ISSN 1993-890X
www.led-professional.com

LED professional

BY LUGER RESEARCH

Review

LpR 104

July/Aug 2024

STANDARDS BEACON: INSIGHTS FROM CIE'S VP, PETER THORNS

FUTURE OF SUSTAINABLE 3D PRINTED LIGHTING

LIGHTING'S EFFECT ON MATERIAL PERCEPTION

The Global Information Hub for Lighting Technologies and Design

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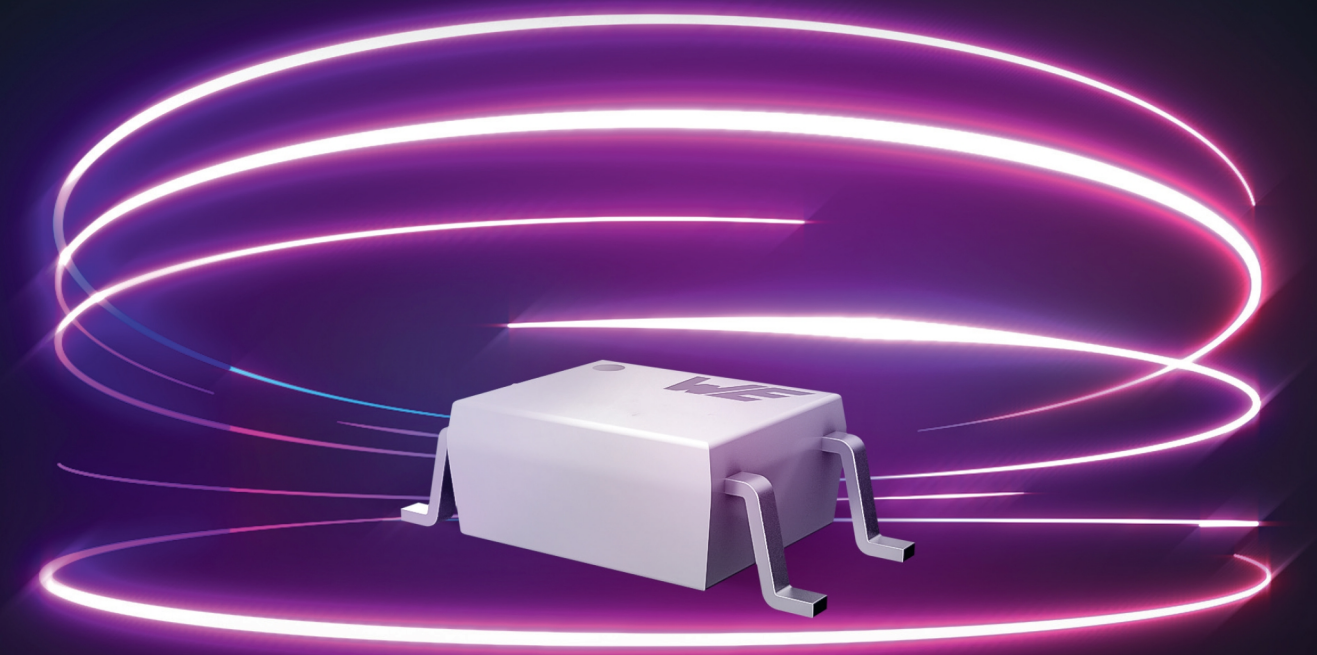

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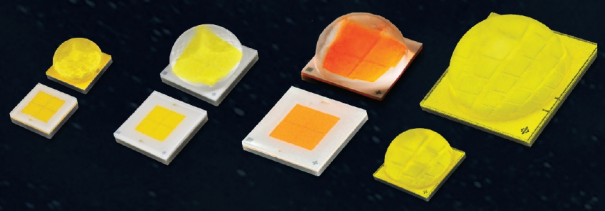
CREE LED



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Serving the Lighting Design and Lighting Industry Community at the Next Level

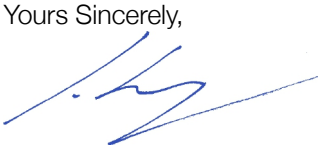
I would like to take this opportunity to inform you that we have streamlined our platforms to deliver even more focused, powerful, and targeted information on lighting applications, design, and engineering. As a first step, we have incorporated the Trends-in-Lighting website under the LED Professional roof, ensuring easier access for both manufacturers and lighting designers/architects. Furthermore, the expert talks on www.LpS-Digital.global have now been redirected to the corresponding YouTube channel.

The Lighting Design and Lighting Industry Community will now be served through three platforms: LED Professional (*www.led-professional.com*), LpS Digital – Expert Talks on Light (*www.youtube.com/c/LpSDIGITAL*), and the Global Lighting Directory (*www.gld.lighting*). These platforms cover content from engineering to application, reflecting the significant overlap in knowledge where both communities can benefit from each other's insights. This networking and overlap were key reasons for restructuring our services to you. Our aim is to provide you with the best possible and most comprehensive information in the industry.

In this spirit, I am thrilled to present the latest issue of LED professional Review. We continue our CIE interview series with Peter Thorns, who guides us through the world of standards. We showcase a remarkable design project at the Jil Sander's flagship store in London, delve into the topic of Eco-Design with a special focus on 3D Printing Luminaires, highlight the latest developments in phosphors, and explore a recent lighting study on material surfaces. Finally, we discuss the latest trends in automotive lighting.

Enjoy your read!

Yours Sincerely,



Siegfried Luger

Luger Research e.U., Founder & CEO
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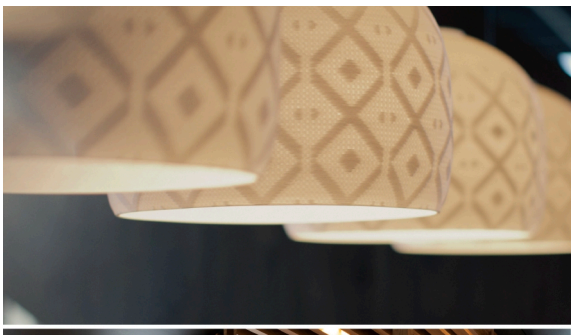
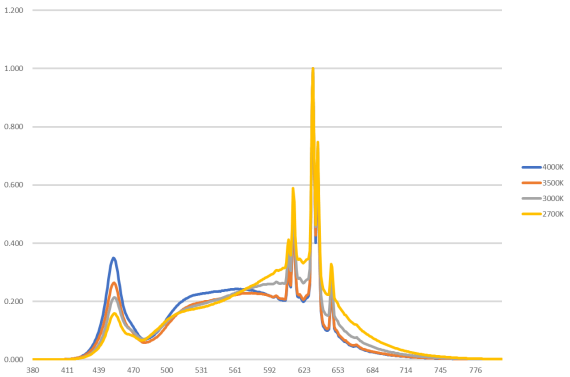
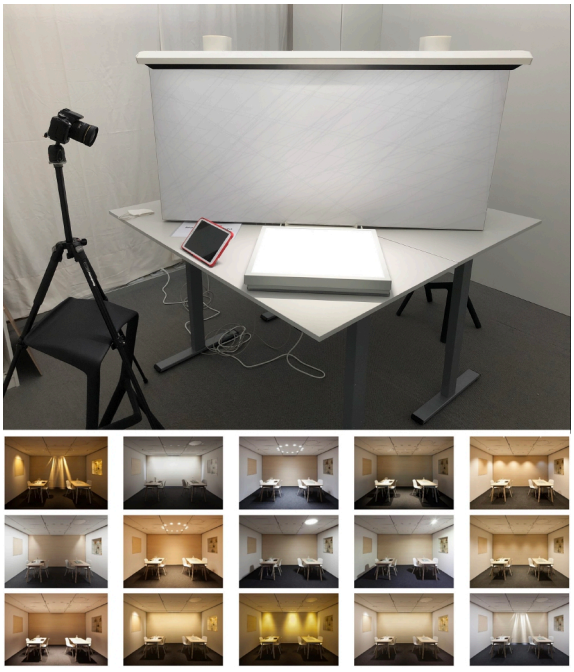


