COMSOL Multiphysics® Version 5.6 Release Highlights

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Major News in Version 5.6

- Graphics: Clip planes, realistic material rendering, partial transparency

- Applications: Layout templates and control knobs

- CAD: Better handling of CAD assemblies

- Solvers: Faster and more memory efficient solvers for multicore and cluster computations

- New products:
  - Fuel Cell & Electrolyzer Module
  - LiveLink™ *for* Simulink®
  - Polymer Flow Module
  - Liquid & Gas Properties Module

- Structural mechanics: Transient contact and crack modeling

- Acoustics: Nonlinear acoustics and faster impulse response

- Electromagnetics: Parasitic inductance for PCBs and faster ray optics computations

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Geometry

- CAD assemblies
  - Interference detection
  - Improved *Form Assembly*

- Design Module
  - Advanced Boolean operations
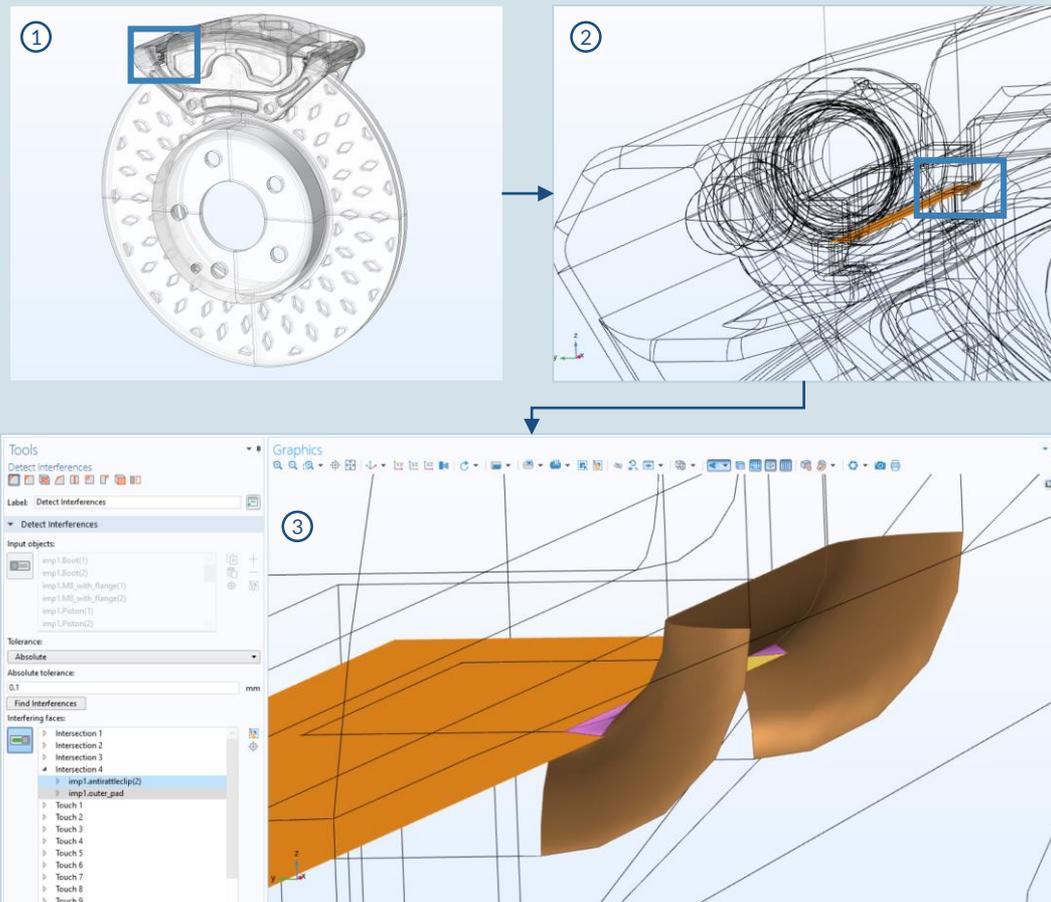
The pink and yellow faces are separated by a gap and belong to the orange and brown objects, respectively. Once detected, it is possible to remove this gap, if it is an unwanted imperfection in the CAD model. If it is not removed, it would cause problems in the model, since it separates two surfaces that should be in contact. The gap would be very difficult to detect manually.

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Mesh

- Boundary layer mesh on 3D faces

- Plot higher-order element nodes

- Plot curved element quality

- Imported meshes:
  - Intersect surface mesh with planes
 - Remesh already meshed surfaces

Swept boundary layer mesh

Boundary layer mesh
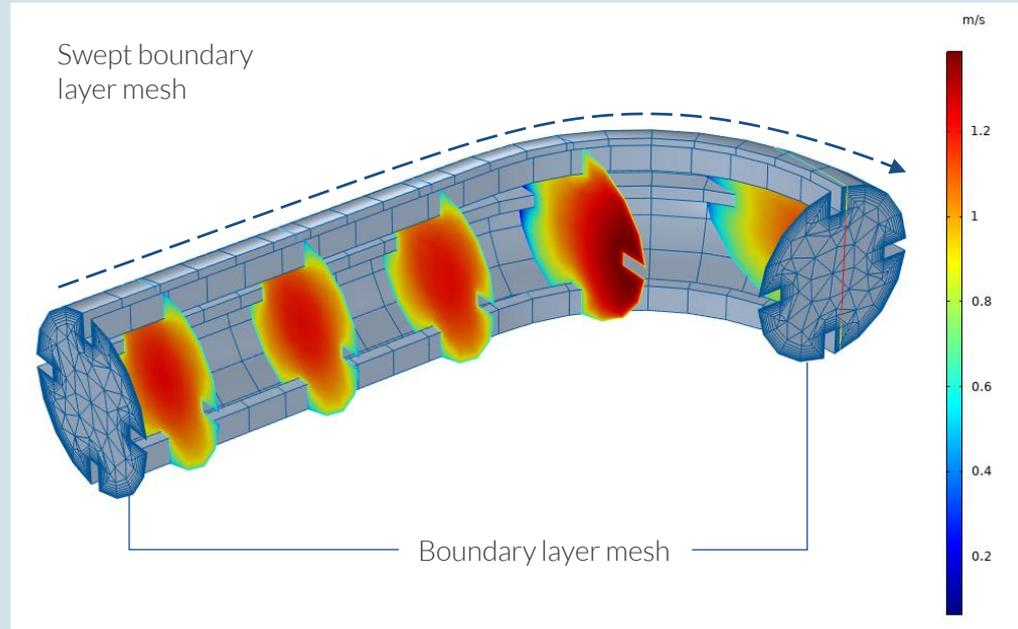
Swept boundary layer meshes are typically required in modeling of channels and pipes in CFD as well as inductive devices in electromagnetics

