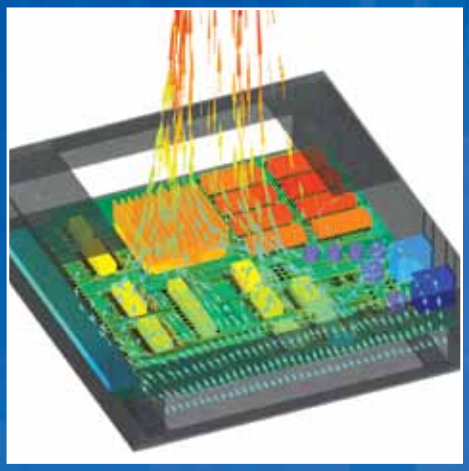
FloTHERM®

Optimizing Thermal Design of Electronics

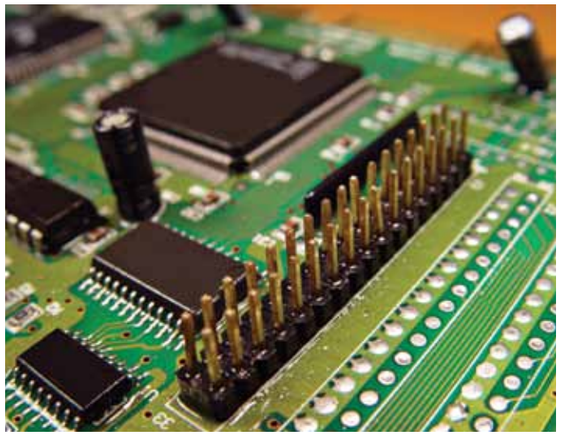


Mentor Graphics®

Mechanical Analysis

Overview

FloTHERM has more users than all other competing analysis software combined, making it the clear market leader in thermal analysis software for the electronics industry. Small and large companies alike rely on FloTHERM to perform their thermal-fluid analysis confident of the return on their investment. As a matter of fact, 19 out of the top 20 global electronics companies use FloTHERM for their product design and development. FloTHERM is the #1 software of choice for industry leaders who face the most challenging thermal problems to keep them ahead of their competition.



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.

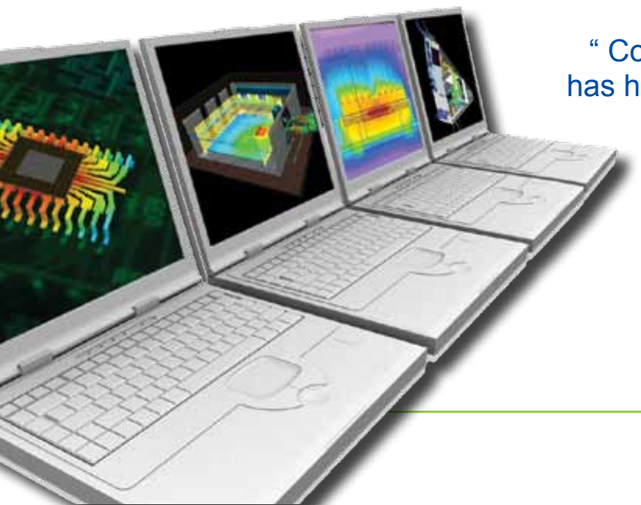
Unlike other thermal simulation software, FloTHERM is an industry-specific analysis tool specially designed for a wide range of electronic applications that include:

- computers and data processing
- telecommunications equipment and network systems
- semiconductor devices, ICs and components
- aerospace and defense systems
- automotive and transportation systems
- consumer electronics

FloTHERM features specialization, built-in intelligence and automation not found in traditional analysis software. This functionality maximizes productivity for thermal design experts, minimizes the learning curve for mechanical design engineers and provides the highest levels of return on investment available from analysis software.