TECHNOLOGY



LIGHTING DESIGN



AUTOMOTIVE LIGHTING

LPS DIGITAL TALKS

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Professor Georges ZISSIS

Prof. Georges ZISSIS, PhD, FMIEE, got his PhD in 1990 from Toulouse University (France). Today, he is full Professor and Vice-deal for the Faculty of Science and Engineering. His primary area of work is in the field of Light Sources Science and Technology. He is especially interested in solid-state and smart lighting systems; impact of lighting to energy, environment, quality of life, health and security; illumination and lighting. In 2006 he won the 1st Award of the International Electrotechnical Committee Centenary Challenge. In 2009, he received the Energy Globe Award for France and in 2022 he got the Alfred Monnier award, the highest distinction of the French Illuminating Engineering Society. He was President of IEEE Industrial Application Society and today he chairs IEEE Smart Cities Technical Community and the 4E-SSLC Platform of the International Energy Agency.

www.univ-tlse3.fr

linkedin.com/in/georges-zissis-9b88887

Roadmap to "Lighting 4.0" Era and the SSL^2 (Sustainable Smart Lighting $\otimes$ Solid State Lighting) Concept

It is foreseen that by 2040, artificial light needs will be attained. This will be almost 200 peta-lumen-hours, corresponding to an increase of 50% in lighting service demand compared to 2020. Further, beyond the implication of lighting in energy, greenhouse gas emissions and depletion of abiotic resources of our planet, artificial lighting, has some additional important side-effects like light pollution in the skies and the associated erosion of the biotopes. The only light source technology evolution perspective, even supported by ambitious policies, is not sufficient to stem uncontrollable growth and more importantly, this causes abstraction of artificial light effects on humans. For a few years now, to serve society as effectively as we can, industry has coined a new term "Integrative lighting" to direct its primary efforts towards meeting human needs. Thus, the real challenge for the next decade will be to offer the best quality of light to end-users, harness the increase of electricity demand, limit the associated greenhouse gas emissions and avoid undesirable effects on the biotope. The objective is somehow switching to smart human-centric lighting driven by both "efficiency" and "quality of light".

Today lighting technology is witnessing its 4^{th} revolution: the transition to Smart Lighting systems. But, what does the term, "Smart Lighting" stand for?

Generally speaking, a smart technological object, including smart lighting, is characterized by an intelligent sensing technology that is increasingly being integrated with internet technologies, thereby allowing it to react to and communicate with the changing environment around it. In principle, this leads to optimal operation and global improvement in efficiency. Based on the fact that such "smart" lighting systems shall serve, at their best, human needs, and reduce the impacts on environment and biotope, as much as possible. Zissis et al.[a], proposed in 2023 the following definition:

"A smart lighting system has a principal function which is to produce, at any moment, the right light: where it is needed and when it is necessary. It should adapt the quantity and quality of light to enhance visual performance in agreement with the type of executed tasks. It must guarantee well-being, health and the safety of the end-users. It should not passively squander the resources of our planet and actively limit the effects of light pollution on the biotope, or have any other impacts on the environment. Optionally, the system could offer additional services (geo-localization, data connectivity, etc.) to the end-users, preferably through Visible Light Communication protocols."

Switching to Smart Lighting can achieve more than 40% additional energy savings than what we get with just massively adopting LED technology. But this forecast could be severely affected by the "rebound effect" described by Jevons in the mid-19^{th} century. A way to rid this undesirable effect lies on the "SSL^2 concept", which merely suggests that "a **S**ustainable **S**mart **L**ighting system uses and tunes into an intelligent way. The best existing technology, namely, for today, are **S**olid-**S**tate **L**ighting devices to best fulfil present needs for artificial light and reduce undesirable side-effects without compromising the ability of future generations to innovate". That way the next-generation of lighting systems provide the "Right Light" for each kind of end-use when and where it is needed, with the highest "application efficacy" corresponding to the best quality and least collateral damage. ■

G.Z.

[a] Zissis, G.; P. Bertoldi, IEEE Open Access Journal of Industry Applications (2023), doi: 10.1109/OJIA.2023.3263182

Good Light Group

The **Good Light Group** is a non-profit organisation. We are a group of scientists, lighting designers, sleep experts, and lighting companies focused on improving indoor lighting for health and well-being.

For more information: **info@goodlightgroup.org**

LightingEurope Welcomes ESPR Publication, Marking a Milestone in EU's Circular Economy Agenda

www.lightingeurope.org

June 28th marked the beginning of a new era in ecodesign as the Ecodesign for Sustainable Products Regulation (ESPR) was published in the Official Journal of the EU.

Following the European Commission's legislative proposal in March 2022, EU co-legislators - the European Parliament and the Council of the EU - have spent over two years defining the requirements and measures for future Ecodesign rules. These rules will apply to key products in the EU market, including lighting products.

LightingEurope has actively participated throughout the legislative process, advocating for the lighting industry, engaging with Members of the European Parliament and Member States' Permanent Representations, and collaborating with other industry associations on common initiatives.

As always in a complex legislative process, we won some battles and lost others, but overall LightingEurope welcomes the ESPR, recognizing it as a pivotal advancement in the EU Circular Economy agenda. The regulation introduces Ecodesign requirements that extend beyond energy efficiency to include aspects such as durability, reparability, presence of substances of concern, recycled content, and environmental footprint.

Additionally, the new Regulation aims to prevent the destruction of unsold consumer products and includes a direct ban on destroying certain unsold items, such as textiles and footwear.

In the new Ecodesign framework, great attention is also attributed to providing better information for consumers on the sustainability characteristics of products, including through a 'Digital Product Passport'.

"We appreciate the 18-month transition period between the entry into force of the product-specific delegated acts and their application, allowing economic operators sufficient time to comply with the new requirements," said Elena Scaroni, Secretary General of LightingEurope.

"The obligation to track Substances of Concern (SoC), for example, will significantly impact manufacturers, given the broad definition adopted by the co-legislators, despite our advocacy for a more sensible and proportionate list of hazardous substances," she added.

LightingEurope also hoped for stronger enforcement provisions, but the Council of the EU's position prevailed during negotiations, leading to a weaker enforcement framework.

On a positive note, our request to provide instructions in digital format was accepted and included in the legislative process.

The ESPR will enter into force 20 days after its publication in the EU Official Journal.

"LightingEurope is already preparing for the review of the Lighting Regulations under the ESPR Framework, expected to start later this year or early next year. We are consolidating the industry's views on the revision process and will engage intensively with the European Commission and Member States to shape future Ecodesign rules for lighting products. We will also support our members in implementing these new regulations", concluded Elena Scaroni, Secretary General.

Contact: Teresa Selvaggio, Director of Public Affairs (Teresa.selvaggio@lightingeurope.org)

About LightingEurope LightingEurope is the voice of the lighting industry, based in Brussels and representing 32 companies and national associations. Together these members account for over 1,000 European companies, a majority of which are small or medium-sized. They represent a total European workforce of over 100,000 people and an annual turnover exceeding 20 billion euro. LightingEurope is committed to promoting efficient lighting that benefits human comfort, safety and well-being, and the environment. LightingEurope advocates a positive business and regulatory environment to foster fair competition and growth for the European lighting industry. More information is available at www.lightingeurope.org. ■

DLC: Final Version of Networked Lighting Controls Technical Requirements Version NLC5.1

www.designlights.org

The DLC is pleased to release the final version of Networked Lighting Controls Technical Requirements Version NLC5.1 ahead of the annual NLC listing update in August 2024. NLC5.1 is a minor revision that contains updates to the policy's cybersecurity requirements and is effective on August 1, 2024. No NLC systems will be delisted from the QPL due to this update.

