future facilities

6SigmaET

Thermal Focus: Aerospace

Thermal trends changing the face of aerospace electronics design

Introduction

No matter what industry you're in, thermal considerations are fundamental when it comes to designing electronic equipment. Here at Future Facilities, our 6SigmaET product team prides itself on staying at the cutting edge of trends and technology that will drive the future of our sector.

To do this, we regularly gather together industry experts to explore the key innovations, opportunities and thermal challenges that design engineers are facing. Through the insights delivered at these focus groups, we can design simulation products that are more accurate, more powerful and more intuitive for today's thermal engineers.

Previously in these sessions, we've put the spotlight on the **automotive, LED** and **IT industries**. Now, in this latest addition of our Thermal Focus series, we're turning our attention to the aerospace industry, exploring thermal trends and challenges that aerospace engineers face today.

Who should read this report?

- **Electronics and design engineers** working in the aerospace industry
- **Thermal engineers** working on aerospace hardware and devices
- **Electronics students** interested in thermal engineering and the aerospace industry

The Experts

To gain a comprehensive understanding of thermal management in aerospace electronics, 6SigmaET hosted a virtual roundtable event, bringing together thermal engineering experts from some of the world's leading aerospace companies.

William Villers

TEN TECH LLC

With a core focus on aerospace & defense design, TEN TECH LLC provides manufacturers with high-end mechanical engineering design, analysis, physical testing support and hardware prototyping services.

Johanne Sevigny

CMC Electronics

Founded in 1903, CMC Electronics is a Canadian electronics company that designs and produces leading technology electronics products for the aviation and global positioning markets.

Wessel Wits

Thales Netherlands

Thales Netherlands is part of the Thales Group, a French multinational company that designs and builds electrical systems and provides services for the aerospace, defence, transportation and security markets.

David Flores

Physical Optics Corporation (POC)

Physical Optics Corporation has been a systems integrator of advanced technology since 1985, serving military and defence, as well as security and selected commercial markets.

Mark Seymour

Future Facilities

Hosting our focus group was Mark Seymour, founder and CTO at Future Facilities. He has more than 20 years' experience working in the thermal simulation software space, including helping implement simulation software for brands across the aerospace industry.

Aerospace: The Industry Trends

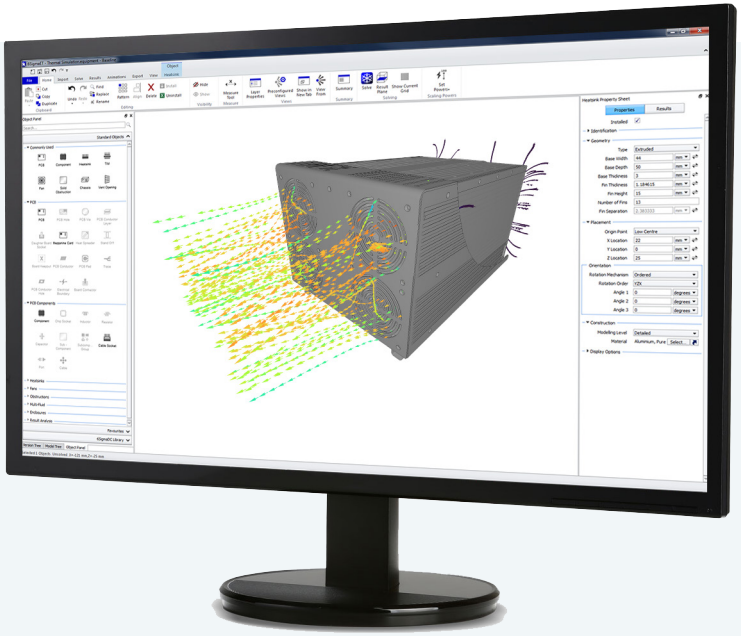
For most electronics, thermal faults typically result in production delays, product recalls or reliability issues. In the aerospace industry, however, the consequences of a thermal failure can be catastrophic.

Critical Consequences

Electronics cutting out in factory machinery or a consumer device is one thing, but when those electronics are part of a critical system onboard an aircraft, missile or space vehicle, the stakes are so much higher.

Faced with these critical consequences, it's vital that aerospace engineers ensure their products are reliable, durable and safe.

When it comes to thermal management, however, this is easier said than done. Aerospace electronics must survive in some of the harshest environments, enduring regular temperature fluctuations, changes in airflow, pressure and even extreme weather conditions. While these challenges have always existed, new trends and innovations are driving further change in the industry, introducing a whole host of new considerations for electronics and thermal engineers. In this guide, we'll explore those trends, and discover how our thermal engineering experts are dealing with them.



