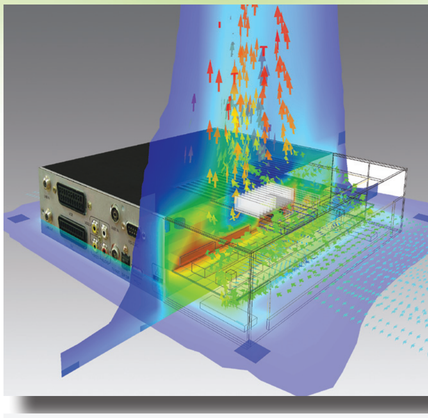
FloTHERM®

Optimizing the Thermal Design of Electronics

Small and large companies alike rely on FloTHERM to perform their thermal-fluid analysis confident of the return on their investment. FloTHERM is powerful 3D simulation software for thermal design of electronic components and systems. It enables engineers to create virtual models of electronic equipment, perform thermal analysis and test design modifications quickly and easily in the early stages of the design process well before any physical prototypes are built. FloTHERM uses advanced CFD (computational fluid dynamics) techniques to predict airflow, temperature and heat transfer in components, boards and complete systems.

Experience the benefits of using FloTHERM for electronic thermal design, that include:

- solving thermal problems before hardware is built;
- reducing design re-spins and product unit cost;
- improving reliability and overall engineering design; and
- significantly reducing time to market.



Parameterized models of common components found in electronics systems enables plug and play with library swapping as well as easy parametric variation.

KEY SMARTPART FEATURES:

- Complete set of SmartParts (intelligent model creation macros).
- Multi-level SmartParts (compact and detailed representations in a single object).
- Explorer-style Project Manager with drag-and-drop functionality.
- CAD-style, mouse-driven drawing board using simple draw, drag and drop operations to create and manipulate geometry.
- Structured Cartesian grid that can be "localized" and nested to minimize solve times and enable multi-scale modeling.
- Hundreds of objects and attributes available in an installed library including fans, blowers, components, heat sinks, materials, thermal interface materials and more.
- Object-associated grid that combines model creation and grid generation into a single step.

Model Creation

SmartParts®

FloTHERM features a comprehensive set of intelligent model creation macros (SmartParts) to allow a broad range of electronics cooling applications to be built quickly and accurately. SmartParts are available for:

- Heatsinks
- Fans
- Printed circuit boards
- Thermo-electric coolers
- Enclosures
- Components
- Heat pipes
- Perforated plates
- Dies
- Racks (Datacentre application)
- Coolers (Datacentre application)

All SmartParts incorporate over two decades of electronics cooling modeling experience at Mentor Graphics' Mechanical Analysis Division, and are aimed at streamlining model creation, minimizing solution times, and maximizing results accuracy.

Integration with MCAD & EDA

FloTHERM also features advanced, tight integration with MCAD and EDA (Electronics Design Automation) software. Data from Creo Parametric, Solidworks, CATIA and other major MCAD tools can be imported, simplified and converted into FloTHERM objects. Interfaces to Board Station, Xpedition PCB, Allegro and CR5000 extract board outline and component information for import into FloTHERM.

FloMCAD™ Bridge

FloMCAD Bridge enables parts and assemblies from Mechanical Computer Aided Design (MCAD) software (such as Creo Parametric, SolidWorks, CATIA, etc.) to be transferred easily and rapidly to FloTHERM for thermal analysis.

FloMCAD Bridge is more than just an interface program - it intelligently filters the geometrical data for a particular part or assembly and creates a simplified "thermal equivalent" for analysis purposes. This is critical because production quality MCAD solid models contain a vast amount of thermally insignificant geometric detail (fillets, small holes, chamfers, screw treads, etc.) that provide no accuracy benefit if included but can drastically slow down the solution process. The ability of FloMCAD Bridge to defeature a part to match its thermal importance prior to translation into FloTHERM objects offers a massive improvement in the efficiency of the model creation work flow process.

