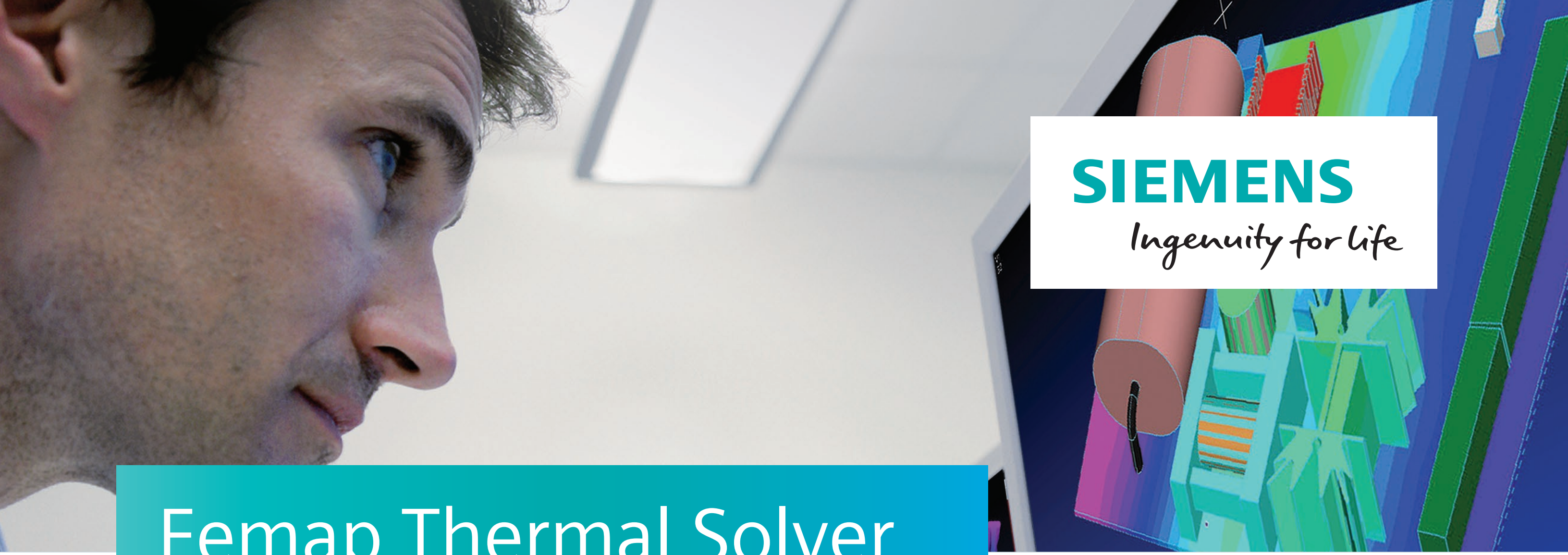

SIEMENS
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Femap Thermal Solver

Finite volume FE-based thermal solver technology to efficiently simulate heat transfer phenomena

Benefits

- Facilitates investigation of multiple "what-if" scenarios involving complex assemblies
- Facilitates assembly building by modeling heat flow between unconnected parts and components
- Enables the user to simulate strong and fully-coupled thermo-fluid interactions, including proper treatment of radiative heat transfer
- Supports mapping results to a Nastran FE model for thermo-elastic analysis
- Works within the Femap environment, allowing users to leverage all Femap FEA capabilities

Summary

Femap™ software, the world's leading Windows-based engineering simulation tool for finite element analysis (FEA), brings a complete range of powerful digital simulation solutions directly to the engineer's desktop easily and affordably. The Femap Thermal module within Femap, part of the Simcenter™ solutions, solves heat transfer problems during the engineering development phases of product design for large Femap model assemblies or single parts. These thermal and heat transfer simulations facilitate high fidelity numerical predictions of radiation, conduction and implicit convection heat transfer problems.

Basic functionality

The Femap Thermal solver addresses thermal analysis requirements in industries including aerospace, defense, consumer products and appliances, energy, medical devices and instruments and electronics. You can also seamlessly couple Femap Thermal with Femap Flow, the Femap CFD solution, for fully coupled thermo-fluid simulations.