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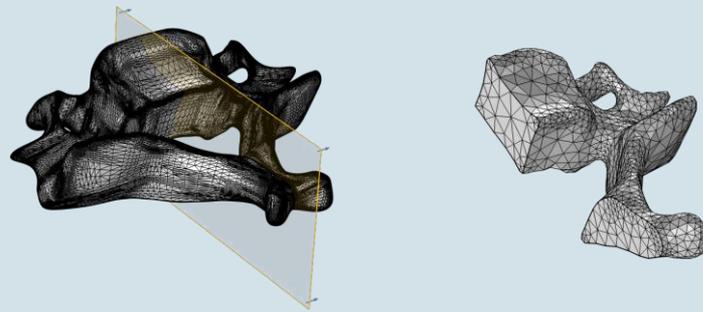
Intersection of a surface mesh with a plane that is then remeshed
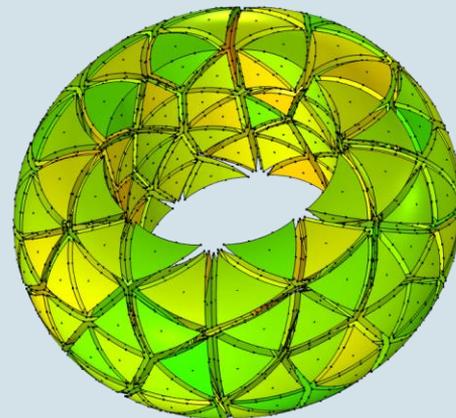
Mesh plot with cubic element nodes and element quality measure for curved elements

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Solver Performance

- General performance improvements:
  - Up to 50% decrease in solution time

- Cluster performance:
  - Up to 30% time decrease in solution time
  - More robust domain decomposition (a method for large systems)
    - Applicable to more types of simulations

- Less memory requirement
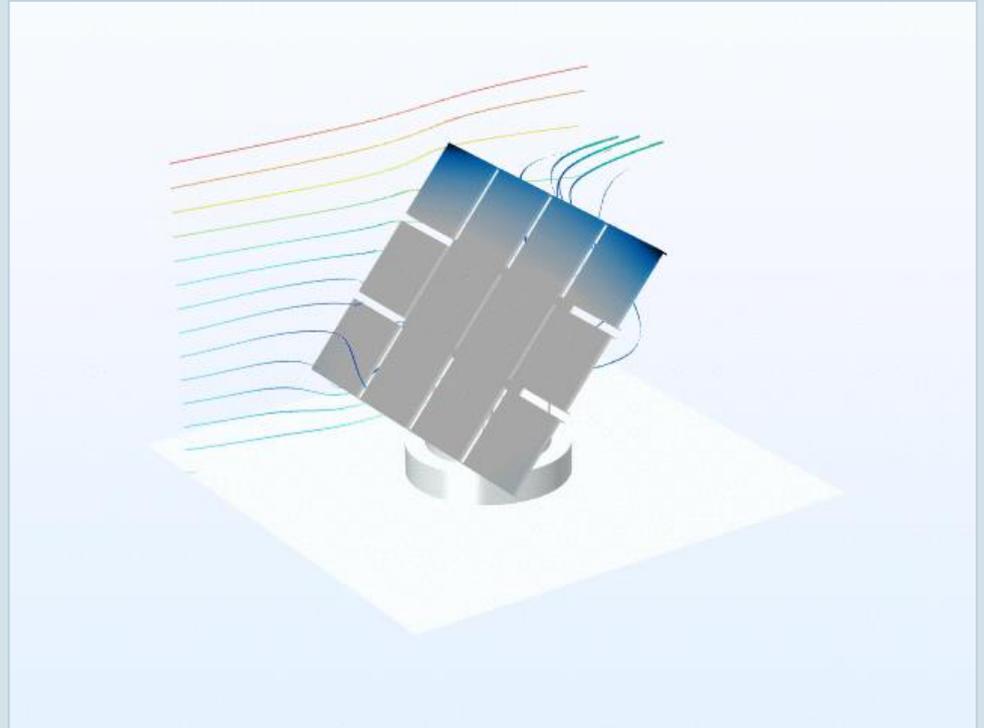
The solution time for the solar panel benchmark model has decreased by 30% on a standard computer

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# Solvers: Reduction of memory requirement

- Algebraic Multigrid
  - Leaner hierachy (Disable *Compact Aggregation*)
  - Less communication

