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SIMCENTER^{TM}, engineering complex products from Siemens PLM Software for electronic cooling

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Annotation:
For electronic devices, temperature is a limiting factor. Packing technology, driven by constant consumer demand and competitive pressure, allows higher power density than current cooling technology can handle. Sustained elevated temperatures act to not only reduce component efficiency, but also to reduce product life. We present a unique platform Simcenter^{TM} that enables predictive engineering analytics by bringing a strong alignment between 1D simulation and 3D computer-aided engineering (CAE).

Anotace:
Teplota je jedním z hlavních limitujících faktorů při miniaturalizaci elektrických přístrojů. Technologie pouzdření nyní umožňuje dosahovat větších výkonové hustoty, než je současnými technologiemi chlazení možné zvládnout. Zvyšující se tepelné zatížení se negativně projevuje na účinnosti elektrických zařízení a na jejich životnosti. Představujeme unikátní platformu Simcenter^{TM}, která umožňuje prediktivní multi-fyzikální inženýrství díky propojení 1D a 3D simulací CAE.

SMART PRODUCTS

Smart product – that is what consumers want today. These products include mechanical and electronic components, software and controls. For that reason, a unique platform, Simcenter^{TM}, that enables predictive engineering analytics by bringing a strong alignment between 1D simulation, 3D computer-aided engineering (CAE), controls development, design exploration, data analytics and physical testing is brought by Siemens PLM Software.

The electronic industry is one of the most rapidly growing industrial sectors in the world with stringent requirements for thermal solutions. The design of electronics devices is a complex task that necessitates balancing numerous competing objectives. Simcenter^{TM} helps 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 electronic enclosures. Designers often work with stringent temperature constrains, size restrictions, weight limitations and widely varying operating conditions. In addition, designers are forced to evaluate multiple design scenarios. Thermal simulation solutions allow to apply virtual testing in order to gauge design performance for numerous scenarios (Fig.1).

Simcenter^{TM} include flexible options for building virtual prototypes as:

- the ability to import printed circuit board (PCB) and component data using the standard intermediate data format (IDF);
- building geometry using standard templates for heat sinks, chips, PCBs, fans, resistances end enclosures;
- importing geometry from any 3D computer-aided design (CAD) program using either native- or standard- data formats.

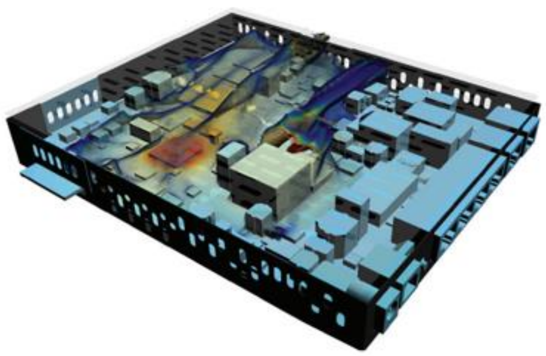

Fig.1: Chip temperatures and convention flow through a wireless router.

Solution of electronics includes also features that enables to group geometry, mesh and physics within one electronic component to more easily bring the data into larger assemblies. By using “quickparts” to create an intelligent simulation component, it is possible to define virtual test conditions and create a library of standard parts unique to your organization. General test conditions can include:

- a combination of the airflow environment, such as temperature, speed, ambient pressure;
- fan curves;
- gravity;
- component heat dissipations;
- contact resistance;

- component thermal network models;
- PCB characteristics and materials.

For obtaining simulation results, a computational mesh is generated first. Then the mesh can be used to solve principal equations. Default mesh settings can be generated on a particular model that can provide a fast, accurate initial solution. In addition, local and global controls to focus the mesh on the most critical areas of the model can be added. The efficient algorithms allow to automatically distribute the mesh generation among available computing cores. Principal equations of computational fluid dynamics are solved by robust, accurate solver. With proven scalability, the solver will utilize whatever computing capabilities you have, from one to thousands of cores.

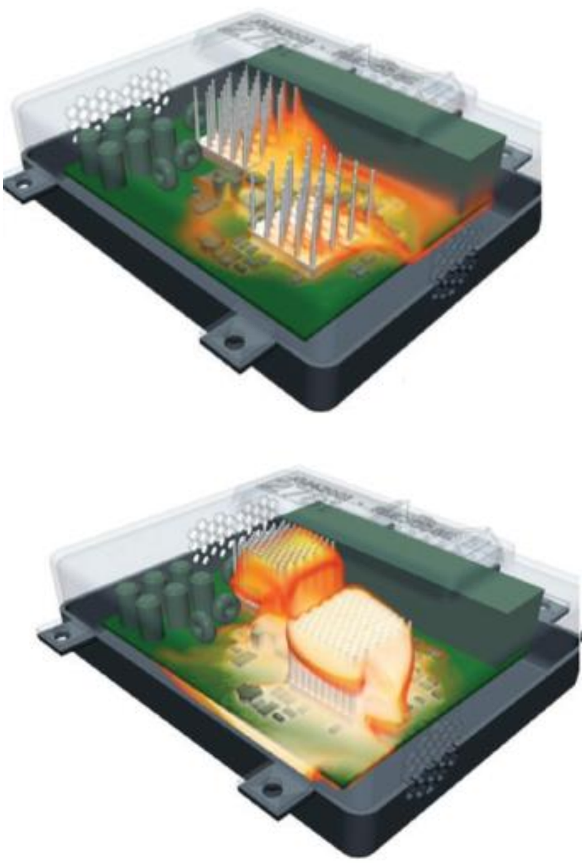

Fig.2: Base design (down) and optimized design (up) showing improved thermal behavior of a heat sink design.