When properly applied, networked lighting controls increase the energy savings of a lighting project by roughly 50% compared to a transition from legacy lighting to LEDs alone. However, lighting projects that involve networked lighting controls are still under-represented in the market. This missed opportunity limits our ability to not only capture energy savings but also to help future proof our investments in LED upgrades.

The DLC NLC program has helped energy efficiency programs enable incentives for networked lighting controls by creating technical requirements that improve cybersecurity, energy reporting, and interoperability. Version NLC5.1 includes minor updates in key areas.

NLC5.1 Updates
Based on stakeholder comments from the public comment period, the Energy Monitoring section of the Technical Requirements remains virtually unchanged. This section will be updated after the ANSI C137.9 standard has been published, to align more closely with the ANSI C137.5 and C137.9 standards.

Version NLC5.1 includes the following updates.

Cybersecurity Updates:

- Now accepts PSA-certified chip level 1
- Includes updated criteria for acceptance

Other Updates:

- A new section clarifies Primary Use Designations, such as "Whole Building" and "Portfolio".
- The "Requirements Other Than Control Capabilities" section is now formatted as Table 0, rather than as text.
- The words "Interior" and "Exterior" were changed to "Indoor" and "Outdoor" to align with other DLC documents.

If you have questions about NLC5.1, please email info@designlights.org. ■

Ennostar Announces High-Level Appointments

www.ennostar.com

Ennostar Inc. announced its high-level personnel changes. Following Ennostar's Board of Directors resolution, Mr. Patrick Fan, President of its subsidiary EPISTAR Corporation, and Dr. Terry Tang, President of Lextar Electronics Corporation will be swapping roles, effective July 1, 2024. Additionally, Mr. BY Chang will step down as Chief Financial Officer (CFO) and Spokesperson of Ennostar effective immediately, with Mr. Jerry Liu taking over the position.

Under the leadership of Chairman Mr. Paul Peng, Ennostar is actively driving the transformation of its core value, "One Ennostar," by advancing its business strategies, organizational integration, and talent development. This senior management rotation aims to strengthen upstream and downstream collaboration, accelerating the "3+1" long-term development strategy. This strategy strives to enhance the group's technological and product positioning in the automotive, advanced display, and smart sensing markets, as well as emerging sectors. In late 2023, the group established the "Talent Development Committee," dedicated to the sustainable development of group talent, enhancing capabilities, and revitalizing the organization to adapt swiftly to the dynamic environment. Through this rotation, Mr. Fan and Dr. Tang will extend their expertise into different market applications, technological development, operational planning, strategy, and execution, gaining more comprehensive integration experience. This move is expected to not only foster collaboration and mutual success but also to further elevate the "One Ennostar" competitiveness in the optoelectronics and semiconductor industries.

Mr. Fan possesses extensive management experience in the optoelectronics industry, having held key positions in production, logistics management, quality, and marketing. As President of EPISTAR, he led the company to move beyond the previous price competition in the LED industry, optimizing the product mix and leveraging the resources of the parent group Ennostar to strategically position next-generation display technology, Micro LED, in collaboration with clients across advanced display, smart sensing, and automotive sectors to develop marketable applications.

Dr. Tang is familiar with LED epitaxial wafers and chip technology as well as the manufacturing field. During his tenure at Lextar, he was responsible for driving smart supply chain initiatives, integrating upstream and downstream resources, developing advanced technologies, overseeing the backlight product business, and managing the construction and operation of manufacturing facilities in China. He has accumulated rich leadership experience in process R&D, production and supply chain management, business operations, and more. In recent years, he has led Lextar in implementing key optoelectronics module projects for major European and American clients in the automotive market, a focus area of the group's "3+1" strategy.

Furthermore, the CFO and Spokesperson roles within Ennostar will also see changes, with Mr. Jerry Liu taking over from Mr. BY Chang. The group extends its heartfelt gratitude to Mr. Chang for his contributions as CFO, aiding in financial transformation and maintaining a healthy financial structure, which has consistently placed Ennostar among the top 5% in Taiwan's Corporate Governance Evaluation. The Board of Directors has approved the appointment of Mr. Liu as the new CFO and Spokesperson. Mr. Liu has accumulated nearly 30 years of experience in the optoelectronics industry and international financial management, and his expertise is expected to significantly support the company's financial development.

Ennostar believes that through the internal rotation of senior executives, the synergy of the "One Ennostar" integration will be further enhanced. Leveraging the talents and experiences of senior managers will foster new perspectives and ideas, more efficiently driving technological innovation and development in the "3+1" fields, positioning Ennostar as a comprehensive provider of integrated optoelectronic solutions.

About Ennostar
Ennostar (TWSE: 3714) was jointly established in January 2021 by EPISTAR and Lextar via share conversion, and is a leading provider of comprehensive optoelectronics integration solutions, specializing in the research, development, and manufacturing of optoelectronics product materials based on III-V compound semiconductors. With strong integration capabilities in the LED industry's upstream and downstream sectors, our products enable the deepening of technological, product, and service offerings, providing customers with one-stop solutions from epitaxial wafers, chips, and packages to modules. Our applications cover automotive, advanced displays, and smart sensing while actively exploring high-potential areas, driving towards enhanced value-added applications. ■

Cooper Lighting Solutions Release of BioUp, a Cuttingédge Line of Melanopic Lighting Technology

www.cooperlighting.com

Light has a profound impact on wellbeing, offering a myriad of visual, biological, and emotional benefits as a key regulator of circadian rhythm. Recognizing the significance of the integration between light and wellbeing, Cooper Lighting Solutions has included BioUp across multiple CLS brands and product families, to provide these enhanced benefits in professional spaces.

How it works: BioUp technology, by Cooper Lighting Solutions, integrates cyan light into the LED spectrum. This enhances the light's biological impact, promoting healthy circadian rhythms in humans without affecting the perceived visual color. Melanopic, also referred to as biological, light influences human sleep patterns, alertness, and mood. BioUp is available in two options: static and dynamic.

The static, spectrally enhanced LED option is ideal for applications with predominantly daytime usage, such as office, institutional, and public buildings. This option makes for a simple and cost-efficient method to enjoy the many benefits of melanopic lighting.

Alternatively, the dynamic tunable and spectrally enhanced LED option provides a more advanced solution for applications that require daytime and nighttime usage, such as hospitals, schools, and airports. This option, when paired with the WaveLinx intelligent digital lighting solution by Cooper Lighting Solutions, can adjust the melanopic portion of the light throughout the day to optimize for the human experience.

Key features of the BioUp include:

- Available in troffers, panels, linear, downlights, and cylinders.
- Suitable for professional spaces including healthcare, office, and education.
- BioUp includes a peak (the cyan part of the spectrum) that enhances circadian rhythm without additional lights, higher lumen levels, and associated energy costs.
- Use BioUp to maximize WELL points for Circadian Lighting Design to earn a WELL certificate, which offers a notable opportunity to increase the value of real estate.
- Elevate health and overall wellness for workers, visitors, and customers in a space.

The launch of Cooper Lighting Solutions' melanopic lighting line marks a significant milestone in the evolution of workplace lighting, offering commercial space an innovative way to prioritize employee health and productivity. ■

Glamox Unveils New Vandal-resistant and Dark Sky-certified Wall Lights

www.glamox.com

Glamox, a world leader in lighting, has launched a family of outdoor wall-mounted luminaires with a difference. The new luminaires, aimed at commercial and public buildings, are vandal-resistant and have a special dark sky-certified version. The latter allows people to navigate safely while helping to limit light pollution that impacts the night-time environment - good news for nocturnal species and astronomers.

The Glamox O21-W wall light uses a design that supports a circular economy which is the opposite of the throwaway society. The luminaire is made to be disassembled so that parts may be replaced to prolong the luminaire's life or reused or recycled at the end of life.

