# NX Space Systems Thermal: Space orbital thermal analysis

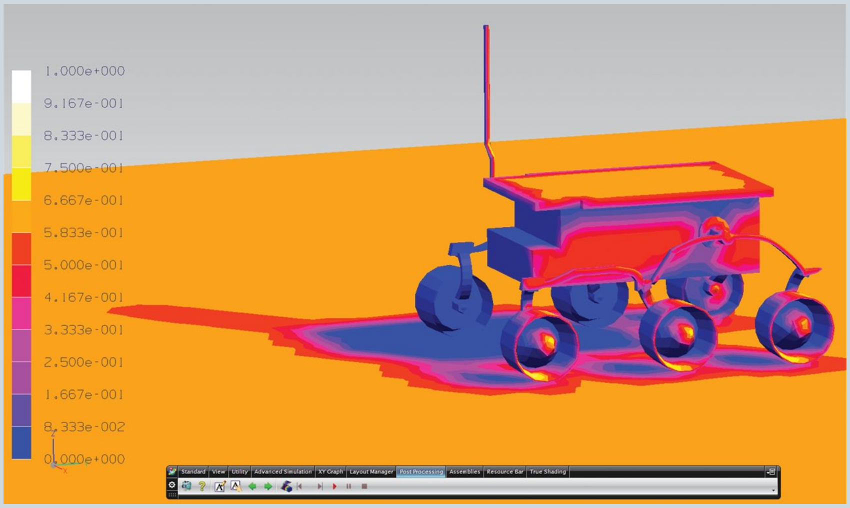
## NX CAE

### Benefits

- Predict thermal performance for orbiting vehicles accurately and quickly
- Reduce costly physical prototypes by using thermal simulation to understand product performance
- Increase collaboration and team productivity with a thermal analysis solution that is easily integrated with your design and engineering process
- Leverage all the capabilities of the NX integrated environment to make quick design changes and provide rapid feedback on thermal performance
- Maximize process efficiency with a highly automated solution that requires no additional input files and carries out analysis in a single pass

### 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.




NX Space Systems Thermal continues Siemens' long heritage in thermal simulation and leverages the same technology that underpinned the I-deas TMG solution. NX Space Systems Thermal is ideal for 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

# NX Space Systems Thermal

made easy with the prerequisite NX Advanced FEM capabilities. No additional input files or geometry conversions are needed to build your thermal analysis 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.

**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 recalculations for the case of articulating geometries, such as for pointing solar panels or antennas
- Multi-layer shell formulation for modeling MLI, composite panels 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
- Axisymmetric modeling
- 1D duct and hydraulic network elements
- 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

*Radiation heat transfer*

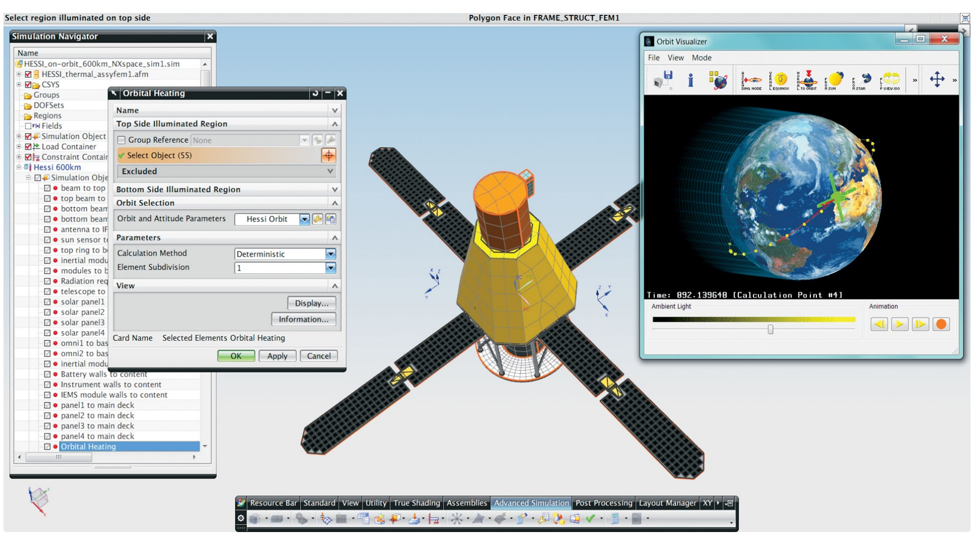
- Constant temperature-dependent and wavelength-dependent emissivity
- Multiple radiation enclosures
- Diffuse view factor calculations with shadowing
- Hemicube-based view factor calculations using graphics hardware
- Ray-traced view factors to account for specular effects
- Monte Carlo and deterministic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

*Convection heat transfer*

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

*Thermal coupling 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
- Advanced thermal connections: join, one-way heat transfer (advection), user-defined heat transfer

*Optical and other advanced material properties*

- Advanced optical properties including temperature and angle dependence (BRDF)
- Transmissivity, specular reflectivity, refraction, extinction through solid media
- Electrical resistivity
- Latent heat of fusion at phase change temperature
- Ablation and charring of materials