- More efficient SCGS
  - Less communication
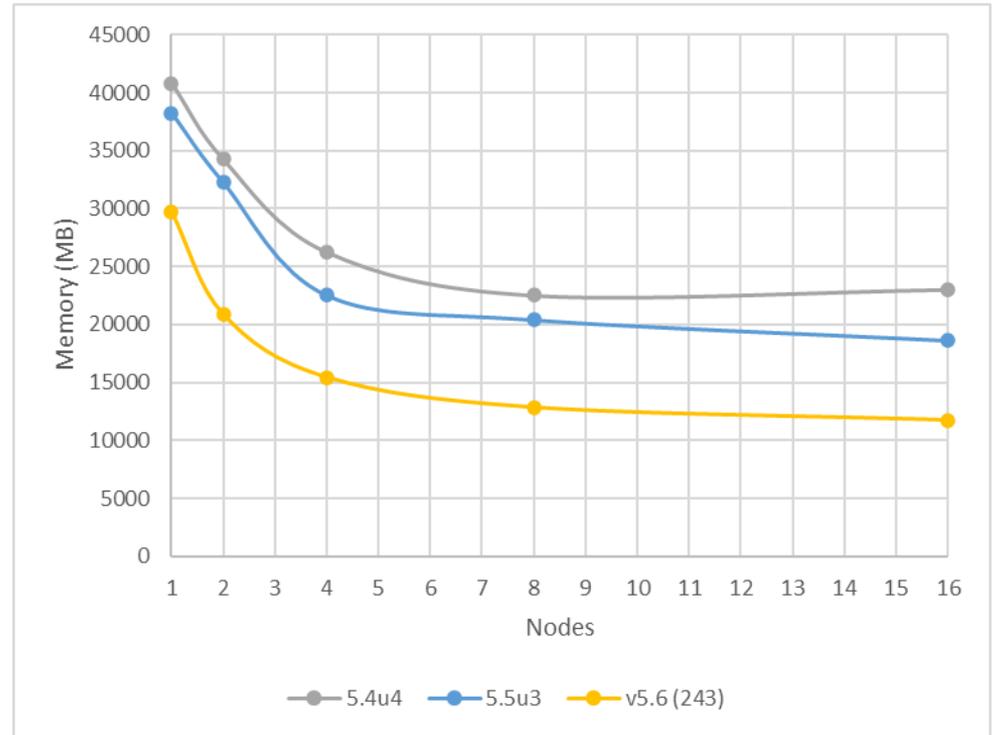
*Memory comparison for the Ahmed body benchmark using AMG on a cluster*

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Solvers

- **FEAST:**
  - New eigenvalue solver
  - Handles high mode densities such as for laser cavities in wave optics

- **Helmholtz preconditioner:**
  - Used with the domain decomposition solver on clusters

- **Navier–Stokes preconditioner:**
  - Decreased memory usage and solution time for CFD
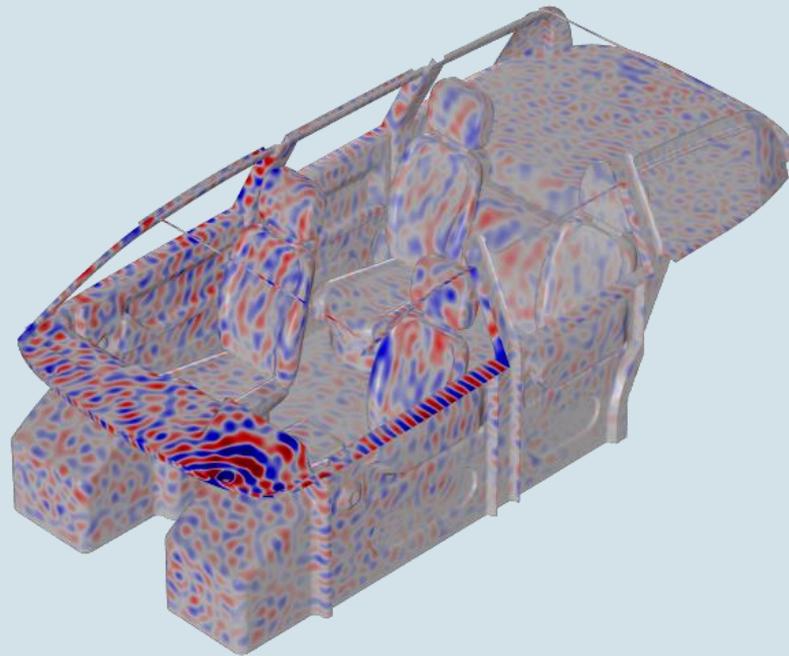
Car cabin acoustics analysis for 5 kHz solved with the new Domain Decomposition preconditioner. Here, 30M DOFs are split into 10 domains. Solution time 2900 sec., 10 nodes, 118 GB.

Visualization

- Clip planes
  - Interactive
  - Alternative to *hide*
  - Types:
    - Plane
    - Box
    - Sphere
    - Cylinder
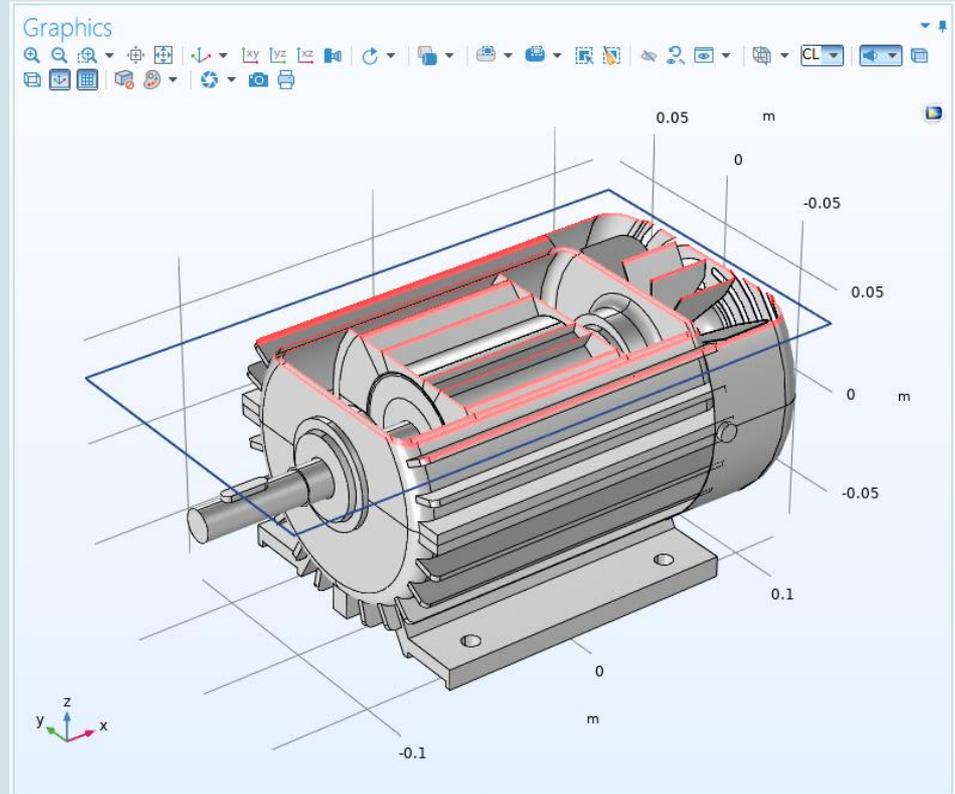
Visualization and Results

- Clipping:
  - Select interior boundaries, etc.

