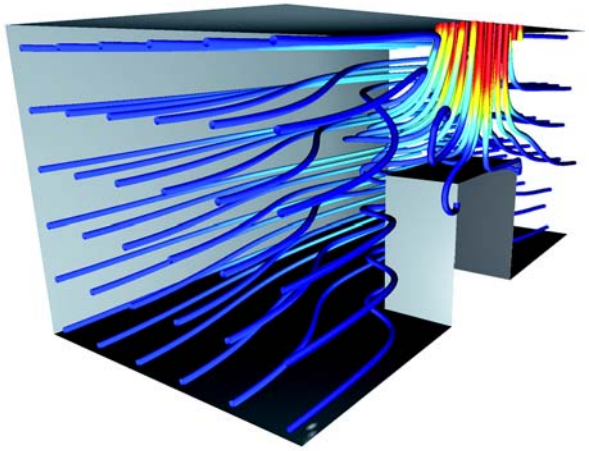
The direct and iterative solvers in version 3.4 are parallelized for multicore processors, resulting in substantial performance increases. The process of assembling the model equations is also fully parallelized.

A new segregated solver with an easy-to-use interface allows you to control the solution process to reduce memory consumption and increase stability for coupled problems. In particular, the predefined coupling for fluid-structure interaction is now substantially more efficient in both respects. You can also use the segregated solver to obtain decent starting guesses for the fully coupled solvers when solving highly nonlinear problems.



The interface for the new segregated solver exemplified for the solution of the k-ε turbulence model for fluid flow.

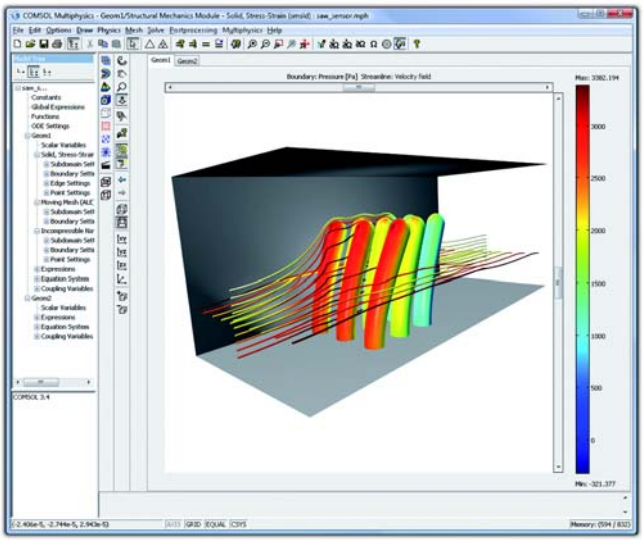
With new functionality for Galerkin least-squares (GLS) stabilization you can take full advantage of the iterative solvers for large fluid flow problems. This functionality dramatically increases performance and robustness of the iterative solvers for incompressible, non-isothermal, and weakly compressible flows.



Model of an impinging jet solved using the new GLS stabilization in combination with the segregated solver.

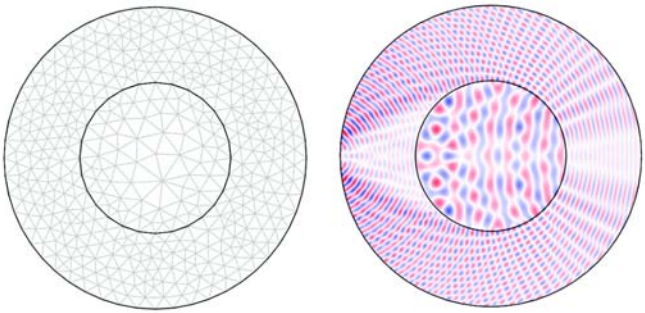
Postprocessing

COMSOL Multiphysics 3.4 features a dramatic improvement in performance for the generation of all plot types and animations, compared to previous versions.