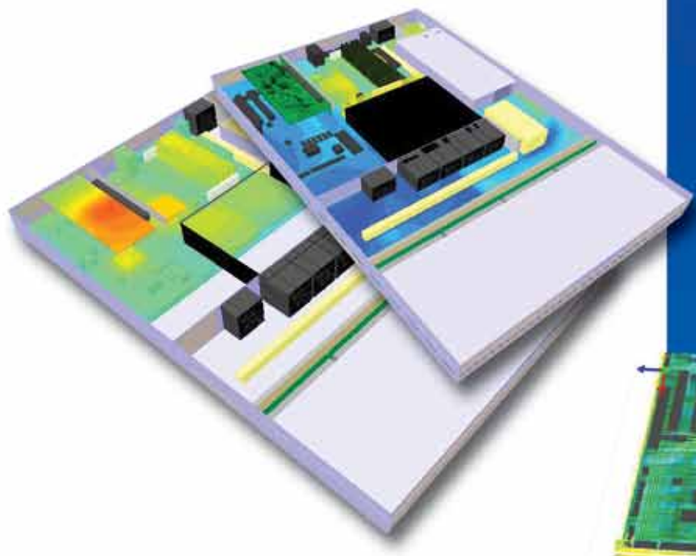
In a small to medium-sized company, FloTHERM can pay for itself several times over in just one year and even faster as the size of the company increases. Experience the benefits of using FloTHERM for thermal design of electronics that include:

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



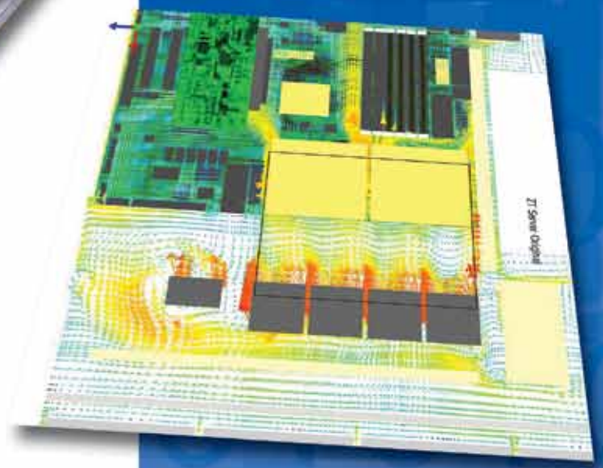
“ Combining FloTHERM® PCB and FloTHERM has helped to reduce the number of engineering prototypes we require, reducing cost and time to market. ”

Wei-Pin Wu, Principal Engineer, Johnson Controls



“ Thermal simulation provides enormous advantages in bringing a new product to market because it helps us visualize airflow and temperature throughout the entire design space and gives us the ability to quickly evaluate the performance of alternative designs. ”

Sepi Pashaie, Thermal Engineer, ZT Systems



Model Creation

SmartParts®

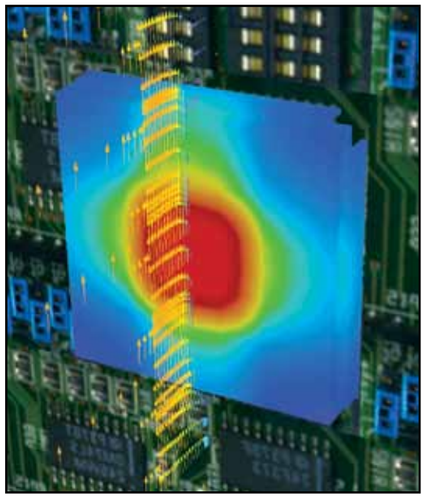
FloTHERM features a comprehensive set of intelligent model creation macros (SmartParts) to allow a broad range of electronics cooling applications to be built quickly and accurately. SmartParts are available for:

- Heat sinks
- Fans
- Printed circuit boards
- Thermo-electric coolers
- Enclosures
- Components
- Heat pipes
- Perforated plates
- Dies

All SmartParts incorporate 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 the industry's best solution for integration with MCAD and EDA (Electronics Design Automation) software. Data from Pro/ENGINEER®, SolidWorks®, CATIA® and other major MCAD tools can be imported, simplified, and converted into FloTHERM objects. Interfaces to Allegro®, Board Station®, Expedition® and CR5000 extract board outline and component information for import into FloTHERM.



Key Features

- Import project and geometry data in a new XML format
- IcePak to XML converter
- 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
- Simple and easy to use modeler for creating and manipulating geometry
- Structured Cartesian grid that can be "localized" and nested to minimize solve times and enable multi-scale modeling
- Thousands 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

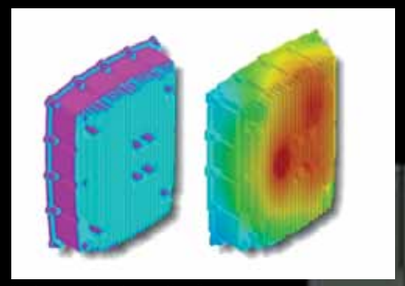
Grid

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

Grid 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.

