

NX I-deas Electronic System Cooling

Modeling and analyzing the flow and thermal behavior in automotive, electronic, medical, HVAC and industrial systems

Benefits

- Simulate 3D air flow and thermal behavior in electronic systems
- Compute fluid dynamics for many automotive, HVAC and industrial applications
- Perform digital thermal simulation early in the design process, reducing the need for building and testing physical prototypes
- Integrate analysis with mechanical engineering and design for guidance, not just verification
- Minimize tedious rework and modeling errors with direct interfaces to electronics design systems
- Display simulation results to gain physical insight and optimize design

Features

- Take advantage of system – and component – level analyses that are easy to learn and use
- Perform system cooling analysis on complex geometry and assemblies
- Use powerful modeling tools to minimize setup time

Summary

NX™ I-deas™ Electronic System Cooling (ESC) software is an add-on module within NX I-deas that helps you simulate 3D air flow and thermal behavior in electronic systems. Augmenting the capabilities of NX MasterFEM, ESC helps you resolve thermal engineering challenges early in the design process and is a valuable aid in understanding the physics of fluid flow and heat transfer for enclosures. With its powerful computational fluid dynamics, ESC is ideal for many automotive, HVAC and industrial applications.

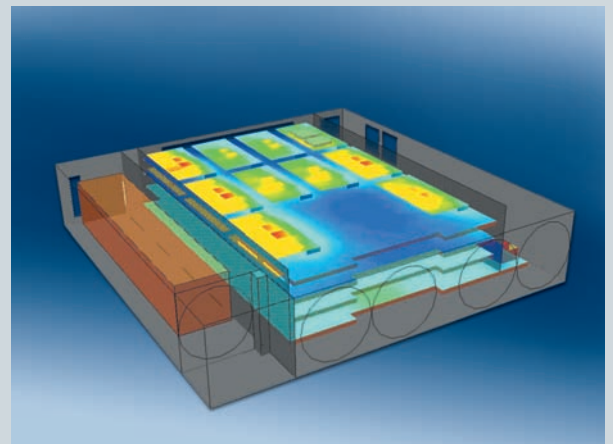
A complete toolset for cooling analysis

NX I-deas Electronic System Cooling provides you with a comprehensive set of tools to simulate 3D air flow and thermal behavior in electronic systems. With its powerful computational fluid dynamics capabilities, it is also ideal for many automotive, HVAC and industrial applications. As an integrated part of NX I-deas, models are created with 3D design geometry using a simple and intuitive graphical interface.

ESC helps you resolve thermal engineering challenges early in the design process and is a valuable aid in understanding the physics of fluid flow and enclosure heat transfer. For quality assurance, ESC is routinely and rigorously tested using an extensive suite of verification test problems.

Modeling and evaluating electronic systems

With ESC, you can effectively model individual components, multichip modules, heat sinks and PC boards, as well as complete electronic systems. This enables you to perform digital thermal simulation early in the design process and reduces the need for building and testing physical prototypes.



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NX I-deas Electronic System Cooling

Features *continued*

- Employ a wide range of simulation capabilities
- Gain rapid and reliable results employing advanced thermal and CFD solver technology

Applications

ESC is capable of modeling more than simple electronic enclosures. It can be applied to a broad range of industries and products:

Computers and peripherals

- Individual components such as disk drives, large rack mounted systems and printers

Consumer electronics

- Ideally suited to complex geometry and compact packaging challenges

Medical and instrumentation

- Electronic systems and instrument sensors and control systems

Automotive electronics

- Individual electronic modules and electrical systems exposed to extreme environments

Automotive cooling and heating

- Heating and ventilation systems, underhood and car cooling, as well as headlamps

Communication

- Rack-mounted systems in climate-controlled rooms and outdoor equipment in extreme environments

Aerospace and avionics

- Electrical and electronic systems on aircraft as well as lighting systems

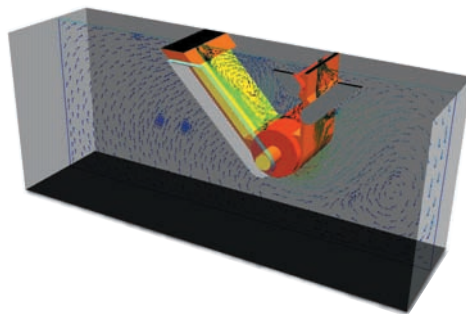
Building HVAC/clean room ventilation

- Duct systems, ventilation diffusers and investigating flow in large spaces or controlled environments

Unstructured free meshing and powerful mesh coupling technology enable you to use a single model for both system-level and component-level analyses. ESC helps you quickly perform a detailed thermal analysis and pinpoint design problems.