- Improved graphics rendering

- Partial transparency

- Realistic material rendering with image reflections

- Embed images in plots

- Powerpoint export

This animation combines several new features in version 5.6: Improved rendering, seen in the metal sheen; environmental mapping, where the environment is reflected on the surfaces; embed images in plots, the COMSOL logo; and the new dynamic contact analysis in the Structural Mechanics Module.
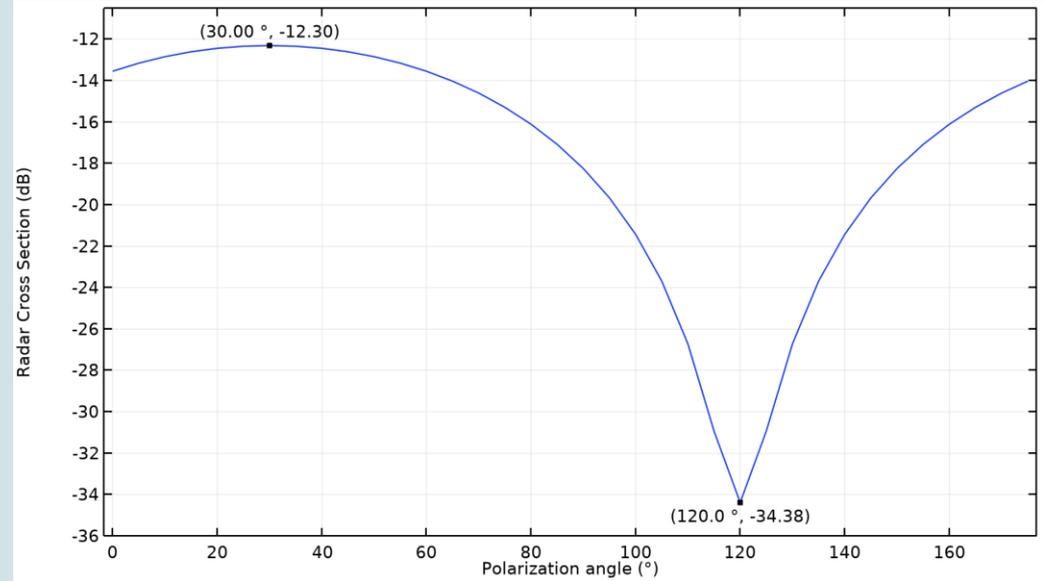
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Partial Transparency

- 5.5 and earlier:
  - Global transparency

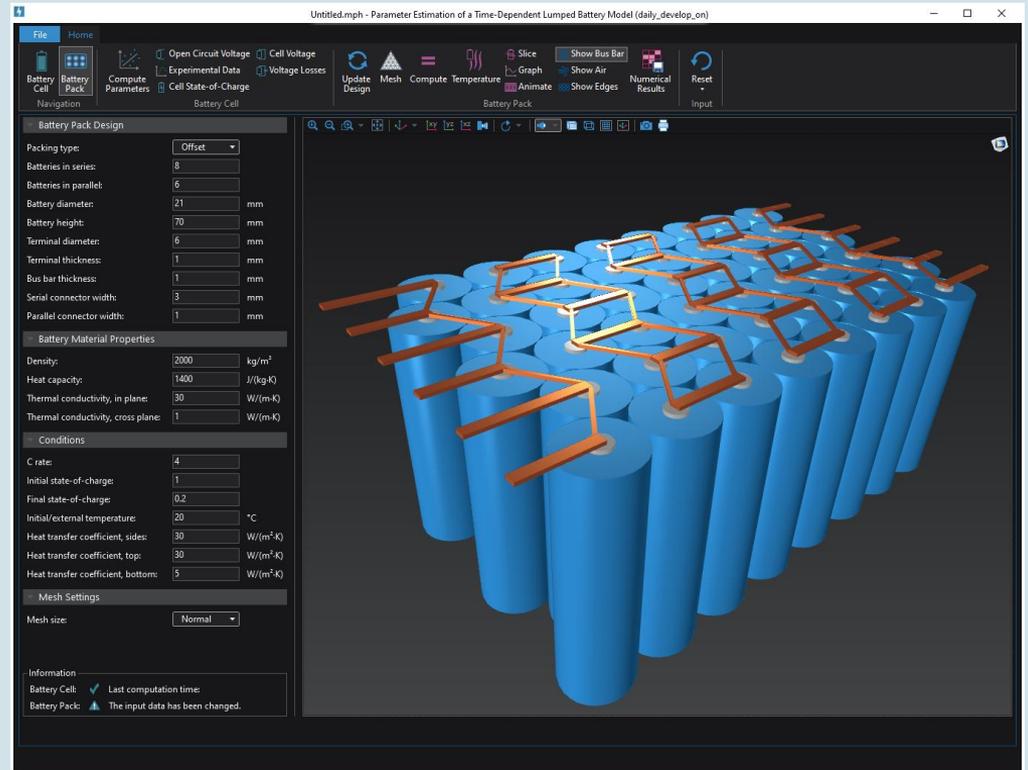- 5.6:
  - Set transparency per plot
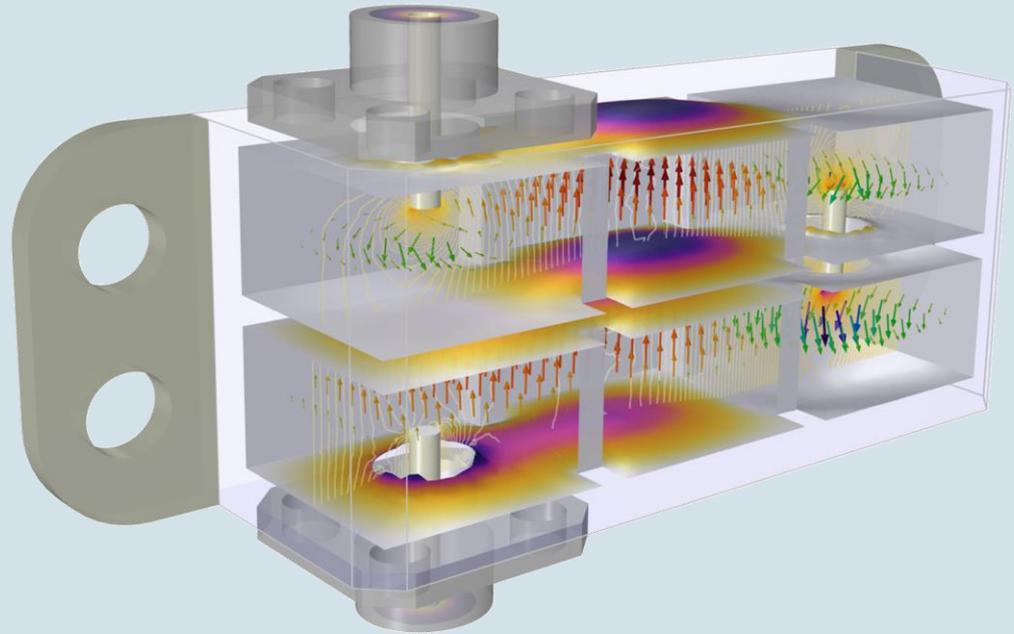
Marker node in 1D, 2D, 3D