The Femap Thermal solver features high-order, finite-volume FE-based technology to accurately and efficiently simulate heat transfer phenomena. It combines the versatility of FE-based analysis with the accuracy and efficiency of a finite-difference scheme. Femap Thermal solver technology facilitates simulation of Femap parts and assemblies within complex thermal environments. The solver and modeling features include:

Solver capabilities

- Steady-state (linear and nonlinear)
- Transient (linear and nonlinear)
- Material nonlinear thermal properties
- Iterative conjugate gradient solver technology
- Fully coupled conduction, radiation and convection heat transfer simulation

Thermal coupling technology for modeling thermal contacts within Femap assemblies

- Thermally connect disjoint and dissimilar mesh faces and edges
- Surface-to-surface, edge-to-edge and/or edge-to-surface contact modeling between parts: constant, time- or temperature-dependent coefficient of heat transfer, resistances or conductance
- Radiative exchange between disjoint part faces and faces within a single part

Femap Thermal Solver

Features
- Thermal couplings for joining disjoint solid or surface meshes within an assembly
- Thermo-fluid and thermoelastic interactions when coupled with Femap Flow or NX™ Nastran® software
- Fast and accurate FE-based finite volume thermal and heat transfer solver
- Interface modeling between connected parts: constant, time- or temperature-dependent coefficient of heat transfer, resistance or conductance
- Convective exchange correlations between faces: parallel plates, concentric spheres or cylinders

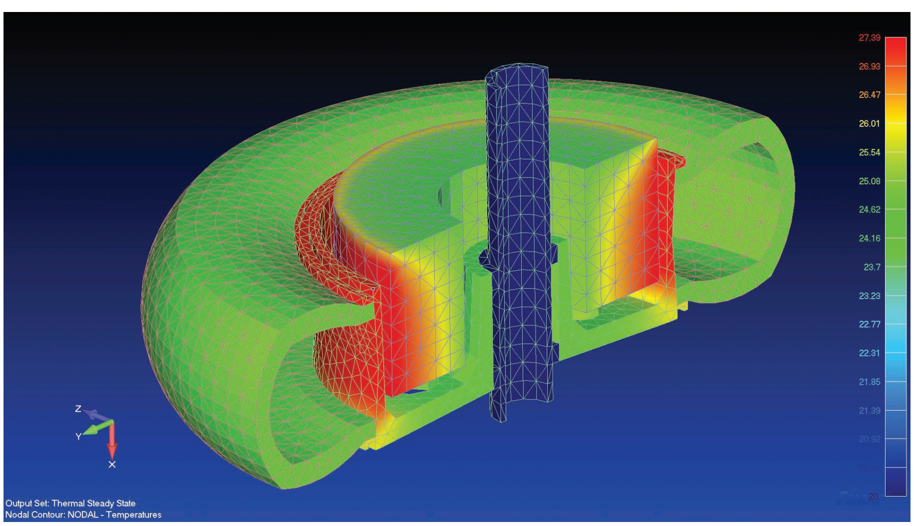
Applied heat loads
- Constant and time-dependent heat loads
- Constant and time-dependent heat flux
- Constant and time-dependent heat generation
- All applied loads controllable with temperature-controlled thermostat conditions

Temperature boundary conditions
- Constant temperature for steady-state or transient
- Time varying for transient and for nonlinear steady-state
- Thermostat temperature controls

Conduction heat transfer
- Ability to handle large conduction heat transfer models (memory efficient data scheme)
- Temperature-dependent conductivity
- Temperature-dependent specific heat
- Orthotropic conductivity

Convection heat transfer
- Constant, time-dependent heat transfer coefficients
- Parameter and nonlinear temperature gradient functions
- Free convection
- Correlation-based free convection to ambient for inclined plates, cylinders and spheres
- Forced convection
- Correlation-based convection for plates, spheres and cylinders in forced fluid flow

Radiation heat transfer
- Emissivity
- Multiple radiation enclosures
- Diffuse view factor calculations with shadowing
- Net view factor calculations
- Adaptive scheme for view factor sum optimization
- Hemicube-based view (form) factors calculation using graphics card hardware