The O21-W is ideal for lighting commercial and residential building perimeters and entrances. Manchester Royal Infirmary and Beaulieu Primary School are two customers that have ordered it for that purpose. The wall light comes in a variety of lumen outputs, color temperatures, sizes, and has a variety of sensor and control options. See the specification and images.

"We opted for an engaging compact design with features to facilitate speedy installation," said Paul Fisher, Luminaires Product Manager Commercial at Glamox. "It is environmentally friendly, not only in helping customers to drive down their electricity bills by using LED technology but also in its use of recycled aluminium. We designed it for possible disassembly, supporting the design principles for a circular economy and we have a dark sky-certified version too."

School of Hard Knocks
The new luminaire is made from diecast aluminium of which around 45% is from recycled aluminium, and has a polycarbonate diffuser. The luminaire can withstand up to 20 joules of impact – the equivalent of having a 5 kg ball dropped from a height of 40 cm – enough to withstand school playground knocks and all but the most persistent vandal.

Dark Sky version
The dark sky variant has a warm color temperature of 3000 K and uses special optics to further restrict light spillage. This helps to avoid light pollution which can negatively impact wildlife species and plants, as artificial light can disturb the way they perceive daytime and night-time, upsetting their natural behaviour.

The wall light has been formally certified by Dark Sky International. This body comprises more than 2,000 volunteer advocates around the world who are dedicated to protecting the night sky. One of its jobs is to certify commercial, industrial, and residential outdoor lighting that reduces light pollution.

The O21 family of wall lights are made by Glamox in Basingstoke, in the United Kingdom, and exported across Europe. ■

Alloy LED Launches Flexible, Low-Profile Aluminum SurfaFlex 1 Tape Light Channel

www.alloyled.com

Alloy LED, a leading designer and manufacturer of premium quality LED tape lights, continues to expand its extensive portfolio of tape light channels with the launch of the SurfaFlex 1 , a flexible, low-profile, surface-mount aluminum channel providing uniform, hotspot-free illumination when paired with the company's compatible tape lights. At only 0.61 of an inch wide and 0.15 of an inch in height, the channel is ideal for curved surfaces – with a minimum bend radius of 5.5 inches – and those commercial and residential spaces when the smallest footprint is needed.

"We continue to expand our tape light channel offering to meet more application needs," said President Joe Flynn, Alloy LED. "Big or small, curved or straight surfaces, the SurfaFlex 1 can be used across an entire commercial building or home, and with its miniature size, the channel can fit in the most compact spaces."

Providing even illumination from a premium frosted lens/diffuser cover — eliminating unsightly hotspots — the compatible Alloy LED tape lights, which feature 93+ color rendering index and high R9 and R13 values for exceptional color quality, include the RazorLine 3.7, RazorLine Neon 300, PrimaLine 2.5 COB and the Radialux 4.2 COB RGB. The PrimaLine and Radialux tape lights offer continuous runs up to 100 feet through the company's customization program.

The 4- and 7-foot kits include one field-cuttable aluminum channel with a snap-in lens, a two-pair pack of end caps and mounting clips with screws. The chosen Alloy LED tape light – or other compatible tape light – is purchased separately or included as a

complete fixture as part of our built-to-order program.

The SurfaFlex 1 is an ideal solution for task and accent applications including in coves; under countertops and shelves; under and above cabinets; and in retail display cases and niches, among others. All Alloy LED products are backed by its guarantee of satisfaction.

For additional information on the SurfaFlex 1 and other product offerings, please visit https://bit.ly/3XtFAUl.

About Alloy LED
Alloy LED is a leading designer and manufacturer of premium quality LED tape light, channels, connectors, LED fixtures and power supplies. Alloy LED products include the PowerLine™, PrimaLine® and Radialux® LED Tape Lights, Continua Channels and AmpChamp™ Connectors. Headquartered in Emeryville, California, the company is a leader in the LED tape lighting market with distribution through lighting showrooms, electrical distributors and online stores. ■

Organic Lighting Launches FortaCast in Europe: Pioneering Modular Drive-Over Lighting

organiclighting.com/fortacast

Organic Lighting announces the international launch of FortaCast, a patented modular drive-over lighting system that simplifies the complexities of inground drive-over lighting with an innovative, proven, and futureproof design. FortaCast introduces a new era of creative design possibilities in lighting, featuring environmentally friendly Glass Fiber Reinforced Concrete (GFRC) sections that allow for continuous straight lines, circles, squares, intersections, and curves with a minimal radius of 30cm.

Engineered for simplicity and robustness, FortaCast can be installed as easily as standard pavers providing significant savings against alternative options. It boasts a high durability level, supporting over 10,000PSI and is suitable for high-traffic areas. The system operates efficiently across extreme temperatures, from sub-zero conditions to above 50°C, and features IP68 certification for long-term submersibility. Maintenance is straightforward, thanks to its pioneering clamshell service point design and slide-in track for each LED strip.

The FortaCast system is illuminated by the encapsulated, diffused Aqueon LED, offering options in mono, tunable white, addressable RGB, and RGBW. These LEDs are floodproof, chemical-resistant, and vibration-proof. With a very low energy consumption of 6 to 12 W/m and operating at 50

A primary goal in developing FortaCast is guaranteeing uninterrupted lighting for users. System reliability is maintained by using non-corrosive materials and enabling the replacement of up to 30 meters of Aqueon LED through a single access point, eliminating the need for excavation or lens removal.

FortaCast's fast-growing inventory of standard sections means most project requirements can be met quickly. Additionally, custom-designed sections can be produced in various colors, textures, widths, and shapes to match specific design needs.

FortaCast has expanded its applications beyond decorative lighting to provide dependable, energy-efficient illumination for transportation and infrastructure projects. FortaCast is a registered trademark of Organic Lighting Systems, Inc. ■

serien.lighting Illuminates the New Building of the Dessau Synagogue

www.serien.com

The newly built synagogue in Dessau is characterized by the long-standing collaboration between the German lighting manufacturer serien.lighting and the well-known architect Alfred Jacoby. This project underlines serien.lighting's expertise in the development of customised special luminaires that can be harmoniously combined with the manufacturer's existing products.

As part of this project, the founders and designers Manfred Wolf and Jean-Marc da Costa created an impressive menorah. This central light sculpture is complemented by a variety of wall, pendant and ceiling lights from the serien.lighting range. The lighting concept of the new synagogue creates a lighting atmosphere that impressively emphasizes the spiritual and architectural significance of the building. serien.lighting once again demonstrates its ability to enrich sophisticated architectural projects with innovative and aesthetically pleasing lighting solutions.

New synagogue in Dessau: The cornerstone ceremony in 2019 marked the start of the construction of the new synagogue in Dessau-Roßlau. The building was completed at the end of 2023 and inaugurated in the presence of Chancellor Olaf Scholz. Architect Alfred Jacoby, who has decades of experience with new synagogue buildings, was responsible for the design of the place of worship. Under the direction of the Frankfurt office, new buildings have already been constructed in Darmstadt, Heidelberg, Aachen, Cologne, Kassel and Chemnitz. Their training as graduate designers at the HfG Offenbach and initial experience in the manufacture of luminaires with their company serien.lighting, founded in 1983, predestined them for this special task.

The menorah: The chandelier was to be installed as a wall-mounted iconic symbol next to the Torah shrine on a wooden panelling. The design presents itself as a reduced arrangement of seven lines, which "float" next to each other without touching each other due to their attachment to a separate plate on the back and radiate a certain lightness and immateriality. This effect is further emphasised by the backlighting of the individual arms. The panel and chandelier are made of solid, laser-cut aluminium. The panel was anodised in black and the chandelier in bronze. LED strips operated by dimmable electronic drivers were chosen for the light source mounted on the back.

Special lighting for prayer room: In Dessau, the architects opted for a ceiling design that incorporates the Star of David as a striking central element. An elaborate chandelier would have clashed with the design of the ceiling and was therefore out of the question. The decision was therefore made to hang individual luminaires from the current serien.lighting range.

