NX Space Systems Thermal

fact sheet

Siemens PLM Software

www.siemens.com/nx

Summary

NX™ Space Systems Thermal software is the space industry vertical application that provides a comprehensive set of tools to simulate orbital thermal analysis within the NX Advanced Simulation environment. NX Space Systems Thermal helps resolve thermal engineering challenges early in the design process and is a valuable tool for predicting and understanding thermal physics for space-bound, orbiting and interplanetary vehicles.

Benefits

Predict thermal performance for orbiting vehicles accurately and quickly

Increase collaboration and team productivity with a thermal analysis solution that is easily integrated with your design and engineering process

Minimize learning time and enhance productivity by leveraging the power of all NX-embedded simulation applications

Maximize process efficiency with a highly automated solution that requires no additional input files and carries out analysis in a single pass

Features

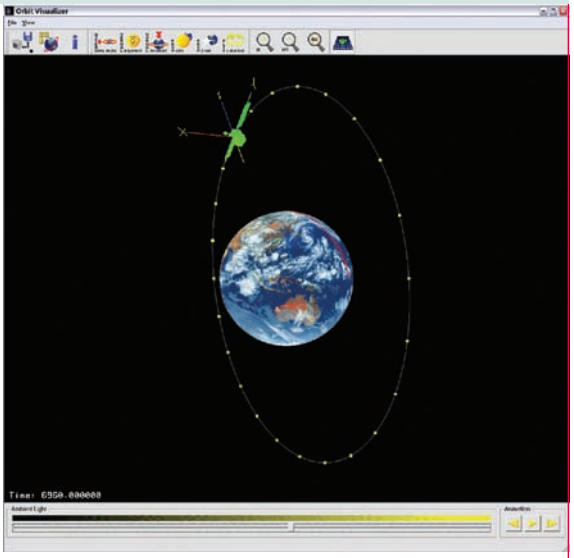
NX 3D part modeling as the foundation for thermal analysis, creating and associating FE models with abstracted geometry

State-of-the-art numerical technologies for the efficient solution of element based thermal models

Orbit definition and orbit display tools for defining environmental heat loads of vehicles in space

Analysis of assemblies with tools that connect disjointed meshes automatically at runtime

Thermal results mapping from/to different and dissimilar meshes for loading structural finite element models for thermo-elastic analyses within the NX Advanced Simulation framework

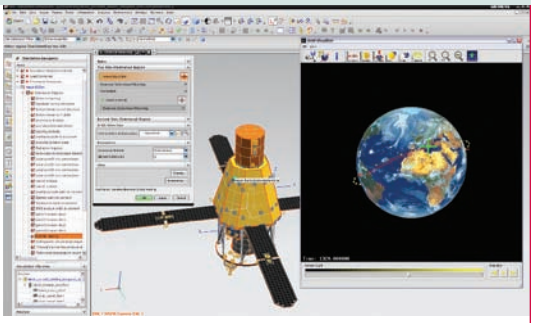


NX Space Systems Thermal is ideal for modeling orbital vehicle applications with complex 3D design geometry. Users can easily employ NX Space Systems Thermal to build small thermal models for conceptual studies all the way to detailed geometry-based models when high fidelity analysis is required.

An integral part of the NX Digital Product Development simulation suite, the NX Space Systems Thermal module enables you to effectively use simulation to provide design guidance early in the design cycle instead of just during design verification. Modeling of complex and/or large 3D CAD assemblies is made easy with the pre-requisite NX Advanced FEM capabilities. No additional input files or geometry conversions are needed to build your thermo-fluid models. NX is an open system with multi-CAD support which makes it easier for you to work with supplier or contractor-provided geometry that originates from another CAD system. NX provides a distributed model approach to assembly analysis whereby the Assembly FEM model does not contain the component FEM models, but instead holds pointers to these models. Assembly FEM enables a more efficient process for building large models comprised of multiple components. NX Design Freedom powered by Synchronous Technology enables users to modify geometry by easily moving or deleting individual faces or features such as bosses or ribs. Synchronous technology empowers analysts to make simple changes to geometry to support what-if analyses thereby speeding up design-analysis iterations. Furthermore, this technology works with native and imported geometry, both with or without history.

NX Space Systems Thermal also has embedded interfaces with other legacy and commercial software tools used for radiation and thermal analysis in the space systems industry.

NX SIEMENS



Main NX Space Systems Thermal features

Specific thermal analysis capabilities for the space industry include:

- Orbital heating modeler for all planets of the solar system
- Powerful and fast view factor calculations (including parallel computing for large Space Systems Thermal models)
- Transient view factor re-calculations for the case of articulating geometries, such as for pointing solar panels or antennas
- Multi-layer shells specific formulation for MLI and TPS applications
- Direct interfaces to other radiation and thermal analysis tools for space systems:

SINDA	TSS	TRASYS
ESATAN	ESARAD	Thermica

Core solver capabilities

- Steady-state and transient analysis of linear and nonlinear problems
- Preconditioned bi-conjugate gradient solver technology
- Fully coupled conduction, radiation and convection heat transfer simulation
- Material nonlinear thermal properties
- Axi-symmetric modeling
- 1D duct and hydraulic network elements
- Articulation and motion modeling (translational motion and rotational joints)