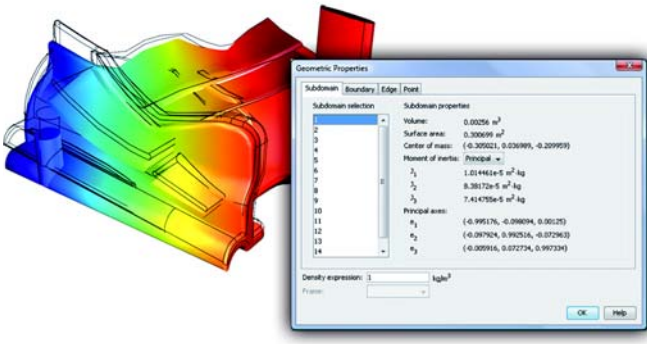
FSI in a MEMS structure. The performance of the postprocessing tools in version 3.4 is dramatically improved compared to previous versions.

Three new colormaps allows you to improve visualization of propagating waves (using the wave colormap), fluid flow (using the HSV colormap), and for black and white publications (using the grayprint colormap).



Acoustic pressure field visualized using the new wave colormap. The model exemplifies the use of the ultraweak variational formulation, which yields a pinpoint accuracy on a comparatively coarse mesh.

In addition to the featured plot types and colormaps, the Postprocessing menu includes new items for calculating geometric properties, such as areas and volumes, center of gravity, and moment of inertia.

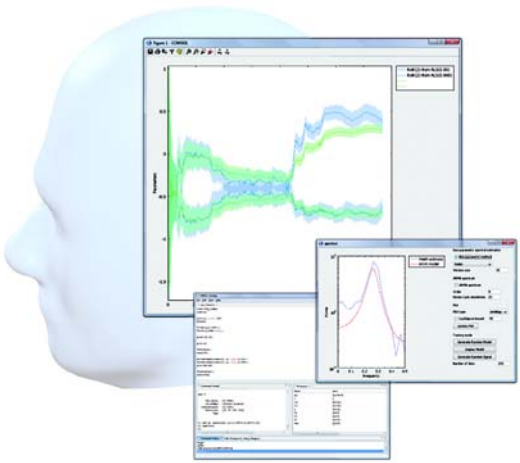


Dialog box for geometric properties exemplified on the F1 wing model in the COMSOL Multiphysics Model Library.

Parameter Estimation in the Reaction Engineering Lab and Signals & Systems Lab

The Reaction Engineering Lab features a new powerful interface for running nonlinear parameter estimation on multiple sets of experimental data. In addition, it is possible to select which parameters to estimate and which ones to keep constant in each run. The output is displayed with confidence intervals and standard deviations.

As a user of the Signals & Systems Lab, you can also access the above-described features for parameter estimation through the COMSOL Script™ command line.



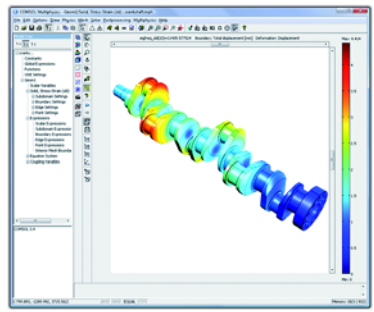
A new interface for nonlinear parameter estimation on multiple sets of data is available in the Reaction Engineering and Signals & Systems Labs.

New Models

The new features in COMSOL Multiphysics 3.4 are exemplified in a number of exiting new models in the model libraries. Below follows a list of these models categorized by product.

COMSOL MULTIPHYSICS:

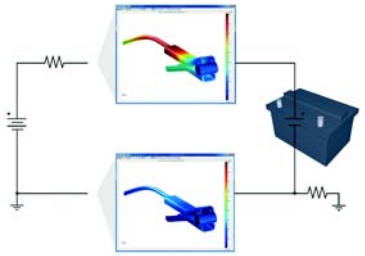
Crankshaft model in the COMSOL Multiphysics Model Library.



MODEL NAME	MODEL DESCRIPTION
two term boltzmann	Solution of the two-term Boltzmann equation for an oxygen plasma

AC/DC MODULE:

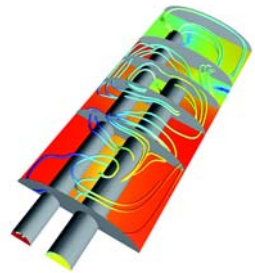
SPICE import of an external circuit describing a battery charger connected to a battery clamp.