Trend 1: Higher Power Density

The first trend identified by our aerospace experts was the need for ever more functionality to be embedded onto compact, more highly-engineered solutions.

Previously, aerospace engineers could easily fit all of the functionality required into a small system that only dissipated around thirty to forty watts. Now, as aerospace electronics grow both more compact and more complex, the same system must dissipate upwards of one hundred watts, that's 3x the power.

Furthermore, the components selected for each system are getting smaller and smaller, with a higher power density. These high-power chips run a greater risk of thermal complication — an issue that is compounded when they are combined in close proximity.

In other industries, engineers would address this through the installation of a fan or via external air cooling. In the aerospace industry, things are more complicated. In high altitude aircraft, fans clog with ice, while in electronics bound for space, the opportunity for natural convection or airflow simply doesn't exist. As such, thermal engineers must look for new ways to dissipate heat away from critical components.

When asked about solutions to these problems, our panel of experts identified liquid cooling and cold plates as the most viable solutions currently available.

What **our experts** say

"**The biggest challenge** facing thermal engineers today is the amount of power that we now put into a system. As components get smaller and smaller and dissipate more heat, we need to be innovative in our designs to cool these components efficiently."

Johanne Sevigny
CMC Electronics

"We are now seeing **multi-chip designs** whereby multiple functionalities are embedded into one chip. As a result, there's more hotspots that need cooling, so engineers require good infrastructure to remove the heat from these hotspots."

Wessel Wits
Thales Group

"We're trying to pack much more electronics in much **higher power density** within the limited spaces on aircrafts like planes and helicopters. The heat that all of these components generate needs a reliable way of being evacuated."

William Villers
TEN TECH LLC

Trend 2: Commercial Devices Enter Extreme Environments

The environments that aerospace electronics are exposed to are much harsher than in almost every other scenario imaginable. A plane taking off in Alaska and touching down in Saudi Arabia is exposed to two extremes in settled temperature, then the difference in temperature on the ground versus at 10,000 ft will further impact the efficiency of electrical equipment

Additionally, components are subject to extreme vibrations, with take-off and landing putting a heavy mechanical burden on equipment and their internal electronics.

Today, more commercial and industrial components are being used in the aerospace industry and many of these are not specifically rated to the limit required to successfully work in the environments they are being exposed to.

As engineers move away from extreme-spec designs, and the use of commercial components becomes more common, this problem is only going to get worse.

Given this trend, thermal engineers must thoroughly test their designs for every environment. With physical tests proving particularly expensive within the aerospace industry, many companies now use digital twinning to model devices in a virtual environment using simulation before developing their first prototypes.

Traditionally, engineers only used digital twinning to model the worst-case scenario. Now, with advancements in CFD simulation, designers can run through numerous parametric variations in a huge variety of different environments — helping to unlock new applications for the aerospace industry.

What **our experts** say

"**The aerospace industry is unique in that it has such a wide variety of environments.** It could be really cold or really hot or in a very difficult place to cool, which makes it extremely challenging for thermal engineers to ensure that components work effectively. That's why simulation is so vital in this space."

Mark Seymour
Future Facilities

"**In extremely hot, sand-based locations,** gritty sand can sometimes stifle the avionics equipment and cause excessive overheating which will cause components to shut down. When it comes to critical missions, you really don't want that to happen."

David Flores
Physical Optics Corporation

Trend 3: 3D Printing for Prototyping and Production

Aerospace engineers are now turning to 3D printing early on in the design process as a faster, more flexible, and more agile way to create prototypes. These prototypes are often used to check that the device will fit withi a particular environment, using 3D printing technology to test unusual component shapes and casings within increasingly compact surroundings.

Given its typically conservative nature, the aerospace industry is not yet using 3D printing for end products. However, many of our panellists do believe that this shift will come in the future.

Eventually, developments in 3D printing will ensure that engineers will be able to print materials for volume use in real-life scenarios. For example, when it comes to thermal management, traditional microchannel heat sinks leave non-uniform channels in the cold plate. But by using 3D printing, engineers can create a more uniform surface finish and be more precise about channel sizes — giving far greater control to engineers.

Going forward, 3D printing and thermal simulation will go hand in hand. As electronics become more compact, engineers will look for subtle opportunities to save on excess heat and energy. Simulation will play a vital role in identifying these opportunities, while 3D printing can help to design smaller and more complex components to plug the gaps.