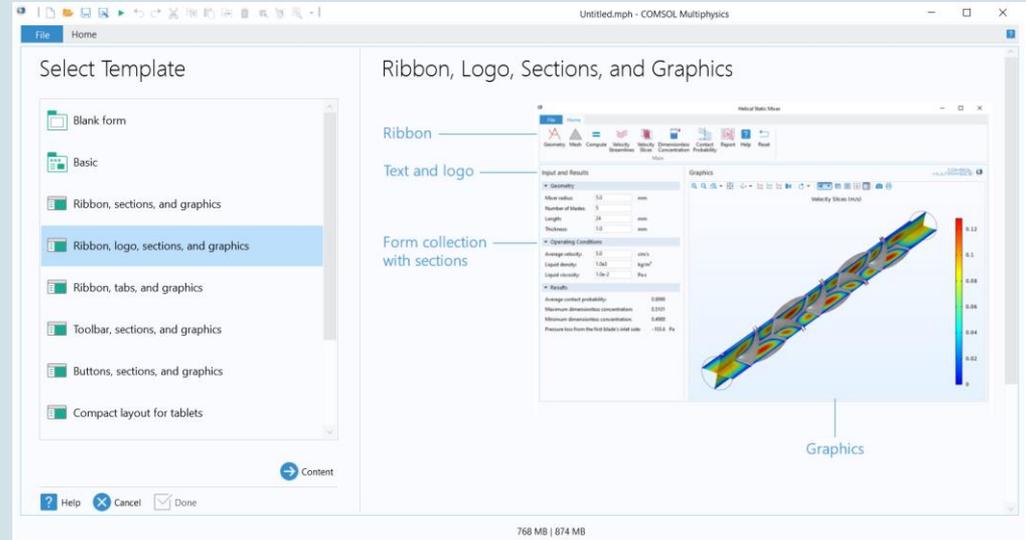- Maximum, minimum, lobe width

Themes

- dark, light

- Also in apps

- Preferences, Color theme

Application Builder

- Layout templates

- Template wizard
  - Quickly create apps with ribbon tabs, menus, sections, graphics

- Desktop, tablet, smartphone layouts

Application layout templates makes user interface creation quicker
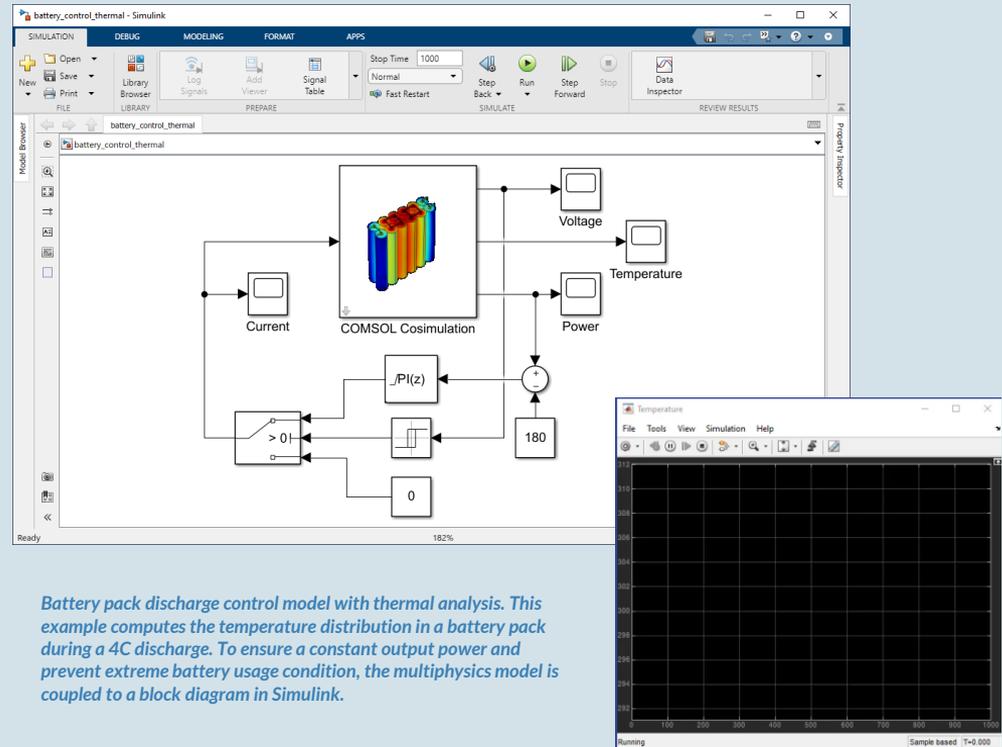
Fuel Cell & Electrolyzer Module

- Interfaces for hydrogen fuel cell and water electrolyzers:
  - Charge transport
  - Electrode reactions
  - Thermodynamics
  - Gas-phase diffusion by Maxwell–Stefan (optional)
  - Momentum transfer by Darcy's law (optional)