Conduction heat transfer

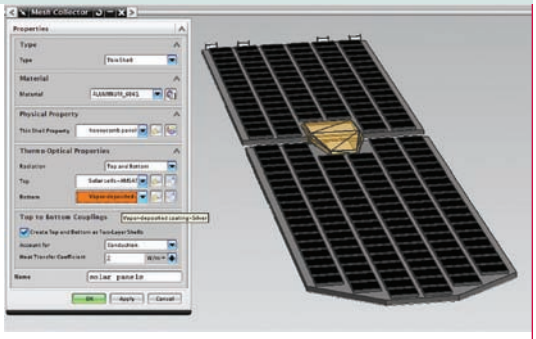
- Ability to handle very large thermal models
- Temperature-dependent conductivity and specific heat
- Orthotropic conductivity
- Heat of formation at phase change temperature

Radiation heat transfer

- Constant temperature-dependent and wavelength-dependent emissivity
- Multiple radiation enclosures
- Diffuse view factor calculations with shadowing
- Monte Carlo and deterministic ray-tracing methods
- Ray-traced view factors to account for specular effects
- Adaptive scheme for view factor sum optimization
- Hemicube-based view factor calculation using graphics hardware
- Radiation patch generation to condense large element-based radiation models
- Radiation matrix controls and parameters
- Defined radiative heat sources (collimated or diffuse, time and spatially varying fluxes)

Convection heat transfer

- Constant, time and temperature-dependent heat transfer coefficients
- Parameter and nonlinear temperature gradient functions
- Correlation-based free and forced convection to ambient for inclined plates, cylinders and spheres
- Coupling to 1D duct networks



Thermal couplings technology for modeling thermal contacts within NX assemblies

- Thermally connect disjoint and dissimilar mesh faces and edges
- Constant, time-dependent, temperature dependent and spatially varying heat transfer coefficients
- Surface-to-surface, edge-to-edge or edge-to-surface contact modeling between parts
- Radiative exchange between disjoint part faces and faces within a single part
- Interface modeling between connected parts
- Convective exchange correlations between faces: parallel plates, concentric spheres or cylinders
- Join
- One-way heat transfer
- User defined

Optical and other advanced material properties

- Advanced optical properties including temperature and angle dependence (BRDF)
- Transmissivity, specular reflectivity, refraction, solid extinction
- Electrical resistivity
- Phase change and ablation properties

Temperature boundary conditions and applied heat loads

- Time and spatially varying temperature boundary conditions
- Heat loads, heat flux and heat generation: variable in time and space
- Electrical Joule heating

Initial conditions

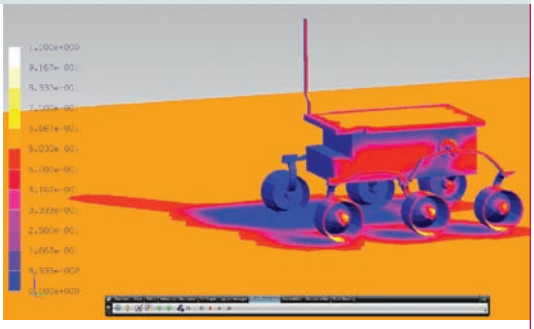
- Spatially varying initial temperatures for both steady-state and transient
- Initial temperatures from previous solution results, from file

Thermal control models

- Thermostats, active heater controllers, fan controllers, PID
- Peltier cooler modeling
- User defined control system logic

Solver 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
- Open architecture (user subroutines)
- Support to include external files



Other features

- Results reports
- Summary of results in html and comma separated values (.csv) format compatible with Excel
- Heat flow calculation between groups
- Heat maps
- Complete or partial deactivation of selected elements (for radiation form factors calculations)
- Temperature mapping to Nastran FE models and external solvers

Results post-processing

- Temperatures
- Temperature gradients
- Total loads and fluxes
- Conductive fluxes
- Convective fluxes
- Convection coefficients
- Residuals
- Heat maps
- Joule data
- Phase change quality
- RC products
- Apparent temperatures
- Radiance
- Net radiative, radiosity and irradiance fluxes
- Orbital and radiative souce fluxes and view factors
- View factors sums

Industry applications

Typical space systems thermal analysis applications include:

- Transient and steady-state orbital heating simulation
- MLI and TPS design, modeling and performance analysis
- Laser pointing and other ray tracing optical applications
- Re-entry vehicle aero-heating and thermal ablation modeling
- Thermal sub-systems optimization
- Interplanetary spacecraft thermal design and analysis
- Material coating selection (checkered board or other strategies)
- Thermal shock transient simulations
- Orbital maneuvering transient thermal simulations
- Thermal management systems analysis
- Space test-bed experimental apparatus thermo-fluid analysis
- Space station and future space modules HVAC

Supported hardware/OS

NX Space Systems Thermal is an add-on to NX Advanced FEM in the NX Advanced Simulation suite of applications. It requires an NX Advanced FEM license as a prerequisite. All standard NX hardware/OS platforms are supported (including Windows, Linux and selected 64-bit platforms). Contact Siemens PLM Software for any other specific hardware/OS support requests.

Contact
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