Gridding 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 grid that eliminates re-gridding for each model modification.

Cambridge Broadband's VectaStar 3500



"Intelligent integration"
A section of the geometry of this point-to-multipoint broadband wireless access equipment is automatically simplified for speedy thermal analysis

"Since we have begun simulating every new packaging configuration, we have never had to make a late-stage design change nor has any product been delayed for thermal reasons."

Jitesh Shah, Advanced Packaging Engineer for IDT.

Solver and Design Optimization

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 heat sink 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.

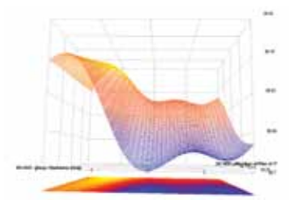
Automatic sequential optimization of the cost function can be performed as well. This gradient based approach will build and solve additional variants of the initial model to explicitly determine and confirm what the optimal thermal solution is. Sequential optimization is able to understand design constraints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

Solver

For over 20 years, the FloTHERM solver has specifically addressed electronics cooling applications. The solver, based on a Cartesian gridding system, results in 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.

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. Updates to the transient model definition are significant starting with the consolidation of all set-up dialogs into the single [Model/Transient] dialog. Other timesaving features include the automatic creation and naming of time patches based on the key point time grid, single edits to multiple time patches and populate save times steps with every Nth step. Also added are the abilities to highlight selected time patches on the time step distribution plot, a display of transient functions overlaid on time step distribution plot and a warning message issued when a material attribute is present with specific heat or density values set at the default of 1.0.



Pressure Drop vs Heat Sink Parameters

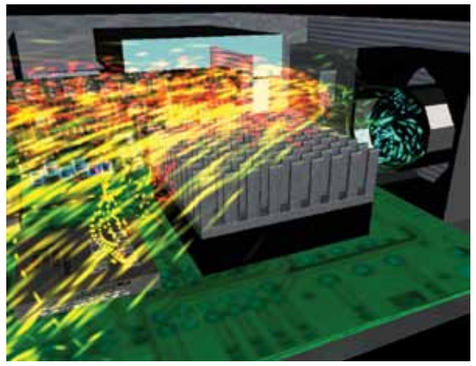
Key Solver Features:

- 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 or laminar 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

Visualization

The FloTHERM visualization toolset is developed specifically to maximize productivity for sharing the results of your design and analysis for your electronics cooling projects. 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 enable communication of thermal-design concepts with non-technical colleagues. Most recently thermal Bottleneck (Bn) and Shortcut (Sc) fields have been added to allow engineers to visualize existing thermal bottlenecks and any opportunities to insert a new heat flow path in order to shortcut the heat to cooler areas.

A complimentary, full-functional version of the post-processor which can be used for easy "off-site" results presentation is available with the FloVIZ Viewer.



Some Key Features:

- Bottleneck and Shortcut fields offer additional insight into improving designs
- FloVIZ™ a freely available fully functional post processing viewer
- Particle animation to visualize complex, 3D airflow
- Reflect temperature dependent leakage effects at sub-90nm scales
- 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

"The value of FloTHERM 9 is in the time and the cost it saved us when developing an IC for a new generation of Energy Star-compliant mobile phone chargers. The baseline simulation using the 'bottleneck' feature quickly highlighted a potential thermal issue, and further iterations confirmed our solution. To achieve the same result by building prototype boards would have taken a long time and drawn resources away from other critical work. FloTHERM has helped us reduce development costs and kept our project on track to meet our customer's aggressive deadline."

Nigel Heather, Vice President of Engineering, CamSemi

FloMCAD™ Bridge

FloMCAD Bridge enables parts and assemblies from Mechanical Computer Aided Design (MCAD) software (such as Pro/ENGINEER, 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 it’s thermal importance prior to translation into FloTHERM objects offers a massive improvement in the efficiency of the model creation work flow process.