The DRAFT pendant luminaire with its blue-colored glass sphere and internal cone, which is closed at the bottom with a translucent diffuser disc, emphasises the special ceiling design with its double ring-shaped arrangement without disturbing it. The main focus in the central part of the building was on the seven-armed chandelier.

Wall and ceiling lights in the prayer hall: The menorah is surrounded by flat, circular wall luminaires from the LID series, which emit their light around the sides of the wall and only allow a corona at the edge of the surface through an opaque glass pane, creating a spherical aura of light.

SLICE² PI, another serien.lighting model, is used in the rear section of the synagogue with a lower ceiling height. The very flat 30 mm high ring of the ceiling luminaire serves as a support and heat sink for the LEDs, which feed their light laterally towards the center into a specially adapted acrylic surface of a five-layer structure. Most of the light is emitted downwards and is finely directed into the room via a pyramid structure. A thin, chemically hardened pane of real glass forms the top. The floating effect of the luminaire is created by a small amount of light that is emitted onto the ceiling via an opaque film. Size M in black was selected.

Black is also the color of the other lights used in the adjoining rooms. One of these is the REFLEX², series, which has a fine frame structure. Its light is emitted onto the ceiling via four LED boards and partially reflected back into the room via the prismatic reflector of the luminaire. The control gear, which supplies the LEDs with an output of 50 watts, is located under this plate, which is held in place by magnets.

The CAVITY model is installed at the side of the suspended ceiling. This ceiling-mounted downlight has a simple cylindrical body that is recessed in a funnel shape towards the light source, ensuring a high level of glare control. As with SLICE² PI, the aluminum body is fixed to the ceiling with a bayonet catch and enables optimum heat transfer from the light source to the housing thanks to a spring-loaded surface contact. There is also a row of CAVITY in the outdoor area above the wide steps to the entrance, which are also fitted with a weather-resistant seal. This row provides inviting lighting for the entrance to this place of prayer and assembly.

About serien.lighting
serien.lighting is an innovation-minded manufacturer of luminaires with high demands on design that combines the latest lighting technology, serial production, craftsmanship and high-quality materials in its products. The company, based in Rodgau near Frankfurt am Main, was founded in the early 1980s by the two designers Manfred Wolf and Jean-Marc da Costa and has been jointly managed by them for 40 years. In addition to the permanent collections for private homes, offices, hotels and restaurants as well as social and cultural institutions, the design team also realises customised solutions for specific projects. ■

Serviceable Indoor Luminaires for a Circular Future

www.zhagastandard.org/circularitylighting

Zhaga enables luminaire manufacturers to design serviceable indoor luminaires with replaceable components that prolong their useful life, contributing to a circular economy. By Jan de Graaf (Signify), Francesco Martini (Inventronics) and Carsten Moellers (Green Gems).

The Right to Repair movement is by no means limited to consumer electronics – it impacts the lighting industry too.

Seen as a key enabler of a circular economy, decision-makers around the world are enacting legislation and initiatives requiring the serviceability of LED luminaires. For example, in Europe, the “Single Lighting Regulation” is in force, setting product design requirements pushing the move to a circular economy. The published provisional agreement of the” Ecodesign for Sustainable Product Regulation (ESPR)“ looks to require that lighting products be designed to not only be more reliable, with a longer lifetime and contain more recyclable material, but also be easier to upgrade and repair. Additionally, it is expected, the future review of the so called “Single Lighting Regulation”, will set additional resource efficiency requirements for lighting products, concerning the removability and exchangeability of light sources and control gears.

At Zhaga, the global lighting-industry consortium with the mission of standardizing the interfaces of components of LED luminaires, we call this ‘circularity lighting’.

Defined as products and systems that support the aims of the circular economy through enhanced serviceability, circularity lighting is based on luminaires designed in a modular way and on component interfaces that are based on standardized and widely recognised specifications. In this sense, circularity lighting includes all LED luminaires that are repairable, upgradeable, replaceable.

Zhaga delivers on all these fronts.

Zhaga’s Contribution to Modular and Serviceable Indoor Lighting

Since its founding in 2010, Zhaga has been developing and standardizing specifications for interfaces of LED modules, intelligent sensors, communication modules and control gear for lighting manufacturers, specifiers and operators to apply in LED luminaires.

Zhaga’s specifications are called Books, with each book defining the interface of one or more component(s) of an LED luminaire. While all Zhaga Books are inherently linked to the concept of circularity lighting, not every Book is needed all the time. In fact, creating a serviceable product or component typically may require only a couple of Books.

Most pertinent to indoor linear lighting are Zhaga Books 7, 14 and 26. Book 7 defines a family of linear and square LED modules that could be used for indoor lighting applications. The LED modules require a separate LED driver (electronic control gear) and are typically mounted in a luminaire by, for example, screws. The only restriction on the light-emitting surface (LES) of the LED modules is that all light should be emitted above the upper surface of the module. This provides maximum design freedom with respect to the placement of LEDs on the module.

Book 14, which has been officially designated as IEC Standard 63356-1, focuses on a family of flat, linear, socketable LED light sources that are suitable for low-profile linear lighting. The standard includes both LED modules (requiring a separate driver) and LED light engines (LLEs) that have integrated control gear. The LLEs or LED modules have a cap/holder system that enables toolless replacement.

Rounding out the modular side of serviceable indoor lighting is upcoming Book 26.

This Book 26 defines a cost-effective mechanical and electrical interface for toolless replaceable linear LED modules, enabling plug and play #interoperability, late-stage configuration of luminaires and supporting #circular economy.

Also relevant to indoor lighting is Book 20, which, together with D4i certification by the DALI Alliance, defines a smart interface between an indoor LED luminaire and a sensing/communication node. The node connects to the LED driver and control system, and typically can provide sensory inputs or enable communication between network components. These nodes can be installed and replaced in the field.

Although not specific to indoor luminaires, Zhaga Book 13 on control gears plays a non-negotiable role in ensuring serviceability by defining mechanical interface specifications of LED drivers can be used in combination with a wide range of luminaires.

Leveraging NFC Technology for Indoor Luminaire Lifecycle Management

Two other Zhaga Books that are relevant to the serviceability of indoor luminaires are 24 and 25, both of which deal with Near Field Communication (NFC) technology. The extremely short-range wireless communication standard allows

manufacturers to configure such lighting components as LED drivers to their specifications, both before and after installation – which can play an important role in enabling circularity lighting.

NFC also lets you manage data over the luminaire's entire lifecycle, from production to installation, maintenance, replacement and repair. Having such lifecycle data not only helps increase efficiency, it also promotes products that use a modular design and that can be easily repaired and upgraded.

Luminaire manufacturers, installers and system integrators now have the option to select a single physical programming tool that will work with all field-maintenance applications from all vendors implementing Book 25 and all NFC-programmable devices implementing Book 24.

Whereas Book 24 is geared towards luminaire manufacturers, Book 25 defines a Bluetooth Low Energy communication protocol for communication between the field-maintenance application on a smart device and the NFC reader. In doing so, it enables maintenance and replaceability with a cross vendor harmonised method of NFC programming for in-field use.

Using Book 25 creates an enormous advantage in the field. For instance, if an LED module is replaced by a more energy efficient LED module, Book 25 ensures that the new operating parameters can be set wirelessly on the driver.

Book 24, on the other hand, allows for configuration by the manufacturer and for customer-specific operating parameters. It also allows the configurations to be set on demand and in accordance with the customer's specific parameters. Furthermore, because an exchange of the driver is usually not necessary, it avoids waste and extends the service life of the driver.

Making serviceability of components of luminaires transparent

Together, the interface specifications established by the Zhaga Books enable an interoperable and serviceable ecosystem of luminaires and components – one that is repairable, upgradeable, replaceable and durable.

To illustrate, let's compare a non-Zhaga luminaire with a luminaire containing Zhaga components.

