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Thermal Focus: LEDs

Thermal challenges and trends in the LED industry

Introduction

Thermal analysis is constantly evolving. At Future Facilities, we pride ourselves on staying at the cutting edge of the trends and tech that will drive the future of our sector.

That's why, each year, we gather together industry experts to explore some of the key challenges design engineers are facing – so together, we can deliver products that are powerful, reliable and safe.

Last year, we took a deep dive into the **IT equipment** space, canvassing expert opinion from leading data centre professionals, academics and engineers.

In the latest edition of our Thermal Focus series, we're putting LEDs in the spotlight. We'll discover the direction this increasingly popular technology is headed in, and the thermal complications that will inevitably follow.

Who is this report for?

- **Thermal engineering** experts
- **Electronics and design** engineers
- **LED and lighting** professionals
- **Thermal engineers** working with LED applications

Meet the experts

To gain a comprehensive understanding of the intricacies of LED designs, 6SigmaET hosted a roundtable discussion with three thermal experts from leading LED and lighting firms, with additional analysis from our very own Chris Aldham.

Signify
Genevieve Martin
Competence Leader

Optimal Thermal Solutions
Norbert Engelberts
Founder/Owner

Thal Technologies
Ad Musters
Managing Director

6SigmaET
Chris Aldham
Product Manager

The LED industry: 2020 trends

LED usage is becoming increasingly common – they're energy efficient, cost effective and environmentally friendly. In the next few years alone, the global market for LEDs is forecast to be worth over $50 billion. But for all their undoubted benefits, the rise of LEDs still presents challenges for designers – with thermal considerations a key concern.

As leaders in this rapidly growing field, our expert panel are perfectly placed to identify the trends that will shape the industry as we enter the decade ahead.

Shrinking space

Electronic devices are becoming more compact – in both consumer and industrial applications. As a result, designers are adopting innovative techniques in order to integrate LEDs into all form factors of light bulbs; including spotlights, strip lighting and LED filaments.

To create smaller, lighter and thinner LED devices, a growing number of engineers are starting to specify LEDs as 'chip-scale packages' (CSP). CSPs allow an architecture with virtually no package beyond the p and n contacts that are metallised in the back-end manufacturing process – greatly reducing surface area.

Simply put, CSPs can be grouped very close together, creating clusters of extremely power-dense modules within these compact designs.

But a consequence of increased power is increased temperature. Such close groupings of high-powered LEDs will inevitably generate a large amount of heat – a watt of power can be produced from an area of LEDs as small as 1mm².

What **our experts** say

"**It's incredibly difficult to direct heat to the right places in such small devices –** even in manufacturing, it's tough to account for all the parameters."

Ad Musters
Thal Technologies

"**Chips are becoming smaller and smaller.** If you put these small chips just on the FR4 board, the potential for thermal complications really increases because the power density is so high. It's a huge challenge to try and solve that problem."

Norbert Engelberts
Optimal Thermal Solutions

"**Working with such small components,** today's thermal simulation platforms must offer a far higher degree of accuracy to understand how to exploit every opportunity to safely transfer heat away."

Chris Aldham
6SigmaET

Decreased design time

Business moves fast these days. LED manufacturers and device designers are working to increasingly condensed timescales, with turnaround time for an entire design project sometimes clocking in at as little as two weeks.

The pressure to get to market as quickly as possible means designers often can't evaluate how components work in tandem as carefully as they'd like, according to our panel. But to ensure LED products do not overheat, components must be meticulously trialled and tested.

Sub-optimal designs can lead to product failures, poor light output or long-term reliability issues. It's vital that time is factored into the initial design processes to adequately account for possible thermal complications.

What **our experts** say

> **"The LED market is currently very price driven,** with quick turnaround times. When I compare it to other markets, things move incredibly fast, and design time is increasingly limited."
>
> **Norbert Engelberts**
> Optimal Thermal Solutions

> **"The LED market is highly dynamic and competitive.** Compared to the conventional market, there's low barrier to entry; that means that some players do not have the means and tools to optimise their products which brings confusion to the end-customer."
>
> **Genevieve Martin**
> Signify

> **"Time to market is critical.** Unfortunately, many designers don't have the time, or indeed the budget, to do the proper thermal simulations required. This could potentially cause problems later down the chain."
>
> **Ad Musters**
> Thal Technologies

The IoT and expanding use cases

Because of their flexibility and energy efficiency, LEDs are now being incorporated into a wide range of products – from 'smart' home lighting to car headlamps and beyond.