MODEL NAME	MODEL DESCRIPTION
high current cable	Joule heating of a cable, clamp, and pole attached to a battery
high current cables circuit	The model as above, connected to an external circuit set up by the new SPICE-import feature
magnetic brake 3d	Induced currents and resulting Lorentz forces in a magnetic brake
railgun 3d	Propulsion of a projectile through electromagnetic fields using the transient electric and induction currents formulation
small signal analysis of inductor	Analysis of an inductor and its core with nonlinear inductance using the new small-signal analysis feature

ACOUSTICS MODULE:

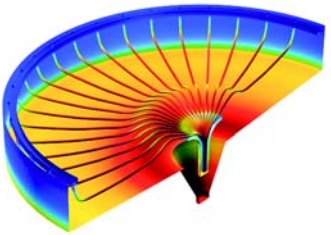
Pressure acoustic analysis in a perforated-muffler model from the Acoustics Module Model Library.



MODEL NAME	MODEL DESCRIPTION
piezoacoustic transducer	Piezoelectric, structural, and pressure acoustic model of a transducer using the new Piezo Axial Symmetry application mode
SAW gas sensor	Influence on the resonance frequency of an adsorbed gas in a SAW sensor using the new Piezo Plane Strain application mode
ultrasound scattering	Scattering of ultrasound waves from a cylinder using the new ultraweak variational formulation

CHEMICAL ENGINEERING MODULE:

Two-phase flow in a sedimentation process for water treatment solved using the Mixture Model application mode.

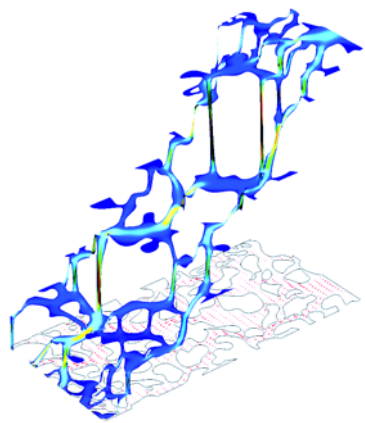


MODEL NAME	MODEL DESCRIPTION
boiling flow	Boiling of a liquid using the level set two-phase flow application mode
bubble column	Bubbly flow in a gas scrubber using the new bubbly flow application mode
capillary filling	Capillary filling using the level set two-phase flow application mode
liquid chromatography 3	Transport of a surge of analyte in a chromatography column
dense suspension	Two-phase flow of a dense suspension using the new mixture model application mode
droplet breakup	Droplet breakup using the level set two-phase flow application mode
electrokinetic valve 3d	Electrophoretic effects utilized for sample injection in a valve

MODEL NAME	MODEL DESCRIPTION
sedimentation	Sedimentation in a secondary clarifier for water treatment using the new mixture model application mode
thermal decomposition	Fluid flow coupled to thermal and material balances with chemical reactions using the new application modes for flow with variable density

EARTH SCIENCE MODULE:

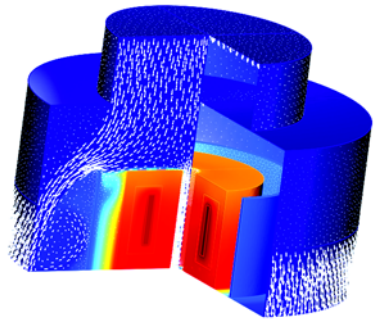
The pore-scale flow model in the Earth Science Module Model Library takes advantage of the new boundary conditions in the flow application modes.



MODEL NAME	MODEL DESCRIPTION
pesticide transport	Solute transport and reactions using the new Reaction Engineering Lab import feature

HEAT TRANSFER MODULE:

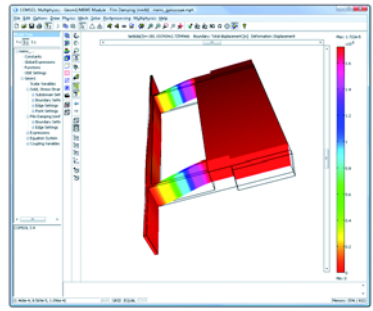
The potcore inductor model exemplifies the use of the new surface-to-surface radiation feature for the axial symmetry application modes.



MODEL NAME	MODEL DESCRIPTION
potcore inductor	Axisymmetric analysis of an inductor using the new surface-to-surface radiation feature for axisymmetry

MEMS MODULE:

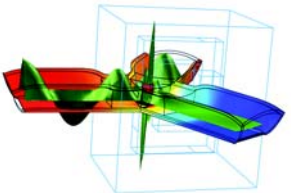
The MEMS-gyroscope model exemplifies the use of the slide-film damping condition.