By choosing a non-Zhaga luminaire you might invest into a luminaire with a limited serviceability. You will certainly face logistical resilience challenges as you have chosen proprietary components that might not be offered by another supplier.

However, a luminaire containing a set of Zhaga components offers for sure a level of serviceability. That's because Zhaga certified components comply with global interface standards, meaning that they can be exchanged with certified components from different manufacturers, which in turn enables repairs and functional upgrades.

In other words, while the end goal is to make the luminaire serviceable, a luminaire is only serviceable when it uses components that are serviceable themselves. By offering serviceable components, Zhaga helps make serviceable luminaires possible.

Minimum serviceability means that the component is replaceable and only that. Maximum serviceability however indicates that the component is replaceable, based on a global standard, is plug and play, has a socket, and in case of a driver is programmable with NFC.

For the luminaire manufacturer, the serviceability that Zhaga guarantees means achieving interoperability, accessing global markets, reducing costs, ensuring quality, staying adaptable to new technologies and protecting themselves against evolving regulations – all while gaining customer confidence. It also eases production processes by late-stage configuration and lowers the risk of not having spare parts available over the years.

But it's not only manufacturers who benefit. It is also city governments and building owners that benefit by future proofing their investments. In fact, also lighting designers and architect benefit when recommending a lighting system based on the circularity concept as their concept has a value-add.

For the lighting industry as a whole, the serviceability that Zhaga brings to indoor lighting means being prepared for a circular future that, due to initiatives like the Single Lighting Regulation, is becoming increasingly imminent. ■

New LUXEON HL4Z Delivers High Intensity, Very-High Light Output, and High Efficacy

lumileds.com

Lumileds announces the release of the LUXEON HL4Z un-domed power LED intended for applications that require very high intensity and superior efficacy. Optical designers and engineers must typically make a tradeoff between optimizing optical design and achieving high efficacy. Lumileds addresses this dilemma with its innovative LUXEON HL4Z. At maximum current, the undomed LED delivers tremendous intensity – over 1400lm – from its 2.16mm2 light emitting surface at 85□C. And at 70CRI, 4000K, 85□C, and 700mA, typical efficacy of the new LUXEON HL4Z is an impressive 189lm/W.

A small, high-intensity LED that allows optical optimization – lm/mm² without sacrificing lm/Watt

"There are many applications from stadiums to torches and even forward lighting on bicycles, mopeds, e-bikes, and motorcycles that require very high intensity light and until now, the pursuit of application efficiency has required a compromise in optical design," said Noman Rangwala, Head of Product Marketing and Management at Lumileds. "LUXEON HL4Z resolves the dilemma by delivering the output, intensity, and efficacy that simply make the intended application better than has previously been possible."

LUXEON HL4Z at a Glance

- Un-domed emitter enables maximum optical control by OEM
- 2.16mm x 2.16mm light emitting surface
- 3.5A maximum drive current
- Superior quality of light, output, and efficacy for stadium and similar lighting
- CCT options of 3000K, 4000K, 5000K, 5700K, and 6500K
- CRI options of 70, 80, and 90
- Maximum punch and intensity for highly focused applications
- Industry standard 3535 package with a 3-stripe footprint
- Large thermal pad allows high drive currents and close-packed LEDs

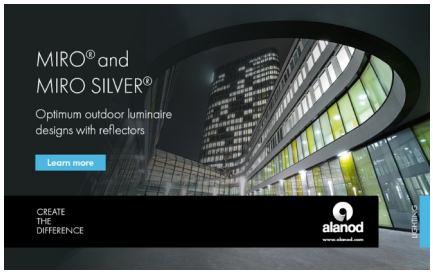
LUXEON HL4Z is available directly through Lumileds distribution network including Future Electronics, Mouser, and others.

About Lumileds: Lumileds is a global leader in OEM and aftermarket automotive lighting and accessories, camera flash for mobile devices, MicroLED, and light sources for general illumination, horticulture, and human-centric lighting. Our approximately 5,500 employees operate in over 30 countries and partner with our customers to deliver never before possible solutions for lighting, safety, and well-being. To learn more about our company and solution portfolios, please visit https://lumileds.com. ■

Lighting Solutions from Alanod for Every Requirement

alanod.com

Innovative Reflectors for Performance Enhancement and Energy Savings Light is an essential factor for human well-being, whether at work, at home, or on the go. Alanod has made a name for itself as a leading manufacturer of semi-finished products for reflectors in the lighting industry and has evolved into a specialist in light control, glare reduction, and homogeneous light distribution.



With our innovative products MIRO® and MIRO® SILVER, we have revolutionized the global lighting world by emphasizing performance enhancement and energy savings. Our highly reflective and transmission surfaces are used in LED luminaires, traditional light sources, UV light applications, greenhouse lighting, and daylight solutions, significantly contributing to creating the right light.

Efficient Indoor Lighting with Aluminum Reflectors Our custom-fit reflector materials offer optimal conditions for light control in indoor spaces, whether offices, shops, or halls. We guarantee the highest light quality through durable surfaces with total light reflection of up to 98%. The broad product portfolio allows the selection of suitable surfaces to better direct light and achieve glare limitation.

Our aluminum reflectors are characterized by:

- Durability: Consistently high performance over years without loss of reflection or color distortion.
- High-Quality Material: Gives modern luminaires a unique quality and value.
- Innovative Processes: Special lighting concepts through pressing, deep drawing, or hydroforming.
- Diversity: Wide product portfolio for every application – from precise to diffuse light control.

Advantages of Reflector Surfaces Made of Aluminum Light Quality through Durability: Our reflector surfaces MIRO® and MIRO-SILVER® have been tested under extreme conditions and retain their high reflection properties even after 50,000 operating hours. Light Quality through Light Control: Excellent light quality depends on light control. Whether isotropic or anisotropic reflection behavior, dark light effect, or ergonomic luminous density – our product portfolio offers the right surface. Light Quality through Glare Limitation: Modern LED technology has brought the issue of glare into focus. Proper light control through reflectors avoids direct glare and enables precise light intensity distribution.

Optimal Luminaire Designs for Outdoor Use Glare reduction is an important topic in outdoor lighting. Our specially developed surfaces MIRO ® and MIRO®-SILVER guarantee optimal anti-glare results, high durability, and a total light reflection of up to 98%.

Accelerate Growth Cycles in Greenhouses Proper lighting can maximize growth effectiveness in greenhouses.

Our product MIRO-SILVER® GL offers ideal conditions for optimal greenhouse lighting:

- High Reflectivity: Directs light and energy to the plants.
- Long Durability: Withstands typical greenhouse conditions.
- Infrared Reflection: Reflects invisible wavelengths, greatly benefiting plants.

Efficiently Utilize Daylight Active planning and incorporation of daylight in interiors offer immense advantages. Our highly reflective and transmission surfaces for daylight solutions help create the right lighting atmosphere and provide benefits such as energy savings, natural warmth, and positive physiological and psychological impacts. Surfaces for Daylight Reflectors: Efficient, modern, and unique for offices, industries, public buildings, and more.

Our products are characterized by:

- Various Surface Textures: From matte to glossy.
- Recyclability: Sustainability is the focus.
- Scratch Resistance and Antistatic: Durability and ease of maintenance.
- Our MIRO® surfaces offer a total light reflection of 95% to 98% and meet the highest requirements for light control and homogeneous light distribution.

Conclusion: Alanod offers innovative solutions for every lighting requirement. With our high-quality reflector materials and surfaces, we create optimal light control, glare reduction, and energy efficiency – for both indoor and outdoor lighting and greenhouse applications. Trust our expertise and benefit from outstanding quality and performance. ■

Compact LED Reflector Module Simplifies Development and Reduces Time-to-Market

https://engineering.arrk.com

To see and be seen is still the most important aspect of road safety. This is ensured by reflector or projection headlights, among other things. Although the latter generally have more functionalities, they are not suitable for all mobility concepts. They require more installation space and a more complex control system, which has a noticeable impact on development time and cost.