- Includes laminar two-phase interfaces
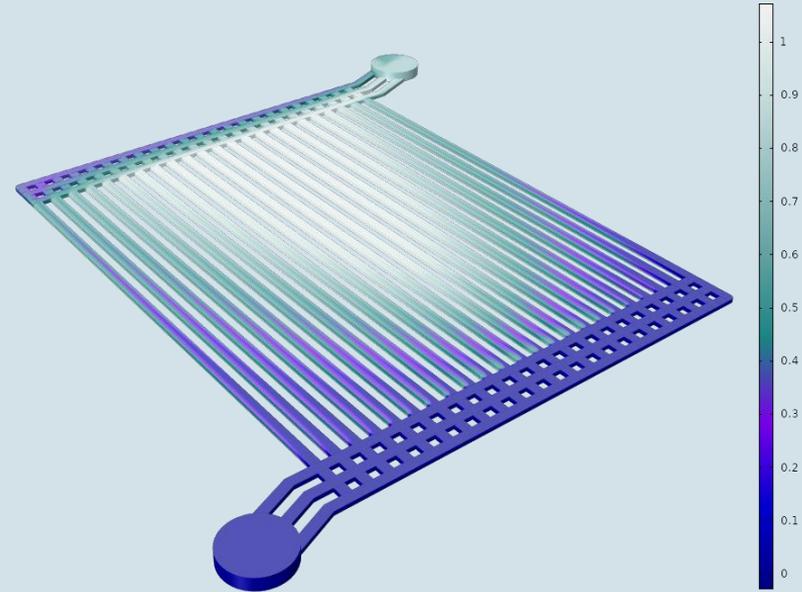
Gas volume fraction in a polymer electrolyte membrane water electrolyzer analyzed with the new Fuel Cell & Electrolyzer Module

LiveLink™ *for* Simulink®

- Drive a COMSOL Multiphysics simulation from Simulink® for control design

- Cosimulation
  - Use a COMSOL block in Simulink® diagrams

- State space blocks
  - Export state space models from COMSOL Multiphysics®
  - Export reduced-order models (ROM) from COMSOL Multiphysics

- Both static and time-dependent models

Battery pack discharge control model with thermal analysis. This example computes the temperature distribution in a battery pack during a 4C discharge. To ensure a constant output power and prevent extreme battery usage condition, the multiphysics model is coupled to a block diagram in Simulink.

Polymer Flow Module

- Non-Newtonian fluids
    - Viscoelastic and inelastic non-Newtonian fluid models

- Polymer, food, pharmaceutical, cosmetics, household, and fine chemicals industries

- Fluid properties as a function of temperature and composition
    - Curing and polymerization

- Fluid–structure interactions
    - Biological fluid moving through a peristaltic pump
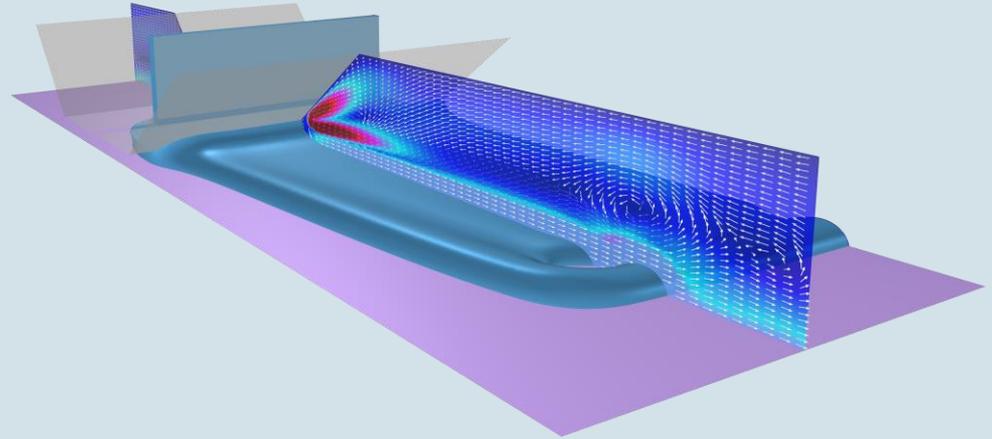
Model of a slot die coating with a shear-thinning fluid. The injection speed and the speed of the die are very important for obtaining a coating of uniform thickness.

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# Chemical Engineering and Electrochemistry

- Electrochemistry
  - Battery Design Module
  - Fuel Cell & Electrolyzer Module
  - Material library for corrosion

- Chemical reaction engineering
  - Predefined systems in thermodynamics for dry air, moist air, and steam
  - Automatic reaction balancing
  - Reactive pellet bed for concentrated solutions

- Liquid & Gas Properties Module
  - Computes properties of fluids for arbitrary composition and temperature
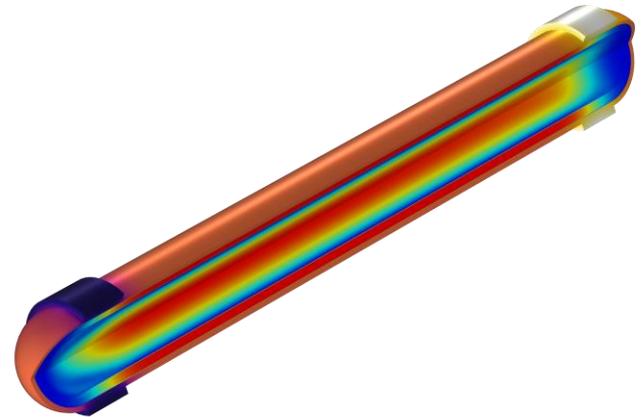
Temperature and flow field in a heat pipe. Mass and heat transfer in free and porous media are accounted for as well as evaporation and condensation.