ESC assists with practical thermal engineering challenges, such as optimizing critical component placement or predicting the operating point from the manufacturer's fan curve data. You can investigate both forced and natural convection cooling schemes, and evaluate the positioning and sizing of fans and vents.

ESC automatically aids with spacing requirements between boards and assemblies. It also helps optimize the size and shape of heat sinks to maximize convection. In addition, you can investigate conductive heat transfer using thermal vias, heat pipes and heat spreaders.

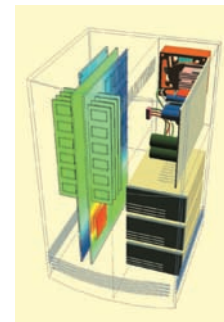


Mechanical design integration

Integration with NX I-deas digital product design suite enables you to effectively use simulation to provide design guidance, not just verification. As an integral part of ESC, no additional input files or geometry conversions are needed to build thermal and flow models.

ESC responds to the needs of mechanical design specialists and nonspecialists alike, providing rapid turnaround. Integrity is assured by maintaining data associativity between model building, solving and results interpretation. ESC provides the ability to model, catalog and share parts and material libraries among the entire design team.

Minimizing tedious rework and modeling errors, ESC interfaces with EDA design systems for direct data exchange with PCB layout programs using PCB.xchange. ESC is fully coupled to TMG Thermal Analysis within NX I-deas, offering both advanced conduction and advanced radiation modeling. Flow and thermal results can be used as boundary conditions for thermal stress and deflection analysis with NX Model Solution, also within NX I-deas.



Easy to learn and use

ESC uses a simple and intuitive interface. All functions are performed using icons and forms. Modeling is performed directly on design geometry. ESC uses

terminology familiar to electronics packaging engineers and offers intelligent defaults for all options. Input is verified as it is entered on the form, and modeling units are shown.

Model checks and diagnostics alert you to modeling mistakes and provide quick solution summaries to help verify your results. Online help and reference materials are always available to guide you through all modeling operations. ESC provides simple and reliable tools to meet the most demanding analysis requirements.

Modeling complex geometry

ESC provides an extensive set of tools for creating analysis geometry. The modeling of complex assemblies is made easy with NX MasterFEM within NX I-deas. Automated free meshing tools enable you to quickly model parts using precise wireframe, surface and solid geometry. You can refine the mesh in critical areas and selectively control mesh density, minimizing model size for rapid solution times. Full associativity with design geometry means that the mesh is automatically updated when your design is modified.

Applications *continued*

Component and electronic packages

- Detailed modeling of wire-bonded, flipchip, MCM and BGA packages (This can be used in combination with NX Model Solution Nonlinear within NX I-deas to solve thermal stress and distortion problems)

Biomedical

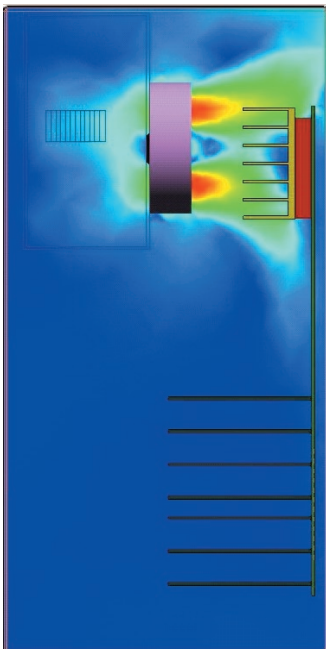
- Blood flow, viscoplastic fluids flow, medical fluid exchange and circulation systems

System requirements

Electronic System Cooling shares the NX I-deas system requirements.