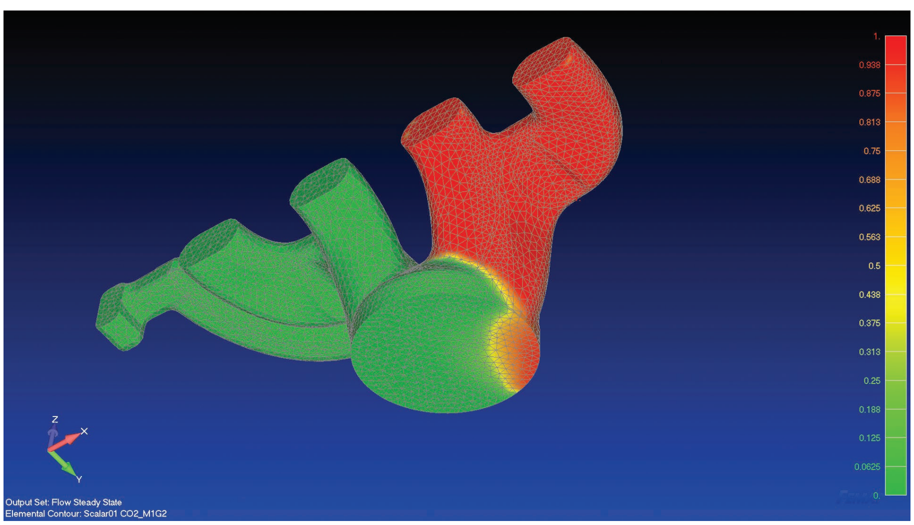
Initial conditions
- Starting temperatures for both steady-state and transient
- Starting temperatures from previous solution results, from file

Solver and solution attributes
- Restart conditions, cyclic convergence criteria
- Direct access to solver parameters
- Solver convergence criteria and relaxation factors
- Solver monitor with solution convergence and attributes
- Intermediate results display and recovery directly from solver progress monitor

Other features
- Results Reporter
- Summary of results to Excel worksheets
- Heat flow calculation between groups
- Heat maps
- Complete or partial deactivation of selected elements (for radiation form factors calculations)
- Improved adaptive time stepping
- Initial conditions from dissimilar meshes
- Enhanced transient end time options

Simulation results
The results list has been updated. The following results are now available:

- Temperatures
- Min/max temperatures and occurence times
- Conductive heat fluxes



- Convective heat fluxes
- Temperature gradients
- Transverse temperature gradients
- Total loads and fluxes
- Residuals
- Free and forced convection coefficients
- Phase change quality
- RC products

Feature-related advantages

Thermal couplings for joining disjoint solid or surface meshes
Thermal couplings provide a powerful and efficient capability for building assemblies by modeling heat flow between unconnected parts, components even with dissimilar meshes. Multiple what-if scenarios and positioning of parts within an assembly can be investigated by defining the thermal coupling parameters between unconnected parts only once. Heat transfer paths are automatically created between elements on opposing parts at runtime. These conductances are established based on proximity; they account for overlap and mismatch between disjoint and dissimilar meshes exchanging heat, allowing parts to be moved freely within the assembly prior to running the analysis. Thermal coupling types include conductive, radiative, convective and interface couplings. Thermal couplings can also be defined as varying with different model parameters such as temperatures or heat loads.

Thermo-fluid and thermo-elastic interactions

Heat transfer modeling capabilities can be explicitly combined with the Femap Flow computational fluid dynamics (CFD) solution. This combination allows a user to simulate strong and fully-coupled thermo-fluid interaction problems, including radiative heat transfer. When Femap Flow and Femap Thermal are purchased together, the thermo-fluid solver automatically turns on at no additional cost, offering both conduction and radiation modeling to be fully coupled with 3D fluid flow.

Integrated thermal and heat transfer solution

Femap Thermal is integrated within the Femap portfolio and takes full advantage of the Femap advanced simulation environment. The Femap integrated application allows both skilled engineers and thermal specialists to avoid any additional transfer of input files or geometry conversions and manipulations breaking the associative link between Femap geometry and FE tasks.

The Femap interface provides Femap Thermal users with a broad set of tools for creating thermal models and analysis-ready geometry. A user can automatically (or manually) remove unnecessary geometrical features. The user can refine the mesh in critical areas and selectively control mesh density, minimizing or optimizing model size for rapid and accurate solution.

By virtue of being native to the Femap environment, Femap Thermal provides the ability to model, catalog and share parts and material libraries among the design team, thereby minimizing tedious rework and potentially costly modeling errors.

Product availability

Femap Thermal is a module in the suite of advanced simulation applications available within the Femap product configuration. When used in concert with Femap Flow, Femap Thermal provides a coupled multi-physics solution for complex fluid flow and thermal interaction applications.

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