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Fluid Flow

- Shallow water equations interface

- Compressible mixture model

- Total pressure conditions on inlets and outlets

- Geometry-based length scale for turbulent inlets

- Density and viscosity averaging in two-phase flow level set and phase field

- Improved default solvers:
  - Stability and performance
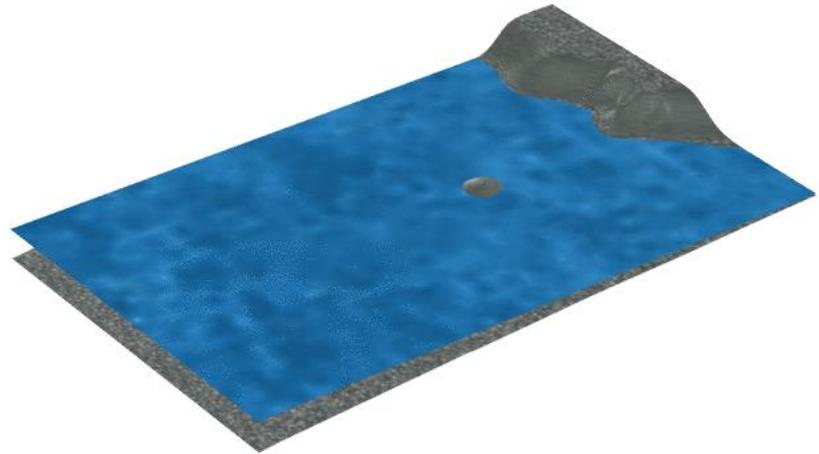

Shallow water equations simulation

Heat Transfer

- Directional surface properties for surface-to-surface radiation

- *Phase Change* interface

- Porous media: New material type and framework for multiphysics coupling

- Heat and moisture transport in unsaturated porous media

- Partial radiation transparency for glass: Transmission/Reflection
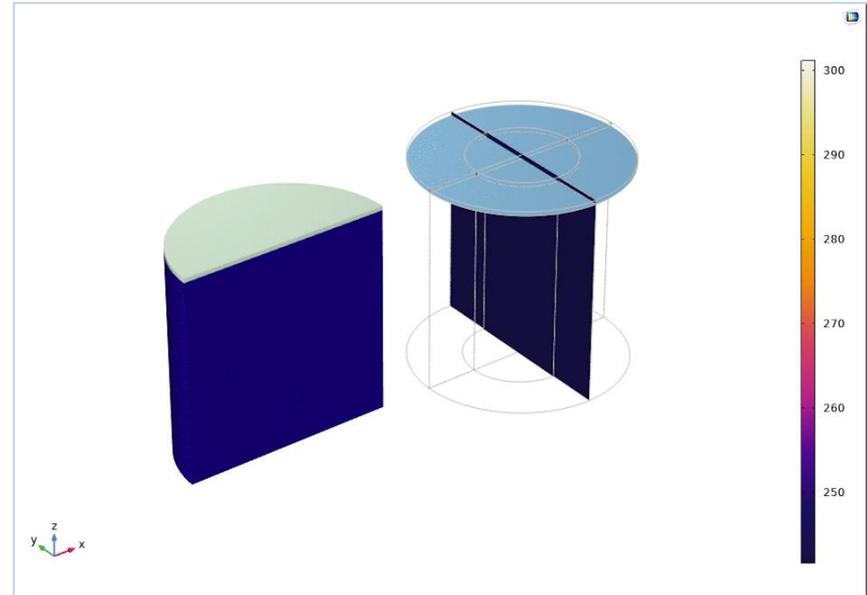
Freeze drying tutorial computed using the new **Phase Change** *interface*

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Structural Mechanics

- Transient contact

- Crack modeling

- Wear analysis

- Embedded reinforcement with rebars, wire mesh, etc.

- Automatic generation of joints

- Active magnetic bearings

- Turbulence effect in hydrodynamic bearings

- Ferroelectric elasticity including nonlinear piezoelectricity with hysteresis
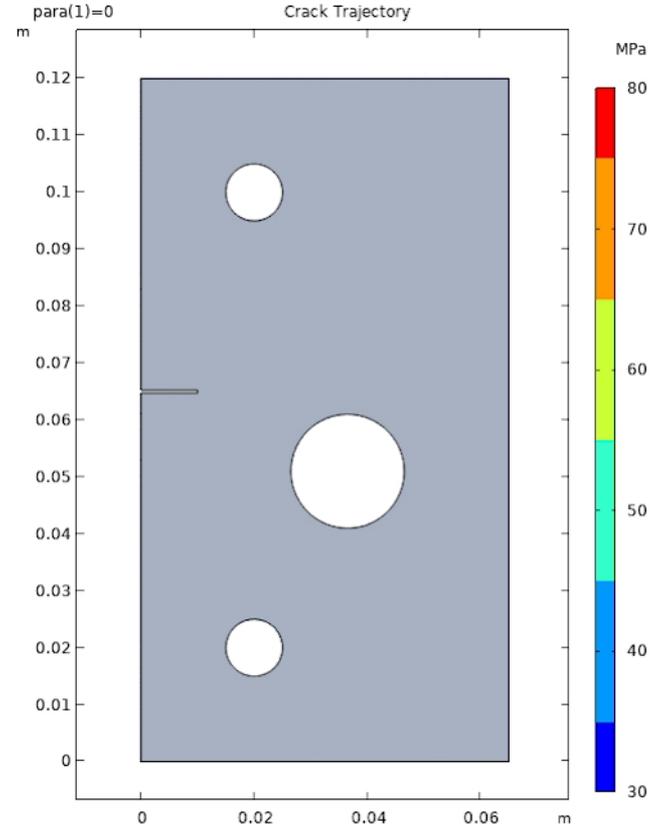
Phase-field-based damage tutorial model

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Wear analysis

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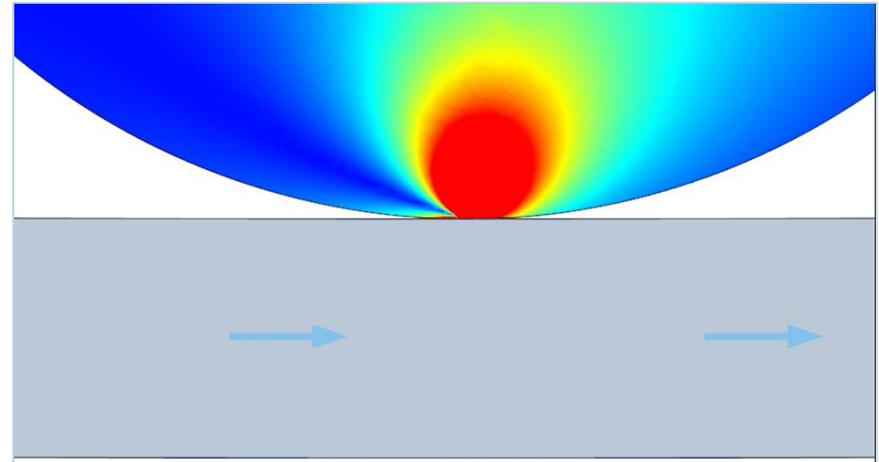
Acoustics