"In half an hour or even less, we can construct a model that previously would have taken us two days to produce."
- Dr. Filip Christiaens, Alcatel

FloEDA™ Bridge

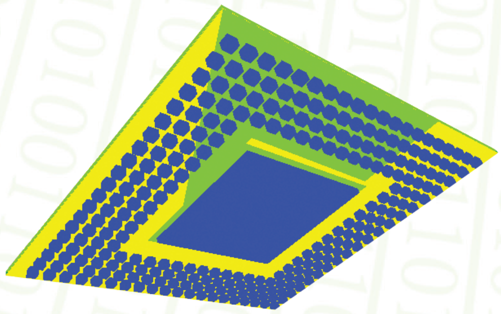
FloEDA Bridge enables both import of detailed PCB designs as well as the ability to quickly sketch out conceptual layouts.

Detailed PCB or BGA substrate designs can be imported in either the industry standard IDF format, or more detailed designs imported from our direct interfaces to the most common PCB design platforms. Full component layout, PCB stack-up and detailed descriptions of the metallic distribution on power, ground, signal and dielectric layers are loaded. A unique method for the capturing of the metallic distribution provides a user controlled ability to define the level of resolution of the thermal conductivity map. Block, 2R, DELPHI or 'Detailed' component modelling levels can be selected, including an automated ability to 'swap-in' higher fidelity models from an existing thermal model library.

Conceptual layouts can be quickly sketched out, stack-ups imported from a user defined library, then transferred to FloTHERM for preliminary thermal simulation investigations.

FloTHERM® PACK

FloTHERM PACK (www.flothermpack.com) is a web-based software program which produces reliable, accurate thermal models of IC packages and associated parts with the minimum of effort. Designed to fulfill the industry´s need for a rapid response to innovations in packaging design, FloTHERM PACK is a web-based application that contains a parametrically-driven menu for each part type. To take advantage of FloTHERM PACK, you use your standard web browser to enter data describing the IC package you want to use. For example, if you want to build a model of a ball grid array (BGA) package, the typical data entry items would include: number of balls, substrate conductivity, die size, and substrate metal layer thickness and coverage.



Automation

FloXML

FloTHERM's geometry and model data can be created by external scripts and utilities, for subsequent import into FloTHERM. The FloXML file format can hold any data that could be manually created in FloTHERM itself. Including objects, attributes, mesh and solver control settings. For standardized applications that would require repeated manual definition in the FloTHERM GUI, such FloXML generating scripts can drastically reduce the effort required for generation of ready-to-solve models and modeling data.

FloSCRIPT

Actions performed in FloTHERM are logged to a FloSCRIPT file. This file can be re-played so as to repeat those actions in a FloTHERM session. This offers additional automation opportunites whereby changes to an existing model can be created by bespoke external scripts and utilities, further reducing what would otherwise be time consuming manual model interventions.

Meshing

FloTHERM mesh is structured Cartesian - the most stable and numerically efficient type of mesh available. The ability to localize is also included for finer resolution where it is needed, minimizing solution time.

Mesh in FloTHERM is associated with SmartParts and is generated as part of the model assembly process with refinement under user control. This methodology is intuitive and straightforward enabling engineers to focus on design rather than analysis.

Meshing is instantaneous and reliable in FloTHERM, as compared to traditional tools that require significant time and expertise to master. Finally, FloTHERM is the only analysis software with object-associated mesh that eliminates re-meshing for each model modification.

KEY SOLVER FEATURES:

- Concurrent solution for convective, conductive and radiative heat transfer.
- Solution termination optionally based on convergence of user defined monitor points.
- Multi-fluids capability.
- Ability to simulate either turbulent, laminar and transistional flow.
- Definition in transient variation in terms of linear ramping, power increase, exponential increase, sinusoidal, periodic or imported .csv pointwise variations.
- Fully automatic radiation exchange and view factor calculation.
- Automatic solar loading boundary conditions.
- Transient thermostatic control.
- Interfacing to FEA tools for thermo-mechanical simulation.