FloEDA™ Bridge

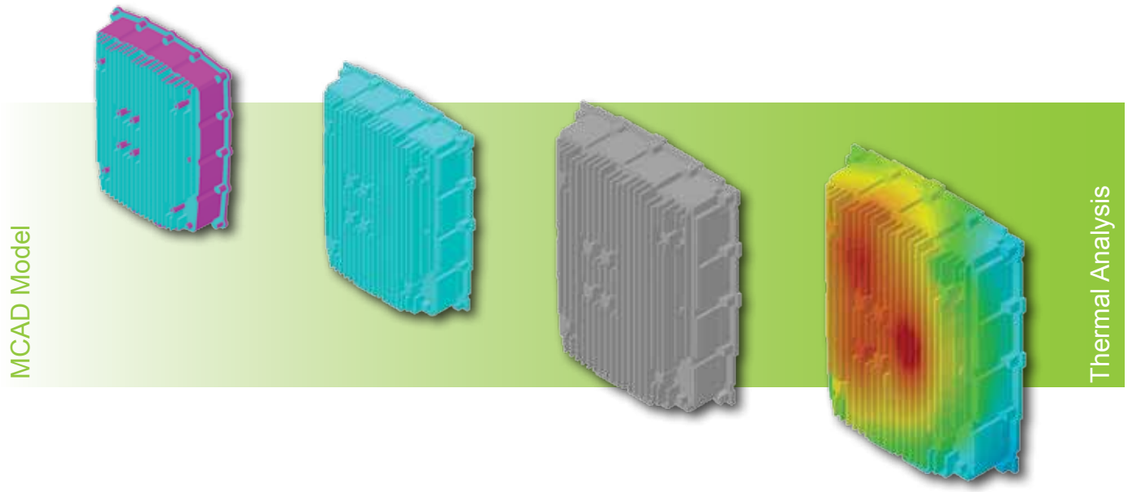
FloEDA Bridge enables printed circuit board designs from Electronic Design Automation (EDA) software (such as Board Station, Expedition, Allegro, CR5000, etc.) to be transferred easily and rapidly to FloTHERM for thermal analysis.

FloEDA Bridge works with extracted information from the EDA tool to create FloTHERM representations of the board outline, layer stack up, via distribution, and component layout. FloEDA Bridge represents the copper distribution in each layer with a tessellated (resolution is user controlled) thermal conductivity map. This ‘filtering’ enables the complex copper distribution in a board to be included with excellent accuracy and without resorting to excessive geometric detail.

After import, FloEDA Bridge offers many features to expedite the further physical description of the board.

- One click to add common items like heat sinks, thermal vias, daughterboards, shielding cans that are not usually found in the EDA tool but with important thermal consequences
- Component filtering to ignore thermally insignificant packages and improve solution times
- Automatic or manual swapping with objects residing in the FloTHERM library
- Import and visualization of power maps

FloEDA Bridge fits perfectly into the existing design flow and permits the user to quickly import existing EDA data, and easily refine that data as appropriate.



“ We use FloMCAD Bridge to simplify our original mechanical CAD files and quickly create computational models for the simulations. The way FloTHERM represents electronic components is a key advantage, enabling us either to use simple thermal data from component datasheets or switch to detailed 3D models for critical components when necessary. ”

Jorge Giménez Romo, Hardware Engineer, Tecnobit

FloTHERM® PACK

FloTHERM PACK 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.

If you do not have detailed information about the internal geometry of your part, the JEDEC library SmartPart wizard in FloTHERM PACK lets you create ‘best guess’ thermal models quickly and easily. All you need to do is answer three or four questions about your component. Utilizing built-in intelligent rules based on common industry design practices, the SmartPart wizard derives the rest of the information needed to generate the model.

FloTHERM PACK also enables you to preview models in 3D to verify that your input parameters are correct. After previewing simply download the model to your local computer and drop it into your FloTHERM analysis model.

All of the capabilities in FloTHERM PACK mean an enormous productivity boost for you. Indeed you can cut your component modeling time by a factor of 20 or more! FloTHERM PACK does all the thinking required for model generation, freeing you to concentrate on optimizing your design. FloTHERM PACK supports just about all popular package styles in the industry including Ball Grid Arrays, Leaded Packages, Pin Grid Arrays, Transistor Outline Packages, Chip-Scale Packages and Multi-die Packages.

FloTHERM® PCB

FloTHERM PCB is a unique, software program for streamlining concept development of printed circuit boards (PCBs), while ensuring good thermal design and accelerating the PCB design process.