What **our experts** say

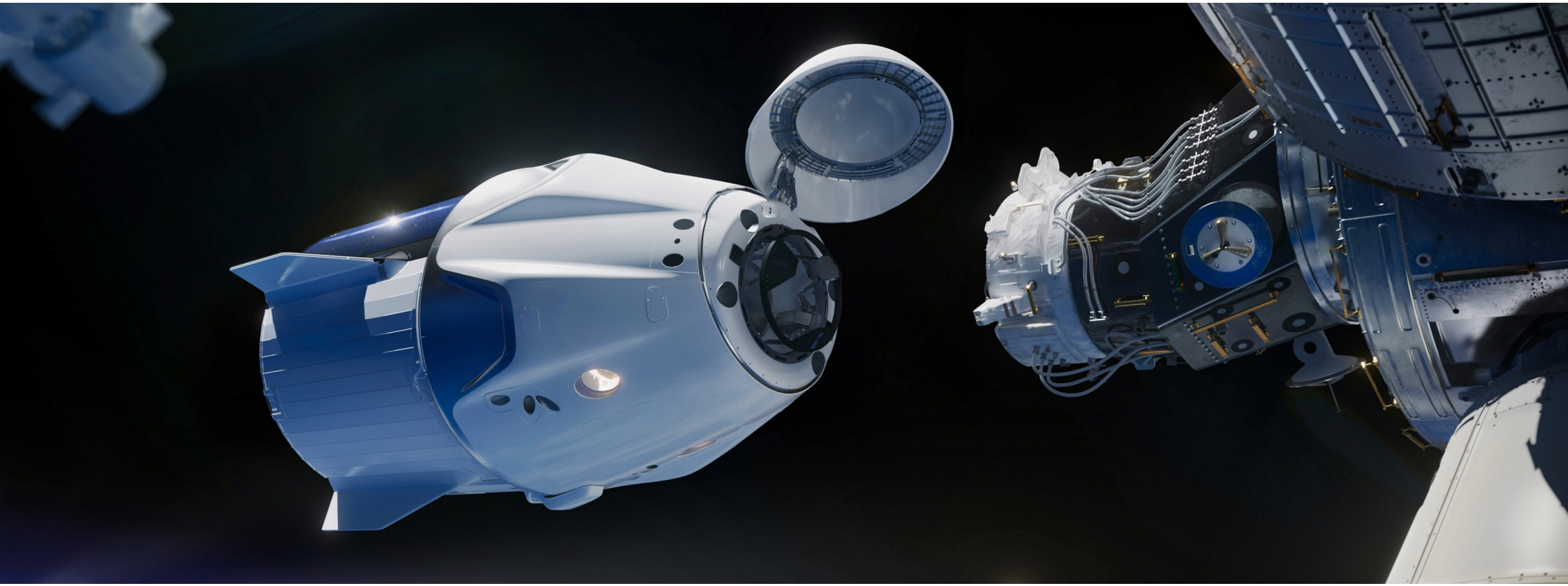
> "**Although it has to be conservative due to the criticality of the design and performance,** the aerospace sector will eventually have to adopt 3D printing for use in its products to greatly improve the thermal performance of devices."
>
> **Mark Seymour**
> Future Facilities

> "**3D printing is really important to validate your design** — you need to know that your components will fit together and work within the environment you're exposing them to."
>
> **Johanne Sevigny**
> CMC Electronics

> "**We use 3D printing for a lot of our prototyping to try and get a feel for what shape the system will be.** But because our data recorders have to be strong enough to withstand the forces of a potential crash, we don't use 3D printing within the finished product."
>
> **David Flores**
> Physical Optics Corporation

Thermal Simulation for Aerospace

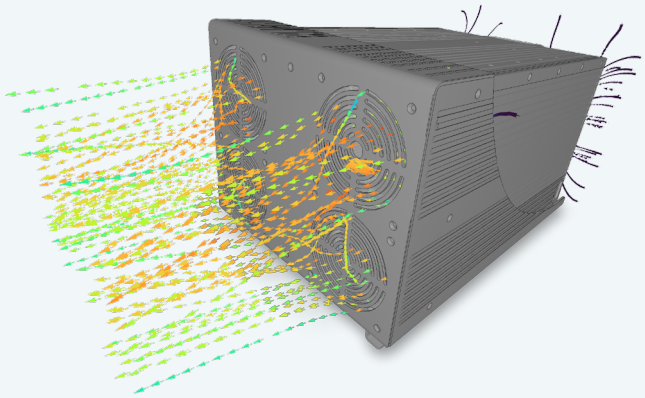
If you combine the demand for high reliability in extreme conditions with the constant need for higher power in a conservative industry, the thermal design of aerospace electronics equipment is under far greater pressure than other industries.