- Nonlinear acoustics, time explicit
  - High-intensity ultrasound

- Nonlinear thermoviscous acoustics
  - Sound distortion in mobile device loudspeakers

- Mechanical port condition
  - Analyzing vibration paths and mechanical feedback

- Lumped port condition
  - Microphones and microtransducers in hearing aids and smart speakers

- Stabilized boundary element method (BEM) formulation
  - Sonar applications, large scattering problems

- Ray acoustics
 - Compute reverberation time, clarity, etc. for room acoustics
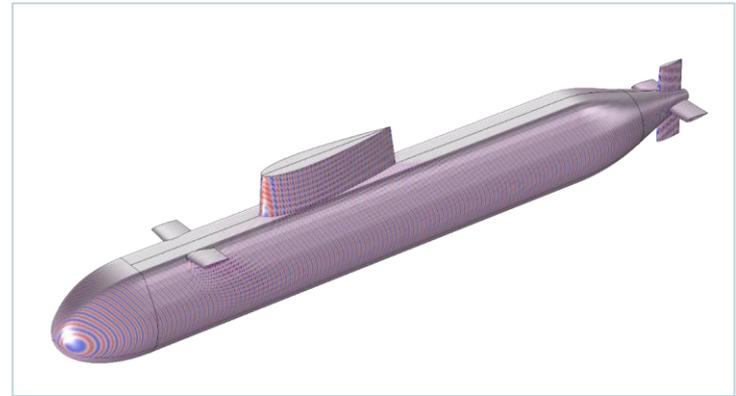
Acoustics scattering off a 50-m long submarine. Solved using BEM at 5 kHz.

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Electromagnetics

- AC/DC
  - Parasitic inductance for PCBs
  - Laminated iron core loss models
  - Ferroelectric materials

- RF and wave optics
  - Solver for fast port sweeps
  - New interface for approximate radar cross-section (RCS) analysis
  - Polarization plot

- Ray optics
 - Scattering in domains and on boundaries
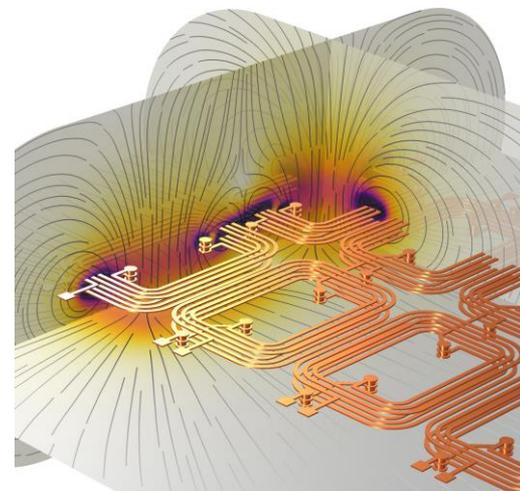
L-matrix extraction using the Magnetic Fields, Currents Only interface
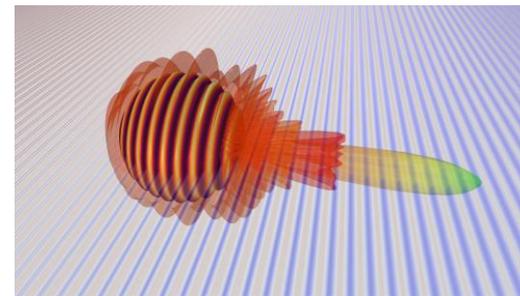
Radar cross-section (RCS) analysis using asymptotic scattering

Optimization and Particle Tracing

- Optimization Module
  - New optimization solver, IPOPT
  - Save intermediate gradient-based optimization solutions (animations)

- Particle Tracing Module
  - Particle properties can now be taken from a material
  - Material and a new formulation for small particles in viscous fluids
  - Vaporization of droplets
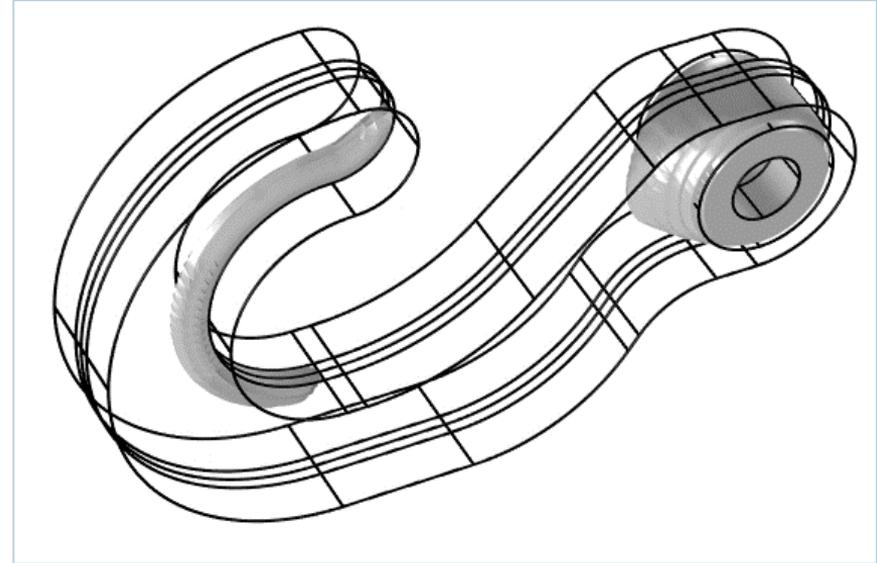
Saving intermediate steps allows you to animate the optimization process

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Try the COMSOL Multiphysics® software

Two-week trial, which includes:

- A guided tutorial

- Full technical support

- Access to examples

CONTACT
*Get in touch with your contact if
you have any questions*

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