FloTHERM PCB facilitates collaboration between product marketing, electronic engineers and mechanical engineers on PCB design, particularly during the conceptual phase of the design process. FloTHERM PCB uses functionality targeted at permitting all team members to contribute to floor planning exercises, quickly running thermal compliance checks for proposed designs, and easily providing clear thermal feedback to the group. With FloTHERM PCB, inefficient communication between different groups is eliminated and thermal checks are easy and fast. The result is pre-optimized concepts in less time and drastic reductions in late-cycle rework as product marketing, mechanical, thermal and manufacturing issues are solved before concept commit.

FloTHERM® IC

FloTHERM IC is a web-based tool from Mentor Graphics that incorporates a high level of automation for key tasks related to semiconductor thermal characterization and design.

Developed with the needs of design engineers and thermal specialists alike, FloTHERM IC offers the ease-of-use of SmartPart technology combined with the power of FloTHERM to greatly boost productivity of thermal analysis in the semiconductor industry – immediately and on the user’s desktop. An intuitive wizard-driven user interface, interoperability with package-level EDA tools, and enterprise-level data scalability and portability are other key features of FloTHERM IC.

“ FloTHERM PACK saved me about 7 hours of package model building time and another 2-3 hours of simulation time, compared to building the model manually. ”

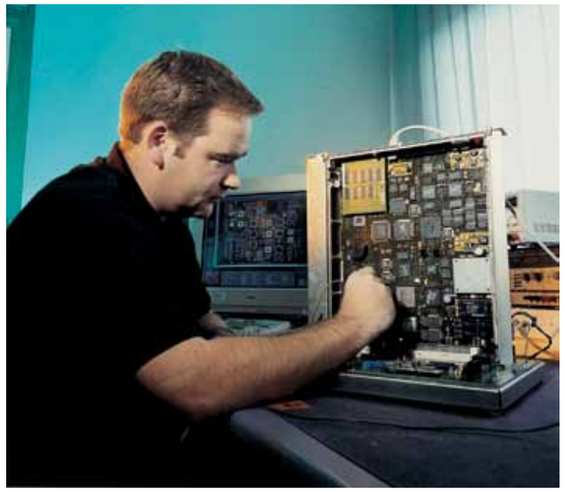
Mark Peterson, Applied Micro Circuits Corporation