Carsten Taeuscher

LED-based reflector technologies focusing on lighting performance are therefore still a popular alternative. This is all the more the case as LEDs are far superior to older, cost-effective technologies such as halogen or HID lamps, due to their high energy efficiency and durability. As many headlight manufacturers have specialized in the more lucrative projection technology, clients from within the mobility industry often have to develop cheaper or smaller front lighting systems themselves, which in turn drives up development time and cost. A new LED reflector module, the prototype of which ARRK Engineering and ARRK SPG Prototyping presented for the first time at ISAL 2023, offers a practical solution. The ready-made module requires little installation space and can be integrated into various mobility concepts. Within the mobility industry, it can help both low-volume OEMs and start-ups by reducing development cost and time-to-market.

Reflector headlights are almost as old as the modern car. In fact, they have been the standard for electric vehicle lighting since the 1910s. Although they have faced competition from more complex projection technology since the 1980s, they are still the first choice for many new cars – in recent years increasingly with energy-efficient and long-lasting LEDs as light source.

“The reflector straightforwardly focuses on lighting functionality,” says Carsten Taeuscher, Head of Optical Systems at ARRK Engineering. “Unlike earlier reflection headlights, the new LED reflectors can now be designed considerably smaller, so they take up less space and are suitable for many applications due to their size and lower development and production cost.” With the LED projection module, on the other hand, you have to pay a higher price for extra functionality: both in the literal sense in terms of production cost and in the form of space requirements and complex control electronics. This noticeably affects development cycles, production and assembly and drives up

overall cost. The “big brother” of headlights is therefore more suitable for higher-class vehicles or for optional equipment packages, while many cars, two-wheelers, commercial and agricultural machinery as well as transport vehicles and pedelecs, are better served with simple but functional LED reflectors.

LED reflector module fills market niche

Yet, vehicle manufacturers who opt for the cheaper lighting solution face a problem: most major headlight manufacturers mainly offer more complex LED projection modules, because they generate higher sales. As a result, vehicle manufacturers have to develop customized LED reflectors for their respective applications themselves, which in turn takes time and involves additional effort. “There is a clear gap in the market for LED reflectors,” confirms Taeuscher. “Last year, we therefore invested in the development of a ready-made LED reflector module for high and low beam that can be easily integrated into different vehicle types, thus drastically reducing time to market.” The development partners ARRK Engineering and ARRK SPG are currently presenting the prototype to interested users and are working on getting the module ready for series production. The versatile combination options for various lighting applications based on two separate reflector modules make it just as suitable for small quantities, e.g. for start-ups, as it is for small and medium quantities for OEMs.

To ensure that the light module can be used as flexibly as possible, the developers focus on miniaturization. “The challenge is to achieve optimum efficiency and light distribution despite the small size,” reports Taeuscher. “Choosing a reflector that is too small quickly results in a significant loss of efficiency, which we don’t want to accept.” During the course of subsequent series development, the positioning of the light source and reflector in relation to each other will therefore be further optimized. In addition, a high-quality coating that provides maximum reflectivity and minimizes light loss is just as important. In this regard as well as on the search for dimensionally stable high-performance materials, ARRK Engineering and ARRK SPG – in particular the business unit ARRK Visibility Solutions (AVS) specializing in lighting – are working closely with the Japanese parent company Mitsui Chemicals.

Slim design for versatile use

Given the current market dominance of cost-intensive LED projection modules, start-ups in particular are dependent on affordable and ready-to-use solutions for front lighting. However, low-volume OEMs can also benefit from the new light module by ARRK Engineering and AVS: Due to its compact yet flexible design, it can be easily customized to individual requirements. This leaves valuable space for additional cameras and sensors, for example, which are required for increasingly complex driver assistance systems, especially ADAS. “As we are focusing development on a slim design with maximum light output, the application is not limited exclusively to the automotive sector. With minor modifications, the LED reflector modules can also prove useful for transport, commercial and agricultural machinery as well as two-wheelers and pedelecs,” summarizes Taeuscher.

Further information at
https://engineering.arrk.com/ and
https://vs.arrk.com/

ARRK Engineering is a globally active development partner for the automotive and mobility industry, specializing in end-to-end and comprehensive support of the entire product development process – from the concept phase through series development to validation and system integration of mechanical and electronic components. The share of development tasks from the fields of e-mobility, autonomous driving and software development in a digitalized development environment has been growing steadily for years and is becoming increasingly important. Through highly efficient project management, ARRK Engineering achieves the set development goals together with their customers. As part both of their developments and as a separate service, ARRK Engineering supplies prototypes and pre-series tools for small quantities. They rely on the long-standing, interdisciplinary expertise of their 1,600 employees at locations in Germany, Romania, the Netherlands, Malaysia, Japan and China. As a member of the international ARRK Group, ARRK Engineering has additional resources available worldwide to support their customers in international markets as well. ■

Melexis Miniaturizes LED Drivers for Automotive Lighting

www.melexis.com

Melexis, an influential player in automotive LED drivers for ambient lighting, announces the extension of its LIN RGB family with the MLX81123. Built on the success of its predecessor, it delivers cost-effective performance and reliability in a small package. By leveraging a new supply chain, Melexis boosts competitiveness and ensures business continuity for its customers.

Ambient LED lighting is now a key design feature for automotive manufacturers, enhancing the end-user’s experience and helping OEMs to provide striking visual distinction. With well known OEMs utilizing ambient lighting extensively across their latest

models, maintaining a reliable supply chain is paramount.

As a successor to Melexis’ incredibly popular MLX81113, the fourth generation MLX81123 features a SOIC8 and a small DFN-8 3mm x 3mm packaging. This miniaturization enables the use of light in any location of the car, whereas before there were limitations due to space constraints. Manufactured using cutting-edge silicon-on-insulator (SOI) technology, the MLX81123’s miniaturization allows for an increased number of ICs per wafer. The result of this advancement is both one of the smallest RGB LIN IC controllers on the market and a significant increase in production output volume – ready to meet the demands of the growing automotive ambient lighting market.

With common software design and pin-to-pin compatibility (SOIC 8) with its predecessor, it offers effortless integration into existing designs. Replacement of current MLX81113 chips with the new MLX81123 is often possible without a full development cycle.

The MLX81123 delivers RGB according to LIN 2. x and SAE J2602. For safety applications, it supports system integration up to ASIL B under ISO 26262.

The advanced 16-bit microcontroller unit (MCU) is equipped with 2 KB RAM, 32 KB of application-usable flash, and a system ROM with a bootloader and LIN driver. A built-in 512 B EEPROM allows for effective configuration, such as LED calibration coefficients, which are needed to ensure uniform cabin brightness and color representation.

The MLX81123’s LIN system includes a transceiver and protocol handler, which facilitate the seamless connection between RGB ambient modules and the pre-existing LIN network of the vehicle. Featuring four high-voltage I/O with free configurable current sources (up to 60 mA), the MLX81123 can support RGB and white LEDs from a wide range of suppliers, allowing for greater procurement flexibility. The IC’s independent 16-bit PWM output provides precise color and brightness control of any connected LEDs, meeting the demands of a variety of vehicle ambient applications such as door trim, accent, and interior cabin lights.

In sleep mode, the MLX81123 exhibits a

typical standby current consumption of just 25 µA and features a 28 V jump start, as well as battery monitoring with over and under-voltage detection. The operating temperature is a wide -40°C to +125°C with a built-in temperature sensor for thermal monitoring, ideal for even the most demanding automotive environments.