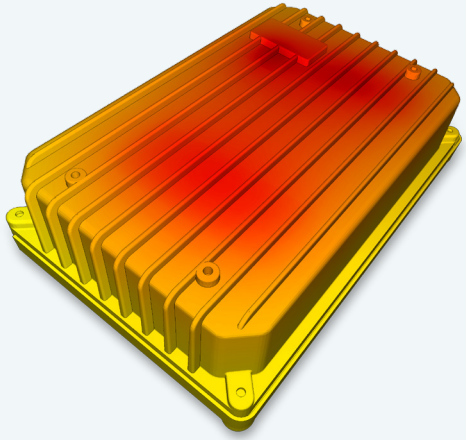
At the same time, designers are challenged with limited cooling resources. As a consequence, they must find clever ways of dissipating heat away from the critical components — without sacrificing performance or size in the final products.

Where the demands for reliability and performance are so high, there is simply no way to shortcut the design process — designers need the right tools for the job if they are to complete projects efficiently, accurately and safely.

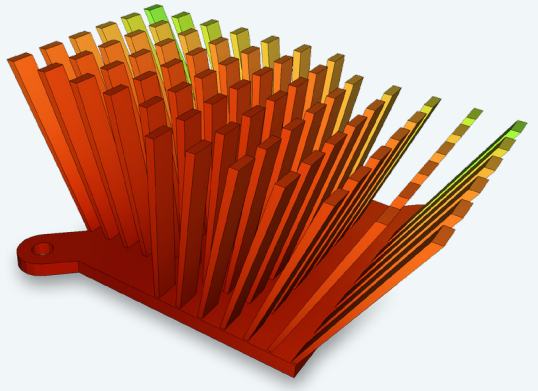
Thermal simulation provides a unique visual representation of the temperature and airflow inside equipment. Aerospace engineers should use these simulations to make better decisions when it comes to offsetting heat and designing cooling systems that will have a big impact on the reliability and performance of their electronic devices.



Solving for high-power density
6SigmaET Simulation



Simulating for extreme environments
6SigmaET Simulation



Simulating complex shapes and 3D printed design
6SigmaET Simulation

6SigmaET: What the Experts Say...

William Villers
TEN TECH LLC

"**If you don't have a good understanding of the thermal environment, you'll end up with a lot of reliability issues.** We need to be sure that the systems that we use are resilient and will survive for a long time in very difficult environments."

Wessel Wits
Thales Group

"**Digital twinning is a great way of monitoring the health of a component or module.** Sensors can monitor things like vibration, temperature or moisture, which is data that you can relate back to your digital twin to give you valuable insights into the life of your module or parts while in operation. You can even compare these to other modules that are on separate aircrafts and see the commonalities and differences between the two."

Johanne Sevigny
CMC Electronics

"**The most important thing to consider when it comes to building reliable aerospace electronics** is selecting the right components so that they meet the temperature range that is needed to function properly in extreme temperatures and environments. It is critical for the device to stay within its rated limit to reduce the 'mean time between failure' (MTBF). The closer you are to MTBF, the less reliable your device will be."

6SigmaET: What the Experts Say...

David Flores
Physical Optics Corporation

Mark Seymour
Future Facilities

"**The number one priority in the aerospace sector is the safety of the pilot and crew onboard.** We need to ensure that all of our systems are extremely robust and won't fail in the middle of an operation."

"**Thermal simulation tools can be used not only for understanding the design of aerospace electronics,** but also to understand any faults and failures. By gathering live data from real equipment that differs from your design and modelling of the device further modelling or model analysis insights can tell you if a piece of equipment might be about to fail or that it requires a redesign to work effectively."

About 6SigmaET, Future Facilities

This expert panel was commissioned by the 6SigmaET product team at Future Facilities, a leading provider of innovative thermal simulation solutions. The 6SigmaET platform has been identified as one of the fastest thermal simulation software suites in the electronics sector, using a combination of cloud solving, unstructured gridding and intelligent automation to generate thermal simulations in a fraction of the time of older, legacy platforms.

To find out more about how 6SigmaET works with the world's leading aerospace businesses, or how thermal simulation could benefit your organisation, visit:

https://www.6sigmaet.info