MODEL NAME	MODEL DESCRIPTION
elevator button	Piezoresistive effects in a device incorporated in an elevator button
mems gyroscope	Operation of a gyroscope influenced by slide-film damping using the corresponding and new boundary condition
SAW gas sensor	Influence on the resonance frequency of an adsorbed gas in a SAW sensor using the new Piezo Plane Strain application mode
tortuous reactor	Microreactor with reaction mechanism set up using the new Reaction Engineering Lab import feature

RF MODULE:

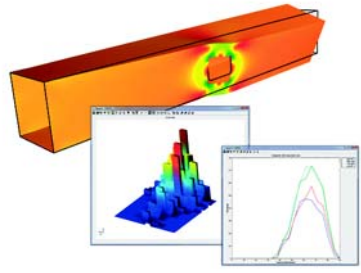
Electric field and thermal deformation in the microwave circulator model in the RF Module Model Library.



MODEL NAME	MODEL DESCRIPTION
bandgap photonic crystal	Nonlinear sweep in an eigenvalue analysis with a normalization equation for the eigenvalue using the new periodic boundaries
microstrip on pcb	Calculation of microstrip impedance using two different terminations with the new lumped port conditions
sar in human head	SAR analysis of the radiation emanating from a cellular phone
sea bed logging	Electric fields used to detect oil reservoirs beneath the sea

STRUCTURAL MECHANICS MODULE:

A shell structure studied using the new fatigue analysis features in the Structural Mechanics Module.

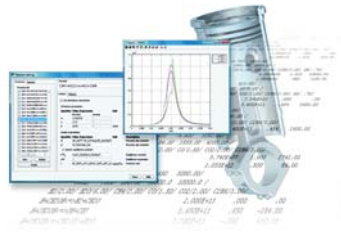


MODEL NAME	MODEL DESCRIPTION
biomedical stent	Stent deformation during deployment in an artery
cylinder hole	The new fatigue analysis feature implemented in an analysis of a cylinder with a small perforation
elevator button	Piezoresistive effects in a device incorporated in an elevator button
flexible footing	Clay under load using the Mohr-Columb yield condition
frame with cutout	The new fatigue analysis done on a shell structure with a square-shaped cutout
piezoacoustic transducer	Piezoelectric, structural, and pressure acoustic model of a transducer using the new Piezo Axial Symmetry application mode

MODEL NAME	MODEL DESCRIPTION
SAW gas sensor	Influence on the resonance frequency of an adsorbed gas in a SAW sensor using the new Piezo Plane Strain application mode
shaft with fillet	A benchmark model of the new fatigue analysis feature; the analysis of a shaft with two different radii
snap hook fastener	Contact and plastic deformation in a snap hook incorporated in the button of a car panel
spherical punch	Contact and elasto-plastic analysis of a circular plate deformed by a spherical punch
vibrating beam	Frequency-response analysis and mechanical heating of a beam using the new mechanical heating feature
wheel rim	Structural and fatigue analysis of a lightweight wheel rim using the new features for fatigue analysis

REACTION ENGINEERING LAB:

The new Reaction Engineering Lab features an interface for parameter estimation on multiple sets of data and CHEMKIN-file import for large sets of chemical reactions.



MODEL NAME	MODEL DESCRIPTION
carbon deposition[a]	Thermal decomposition of methane in a catalytic bed
catalytic cracking	Catalytic cracking of flashed distillate feedstock in a plug-flow reactor
cinnamaldehyde hydrogenation	Study of the reaction mechanism for catalytic hydrogenation of aldehydes
enzyme inhibition	The new parameter estimation tool used on multiple sets of data for an enzyme catalyzed reaction
parameter estimation CO absorption	Different variations of the new parameter estimation feature on the analysis of kinetics data for CO absorption in water
pesticide transport[a]	Degradation mechanism and transport of Aldicarb in soil

MODEL NAME	MODEL DESCRIPTION
pressure time	Parameter estimation of a batch reactor process for peroxide decomposition
tortuous reactor[a]	Mechanism for a surface reaction and transport in a microreactor

a. Space-dependent and space-independent models.