There are many variables to consider in thermal design of electronics devices including: chip locations, heat sink geometry such as the number of fins and their spacing, height, thickness and material, fan operating speed, fan location and enclosure venting. During the process of solving equations for these variables, results are investigated in real time. Also, additional methods to gain further insight into system performance to help guide decisions and recommendations for system improvement can be accessed, such as:

- quantitative data analysis tools for evaluating peak chip temperatures, heat flux rates, air flow speeds and pressure drop;
- qualitative tools to visualize multi-dimensional flow patterns with surface plots, section views, vectors, streamlines and isosurface.

It is possible to communicate results using static images, animations and data exported to a text file or spreadsheet software. In addition, you can export and review portable 3D results using the free viewer, which requires no license and can be easily downloaded and installed.

Simcenter™ portfolio is provided with powerful simulation solution to explore a broad range of design options to improve electronic device (Fig.2). Automated exploration allows to simplify the process, add learning algorithms to intelligently search the design space and clearly show the impact of proposed design alternatives. Simcenter™ portfolio is built for automated exploration and is well suited to help your efficiently explore design alternatives.

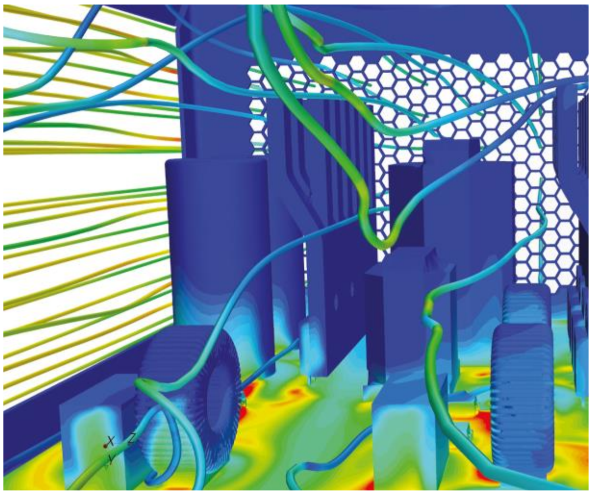

Fig.3: Pressure distribution and streamlines.

For electronic devices, temperature is a limiting factor. Packing technology, driven by constant consumer demand and competitive pressure, allows higher power density than current cooling technology can handle. Sustained elevated temperatures act to not only reduce component efficiency, but also to reduce product life. Effectively controlling the temperature of electronic systems, in an intelligent and sustainable manner, is therefore the key to producing smaller, more powerful and more resilient electronic devices.

Air-cooling, while effective for low- to medium-power applications (where space and noise are not a concern), is generally neither practical nor cost-effective for high-powered systems. Put simply, the “brute force” approach, in which high-temperature components are strapped onto a large aluminum heat sink and blasted with cold air, is no longer an option.

So, what is the best method for cooling high-power electronics when air solutions are not practical or possible? The future of electronics cooling involves the implementation of cooling strategies that leverage multiple modes of heat transfer. The problem for engineers developing electronics cooling solutions is that many of the simulation tools were developed entirely for analyzing simple “bread-and-butter” scenarios. These tools, although adequate for obtaining “quick and dirty” fan-assisted air-cooled solutions, are generally not fit for simulating the more advanced physics required to represent more recent and sophisticated cooling strategies.

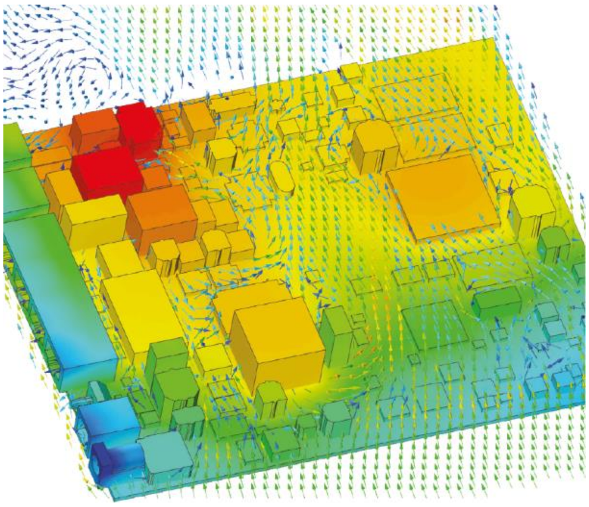

Fig.4: Temperature map and velocity vectors of PCB

Among the more advanced physics we can count:

- Fan performance and acoustics
- Phase change (heat pipes, phase change heat sinks)
- Dust build ingress and accumulation
- Anisotropic thermal conductivity(PCB)
- Radiation

For solving advanced physics we therefore need an advanced simulation tool like STAR-CCM+ with the multiphysical capabilities.

The length scales represented in electronics cooling problems can span many orders of magnitude: from individual transistors to entire datacenters. No tool can account for every single electronic component in a datacenter cooling simulation. Even if it were possible to do so, it is doubtful that such a simulation would provide additional useful information.

Therefore, engineers use a combination of 1D simulation tools like Simcenter Amesim and 3D simulation tool like STAR-CCM+ together with the engineering assumptions and focus the 3D simulation on those length scales that are most important for the simulation. However, care must be taken not to over simplify things, if the assumptions are too great then the results predicted by the simulation begin to diverge from those that would occur in reality.

LITERATURA

[1] Siemens PLM Software, www.siemens.com/plm