Recommended system configuration

For information on particular operating systems or graphics cards, please visit <http://support.ugs.com/>



Unique modeling approach

Analysis turnaround is significantly reduced through the use of powerful modeling tools. The fluid flow mesh does not need to be aligned to the solid thermal mesh. The fluid flow model adapts around convecting surfaces and flow obstructions. Convection heat transfer from the components, boards and enclosures is calculated using local flow conditions and geometry. The simulation can be tuned for modeling convection from PC boards and the drag due to components. Heat transfer coefficients and surface roughness can be automatically calculated or specified.

Dissimilar meshes are automatically coupled, greatly simplifying meshing and dramatically reducing mesh density. Thermal couplings are automatically established based on proximity and are distributed to account for overlap or mismatch between dissimilar meshes.

This is a powerful tool for modeling junction-to-case thermal resistances, component-to-PCB interfaces, card edge guides, bolted or bonded connections, multilayer materials and free convection from exterior surfaces. Isotropic and orthotropic conduction can be modeled using 3D solid, 2D shell and beam elements.

Powerful computational fluid dynamics and thermal simulation

ESC uses computational fluid dynamics coupled with a finite volume thermal solver to accurately and efficiently simulate fluid flow, convection, conduction and radiation. An element-based, finite volume CFD scheme is used to compute 3D fluid velocity, temperature and pressure by solving the Navier-Stokes equations.

The combination of 3D CFD and thermal solver technology allows you to simulate complex situations, including:

- Coupled 3D fluid flow and thermal problems
- Component heat loads and operating temperatures
- Forced, natural and mixed convection on arbitrary geometry
- Turbulent, laminar and mixed flows
- Steady-state and transient analysis
- Multiple enclosures

- Internal or external flows
- Orthotropic and isotropic conduction
- Nonlinear material properties
- Radiative heat transfer between surfaces
- Thermal characterization of component packages and heat sinks
- Internal and external fans
- Predicting the fan operating point with manufacturing fan-curve data
- Recirculation systems
- Altitude effects
- Losses in fluid flow due to screens, filters and other obstructions
- Convection to the surrounding environment and solar heat loads
- Moving or rotating surfaces
- Slip and symmetry conditions
- Thermoelectric coolers
- Rotating machinery, including periodicity
- Humidity, condensation and evaporation
- Particle tracking
- Non-newtonian fluid flow
 - Power Law (molten polymers)
 - Herschel-Bulkley and Bingham for viscoplastic fluids (blood flow, drilling mud, nuclear fuel slurry, etc.)
- Supersonic flow up to Mach 4

Robust and reliable solver technology

ESC combines the versatility of FEM-based analysis with the power and accuracy of a control-volume formulation. The fluid flow and thermal models are solved iteratively. Algebraic, multigrid solver technology is used to ensure efficient solution convergence; solution time is linear with model size.

Calculation points for momentum, mass and energy are co-located and the momentum and mass equations are solved together. Turbulence models include mixing length, k-e and fixed turbulent viscosity. Advanced 3-layer log-law wall functions are used to model convection and surface effects. First- or second-order advection schemes can be selected.

During analysis execution, a solver monitor dynamically plots solution convergence and displays intermediate results to monitor progress. You can stop the solution, display intermediate results or change solution parameters and restart at any time.

Simulation results

Simulation results can be displayed with graphical plots, charts and reports. This helps you understand and gain physical insight, as well as improve or optimize your design. Results can be displayed using 3D vector, particle path, contour, criterion and carpet plots. You can dynamically rotate result displays and interactively probe for specific data. It is easy to generate tabular reports, XY or XYZ graphs to communicate your results to a design team.

The following simulation results are available for post-processing:

- Fluid velocity
- Fluid and solid temperatures
- Fan, vent and screen mass flux
- Heat flux
- Fluid pressure
- Heat transfer coefficients
- K- turbulence data
- Fluid density
- Surface shear stresses
- Error and local dimensionless values
- Mach number
- HVAC human thermal comfort results:
 - ASHRAE Predicted Mean Vote (PMV)
 - ASHRAE Predicted Percent Dissatisfied (PPD)

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