This is great news for end-users. However, LED designers rarely know which application their product will be used in. The rise of the IoT means LEDs can find themselves encountering a variety of different climates and environments, making it virtually impossible to predict the thermal forces the design will have to withstand.

Our panel noted that this situation is further complicated by the fact that, though conventional lighting solutions have a maximum filament temperature of around 3,000°C, whereas for junction temperatures, LEDs need to be closer to 100°C to achieve their desired lifetime. This means there's a greatly reduced margin for error when designing LED products.

What **our experts** say

> **"LEDs are incredibly flexible;** you can put them anywhere. You can put them in cars, mobiles – virtually wherever you want. Certainly, if you look at the IoT, the challenge then becomes how we're going to keep products cool."
>
> **Norbert Engelberts**
> Optimal Thermal Solutions

> **"Connected IoT means we're no longer talking about constant usage of LEDs,** but mission profile use. This could have a big impact on the end-life of your product and must be taken into account in the design cycle."
>
> **Genevieve Martin**
> Signify

> **"In the past I thought LED headlights would be impossible,** but we're beginning to see use cases like that now. With all these innovative new integrations of LED technology, thermal complications will be the major concern."
>
> **Ad Musters**
> Thal Technologies

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LEDs: Priorities for 2020

With the industry looking to incorporate LEDs into an expanding range of products, coupled with increasingly compact designs that must be turned around in record time, expectations are shifting. In order to keep up with this rapid pace of change, here are the top priorities identified by our expert panel for the year ahead.

Our experts' priorities

Ad Musters
Thal Technologies

"**In 2020, I believe we're going to see a rise in customisation** and LEDs entering increasingly niche markets. But it's crucial we look at these specialised applications from a thermal point of view."

Norbert Engelberts
Optimal Thermal Solutions

"**The benefit of the IoT** is that we can combine experimental testing with simulation tools, so we can really get a good idea of how our LED products work in reality. This is something to take advantage of moving forward."

Genevieve Martin
Signify

"**From my team's perspective,** in 2020 we will look to provide insights at a faster rate and optimise our products as efficiently as possible. Deploying new working methods and tools is an essential part of this process – with simulation a high priority."

Thermal simulation and LEDs

Clearly, implementation of LED technology will only continue to increase in the coming years – they have numerous advantages over conventional, legacy lighting solutions.

So, given the increasing ubiquity of LEDs in our personal and working lives, how can designers and engineers overcome the challenges our experts identified in this report?

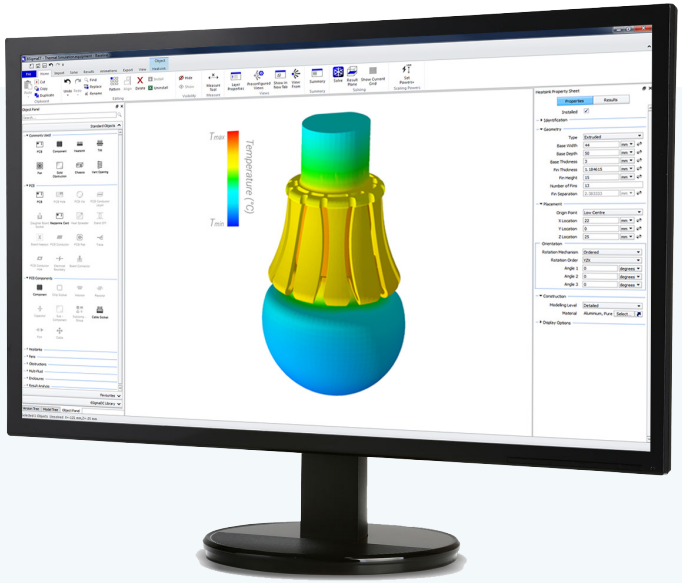
A common theme that all of our panel touched upon was the need for comprehensive thermal simulation of LED products. With LED devices in high altitudes, extreme heat and cold, or even permanently submerged underwater, accurately predicting heat dissipation is more vital than ever.

Thermal simulation gives you a unique visual representation of the temperature and airflow inside equipment. This allows engineers to make better decisions when it comes to offsetting heat, and helps them to design cooling systems that balance performance and cost.

What **our experts** say

> "For LED devices, everything depends on temperature, but temperature depends on everything else. It's so interlinked that it's impossible to look at it in isolation: the entire design matters."

Chris Aldham
6SigmaET



About 6SigmaET

This expert panel was commissioned by 6SigmaET, a leading provider of innovative thermal simulation solutions. The 6SigmaET platform is one of the fastest thermal simulation software suites in the industry, 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 can benefit your business, visit **http://www.6sigmaet.info**