*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*

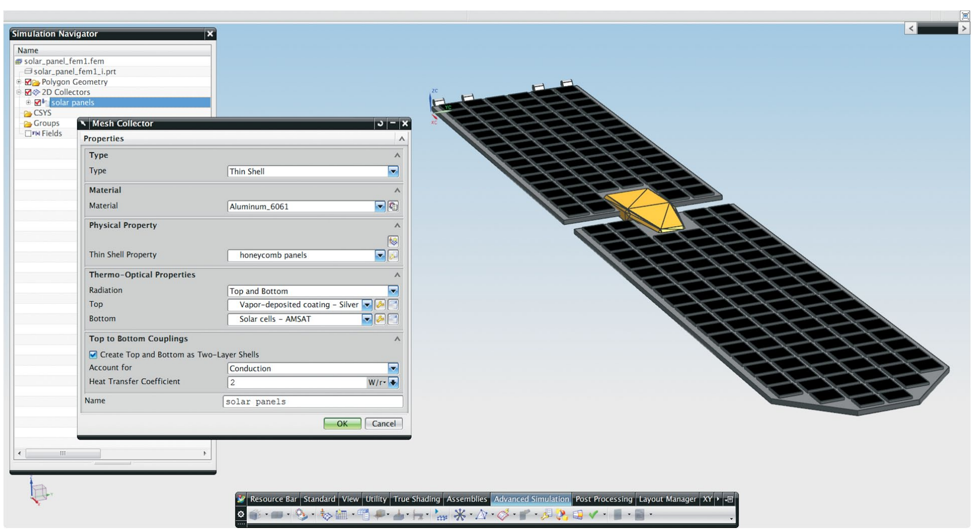
- Spatially varying initial temperatures for both steady-state and transient analysis
- Initial temperatures from previous solution results and from file

*Thermal control models*

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

*Solver solution attributes*

- Restart conditions
- Orbit periodic 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 input files

*Parallel processing of view factor and environmental load calculations*

- Up to eight processes per analysis on a single machine
- Unlimited processes across multiple machines, including support for clusters, with NX Thermal/Flow DMP add-on

*Other features*

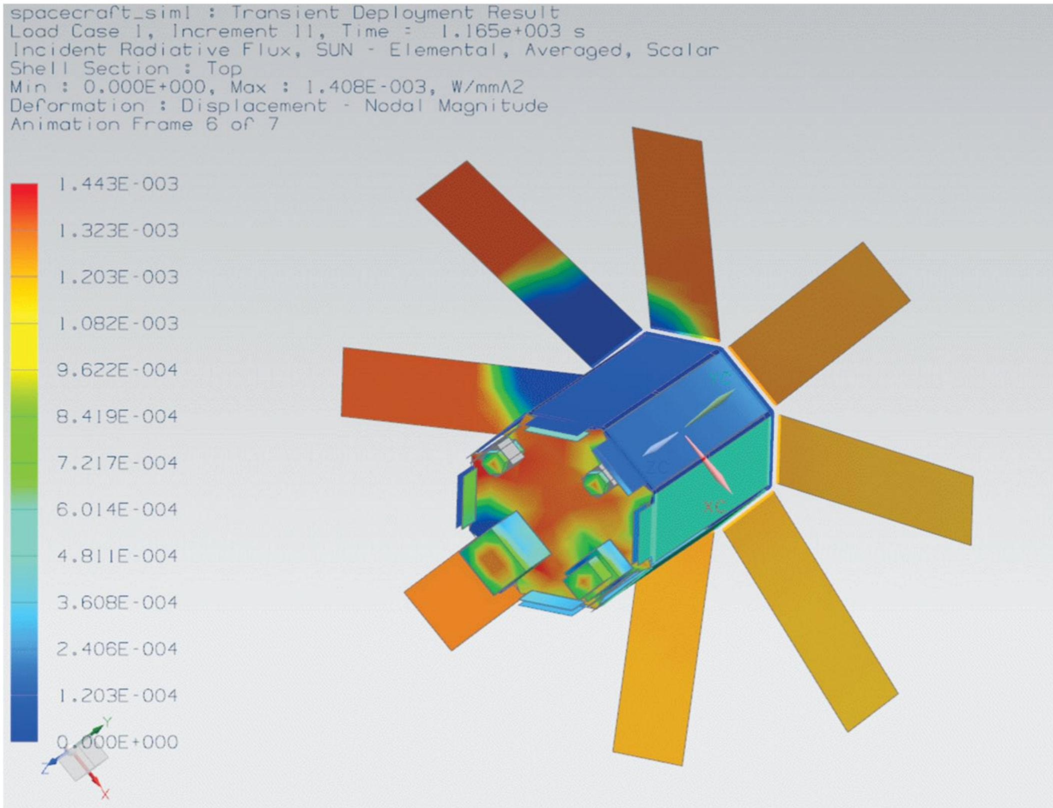
- Results reports
- Summary of results in html and comma separated values (.csv) format compatible with Excel
- Heat flow calculation between groups
- Heat maps
- Complete or partial deactivation of selected elements from conduction and/or radiation calculations; useful for what-if analysis
- Override material properties for what-if and EOL/BOL analysis
- Temperature mapping to Nastran FE models and external solvers
- Import and export of the STEP-TAS radiation model
- Merge elements for reduced model preparation

*Results postprocessing*

- 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
- Re-entry vehicle aero-heating and thermal ablation modeling
- Thermal subsystems optimization
- Interplanetary spacecraft thermal design and analysis
- Material coating selection
- Thermal shock transient simulations
- Orbital maneuvering transient thermal simulations
- Thermal management systems design and 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.

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