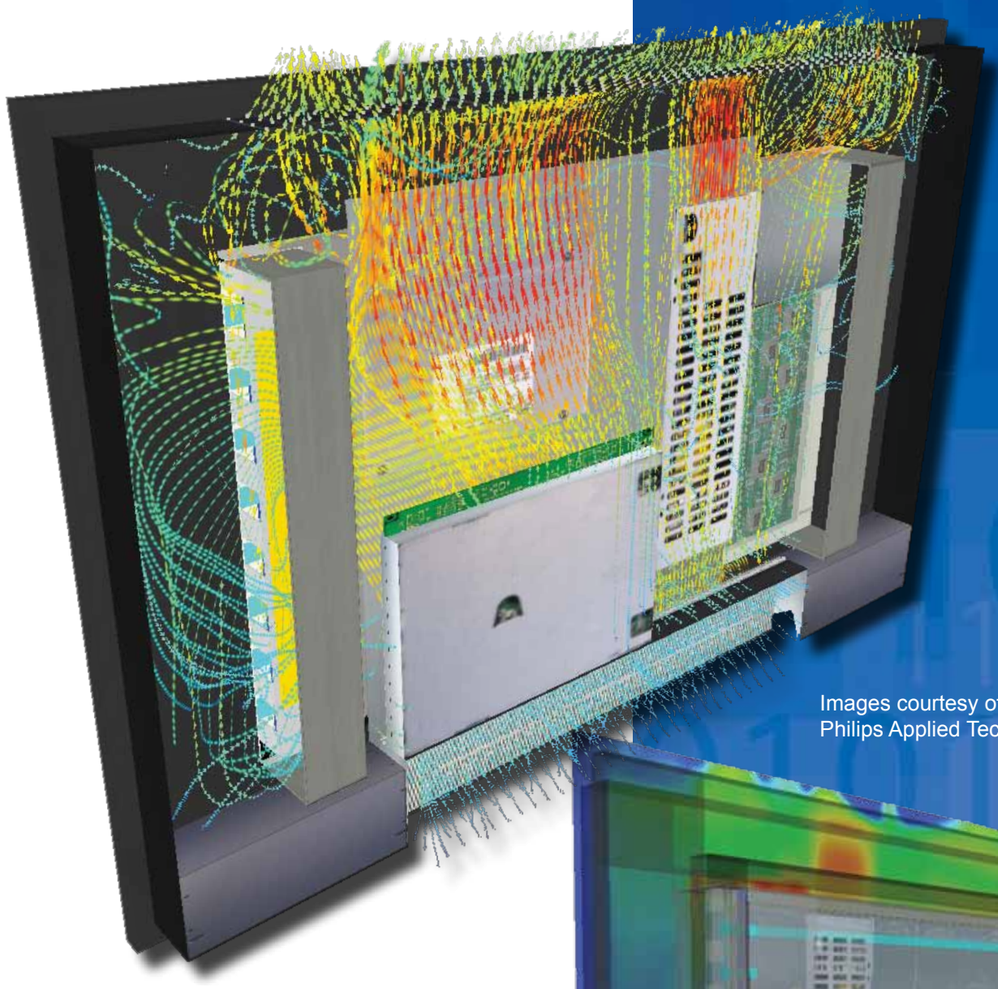
Technical Support

Not just a software company, Mentor Graphics also offers customers comprehensive training as well as on-line and telephone support. In addition, the User Support Area allows licensed users to download the software with the latest documentation and to submit questions and support issues. A wide range of application examples and technical papers are also available on our website: www.mentor.com/mechanical

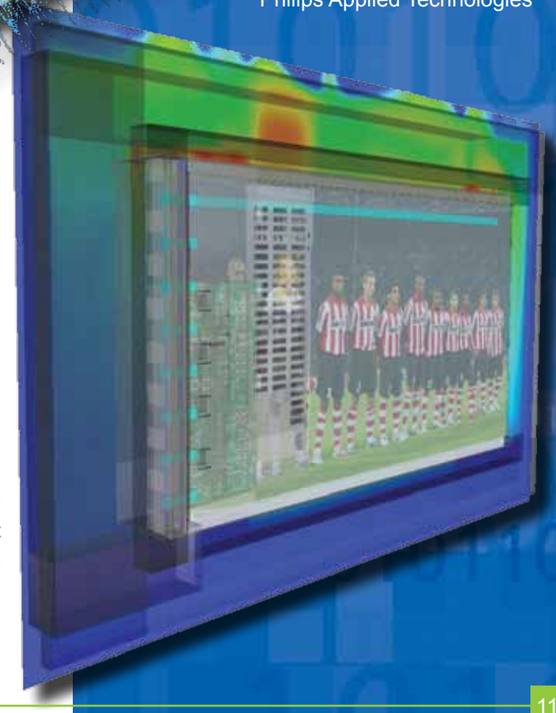
Design Services

If you prefer to outsource part or all of your physical design, our Mechanical Analysis team is ready to help. When you engage us, you effectively add to your staff some of the world's most experienced engineers in thermal analysis of electronics. Starting with any design information you have, we will quickly plan and execute an assessment, regardless of the stage of your product.

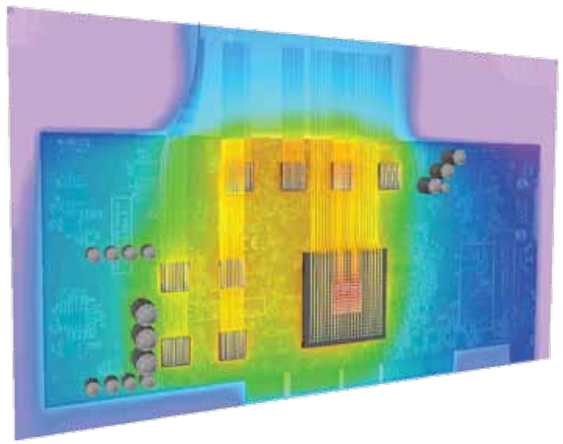




Images courtesy of
Philips Applied Technologies



(Above) Image captured from an animation sequence produced in FloTHERM showing air flow trajectories and velocities for the engineer's proposed vent layout for an LED television



(Right) Image with cross-section showing temperature due to conduction, convection and radiation within product components, the casing and air space

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