Solver

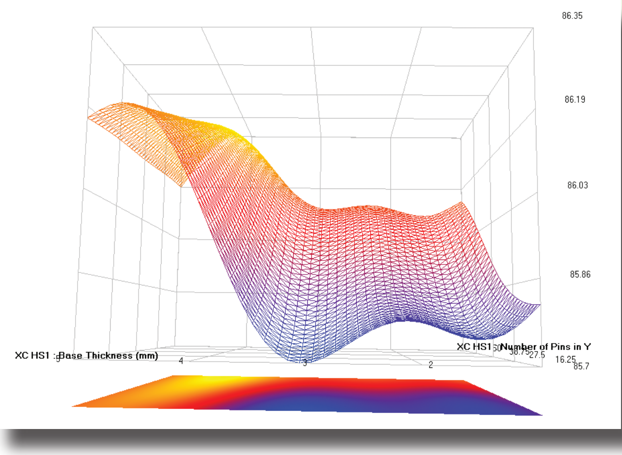
For over 25+ years, the FloTHERM solver has specifically addressed electronics cooling applications. The solver produces the most accurate results possible and the fastest solution time per grid cell. Massive disparities in geometric length scales are resolved using the unique 'localized-grid' technique which allows for integrally matched, nested, non-conformal grid interfaces between different parts of the solution domain. The conjugate nature of heat transfer within electronic systems is concurrently solved using a preconditioned conjugate residual solver together with a flexible cycle multi-grid solution technique. Pragmatic, unique and accurate solution termination criteria produce useful results in engineering, not academic, time scales.

FloTHERM®

Transient Analysis

The powerful transient analysis capabilities in FloTHERM also allow for prediction of a number of different transient behaviors. Time dependent power dissipation in components can be defined via .csv import of power versus time data. An accurate prediction of the thermal response of the component temperature, in time, may then be produced without the conservative assumption of constant “steady state” power consumption.

Transient thermostatic control modeling can be performed via the ability to have a model input vary, not only as a function of time, but also optionally as a function of a monitored temperature during the transient solution. This allows for temperature controlled fans to be considered as well as determination of power derating and thermal mitigation strategies.



Pressure Drop vs Heat Sink Parameters

Post-Processing

The FloTHERM visualization toolset is developed specifically to maximize productivity for design of electronics cooling. Fully rendered models, 3D flow animation and tools for dynamic manipulation of temperature and flow results, enable engineers to pinpoint thermal issues and visualize design improvements quickly and effectively. Texture mapping and AVI output enables communication of thermal-design concepts with non-technical colleagues.

KEY VISUALIZATION FEATURES:

- Particle animation to visualize complex, 3D airflow.
- Contour animation to visualize heat transfer paths.
- Isosurfaces and surface temperatures.
- Airflow representation by vectors or ribbons colored by temperature or speed.
- AVI output of flow animation.
- Dynamic particle tracking allowing the user to gain a better understanding of complex flows.
- Image texturing for realistic visualization.

PARAMETRIC ANALYSIS AND OPTIMIZATION

SmartPart-based modeling and structured Cartesian grid enable Design of Experiments technology to be applied to a FloTHERM model. Design of Experiments (DoE) is a structured method for determining the relationship between design parameters (e.g., number of heatsink fins, location of vents, etc.) and results (component temperatures, fan flow rate, etc.). FloTHERM’s Design of Experiments implementation efficiently explores the design space by building and solving variants of the initial model. This provides critical information regarding the sensitivity of the thermal results to changes in the design parameters while minimizing the number of simulations to be solved and serves as the foundation of the powerful response surface and sequential optimization design tools. To assist with the solution of the Design of Experiment cases, the user may optionally use a distributed network of computers using ‘Volunteer’ solution technology.

FloTHERM extends this concept by computing response surfaces for all results of interest. Response surfaces are mathematical equations derived from the DoE results that estimate the thermal solution anywhere in the design space instantaneously. The user may interact with the constructed Response Surfaces with real-time 2D and 3D plots that have slider bars to control the design parameter values. Mathematical optimization of a user defined cost function is fully supported with the Response Surfaces as well, enabling the optimal solution to be estimated without solving additional cases.

Automatic sequential optimization of the cost function can be performed as well. This gradient based approach will build and solve additional variants of the initial model to explicitly determine and confirm what the optimal thermal solution is. Sequential optimization is able to understand design constraints (such as maximum component temperatures) and incorporate them into the presented optimal configuration.