"Ambient lighting transitioned from an aesthetic option in high-end vehicles to a fundamental automotive feature, providing a new landscape for customization and visual differentiation. This creates additional demand for automotive LED controllers," said Michael Bender, Product Line Manager of Embedded Lighting at Melexis. "Our third generation LIN RGB IC controllers have seen incredible success. The fourth generation MLX81123 takes existing strengths, miniaturizes the solution and adds production capabilities. We deliver an unrivaled feature set at a price point that enables a roll-out across vehicle ranges from luxury to entry-level models". ■

Insta GmbH Launches CSA-Certified Matter Module

www.insta.de

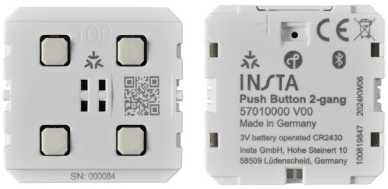
Insta GmbH, a leading electronics specialist based in Lüdenscheid, proudly announces the launch of its first CSA-certified Matter product. The Push Button Module, a battery-powered device featuring four buttons, is now available as an OEM or white-label product for B2B customers. Utilizing the Matter 1.1 communication protocol, this module allows customers to integrate standardized smart functions into their switch programs, thereby enhancing their product portfolios.

Smart Lighting at the Touch of a Button

The Push Button Module (battery type CR 2430) offers users the convenience of turning on lights and adjusting brightness with a simple button press. Furthermore, users can control shading, activate scenes, and utilize automation functions with this module.

With various button combinations (single, double, or long press) and a durable, easily replaceable battery, flexible installation and use are guaranteed. The module's four buttons can be configured directly in Matter to control devices or activate specific scenes. A connected Matter system translates these commands into the desired actions or switches assigned devices.

The Push Button Module is a "Matter over Thread" device, ensuring energy-efficient radio communication through Thread. Commissioning is conducted via Bluetooth LE and can be performed using any standard smartphone.



Versatile Integration, Compatibility with Major Platforms

Insta GmbH's new product fits seamlessly into existing switch programs with inner dimensions of 55x55 millimetres, offering high application flexibility. Additionally, the module utilizes the Generic Switch Cluster, making it compatible with systems like Apple Home, SmartThings, and Home Assistant. It is also prepared for use with bindings.

This compatibility facilitates seamless integration into existing smart home systems. Updates can be easily managed through the respective Matter platform apps, ensuring the system remains up-to-date.

The Matter module from Insta GmbH is suitable for various applications, including:

- Matter Platform Apple Home: Activating the "Movie Night" scene in the living room with a short press. Configuration is done via the Apple Home app.
- Matter Platform Samsung SmartThings: Turning on lights throughout the ground floor with a long press. Configuration is done via the SmartThings app.
- Matter Platform Apple Home: Starting Apple Music with a favourite playlist using a double press. The configuration is done via the Apple Home app.

The Push Button Module is now available as an OEM or white-label product for B2B customers.

About Insta GmbH: Insta GmbH is an electronics specialist headquartered in Lüdenscheid, North Rhine-Westphalia. The company serves as a research, development, and manufacturing center for digital networking in building technology and acts as a think tank for the future of building automation. With approximately 500 employees, Insta GmbH generates about 75 million euros in revenue through products and OEM components, ranging from LED dimmers to Internet of Things (IoT) solutions.

For over 50 years, Insta has been a leader in building and lighting automation. As a co-founder of the KNX Association, Insta emphasizes the importance of unified standards to ensure seamless integration of various components in home and building automation. Established in 1970 as a technology-driven joint venture by German socket and switch manufacturers, Insta GmbH remains jointly owned by Gira Giersiepen GmbH & Co. KG (Radevormwald) and Albrecht Jung GmbH & Co. KG (Schalksmühle). ■

LiteScout® Supports the Developmental Skills of Visually Impaired Children

www.plexiglas-polymers.com

With their luminous colors and rounded edges, the circles, triangles and squares made of PLEXIGLAS® molding compound are true eye catchers and invite little hands to touch and play with them. And this is precisely the intention, as they are designed to encourage the early development of children with visual impairments and multiple disabilities. They form part of the LiteScout® system, which consists of a light-up magnetic board, transparent tokens and a variety of learning games. Glare-free light, colors and contrasts promote children's residual visual function and improve their visual perception, hand-eye coordination and mental development.

Today, LiteScout® is an effective therapeutic learning tool used in 30 countries – and it's all thanks to a chance encounter between the plastics and lighting specialist Hagen Glass and a therapist for early visual development. The insight into her work inspired the owner of Plastolight to replace conventional light boxes using frosted glass and fluorescent tubes with modern light technology and lighter materials.

PLEXIGLAS® impresses with unsurpassed light-guiding properties

An automotive supplier advised Glass to use PLEXIGLAS®, as the brand PMMA from Röhm is also a proven material for lighting applications in vehicle construction. "The light transmittance and light-guiding properties of PLEXIGLAS® are simply unsurpassed. It is very easy to process and lightweight," comments Glass, listing the properties relevant to him. "In addition, all materials need to be safe for children and therefore free from harmful substances."

The name LiteScout®, a play on the words "light" and "lightweight," names two advantages of the therapeutic tool: Light

stimulates visual perception, while lightweight refers directly to the fact that LiteScout® weighs much less than older light box designs. For therapists there is a very noticeable difference between carrying ten kilograms or just three when visiting the children they support.

PLEXIGLAS® Softlight for soft light and a matte effect

The very bright and homogenously illuminated white surface is made of backlit PLEXIGLAS® sheet material, while the translucent colored tokens are made of a PLEXIGLAS® molding compound. Application engineers from Röhm's Molding Compounds business unit supported Glass and his LiteScout® project when it came to selecting the right molding compound and processor. They chose PLEXIGLAS® Softlight.

Heinz Schubkegel, Senior Business Manager at the Molding Compounds business unit at Röhm, describes the special features of the product: "The molding compounds from this series offer finely graduated diffuser effects for homogeneous and glare-free light extraction. This makes them suitable for all kinds of lighting applications, including light covers, lenses and ambient lighting. When certain processing techniques are used, it is possible to create satin-matte or frosted surfaces. Moreover, the range of properties and ability to color the material mean that there's a high degree of design freedom."

To make the LiteScout® tokens, a colorless molding compound is transformed into vibrant colors using fluorescent pigments. "PLEXIGLAS® is ideal because we can use it to manufacture tokens with a matte finish that glow with an appealing soft light when placed on the luminous surface. All LiteScout® components need to be matte, as light reflections on reflective surfaces are irritating for people with visual impairments," explains Glass.

Injection-molded and extruded tokens

Glass continuously improved the tool in close collaboration with therapists, educators and self-help groups, e.g., by improving the tokens' thickness and their feel. Depending on the type of learning game in question, these are either injection-molded or extruded from Röhm's PMMA molding compound.

For instance, a peg game trains the fine motor skills of blind and visually impaired children using five-centimeter-high blocks in triangle, square and circle shapes. To make these, two-meter-long profiles with a diameter of 2.5 centimeters are extruded and then cut and the contours milled and polished.

In contrast, the injection molding process is used to manufacture the "logic blocks" – flat geometric tokens for insertion according to color, shape and size into a black puzzle panel that is mounted on the lightbox's luminous surface. With a depth of seven millimeters, they are now more than twice as thick as they were in a previous design, making it easier for children to grip them. To prevent the tokens slipping out of tiny hands, the injection molding die creates a grained surface structure. This is where the high reproduction accuracy of PLEXIGLAS® molding compounds really comes into its own. Finally, the gate marks are removed with a laser so that there is no risk of injury. "The result is a beautiful, high-quality product," comments Glass. "The tokens feel good to touch, they are robust and they are scratch-resistant."

Praise for design, function and effectiveness

"PLEXIGLAS® appeals to nearly all of the senses – it has a high-quality appearance, is pleasant to the touch and even sounds good. It is an emotional product and is especially captivating when combined with light and color, sparking the curiosity of children and adults alike," explains Siamak Djafarian, Senior Vice President Molding Compounds at Röhm. "We are delighted that our material and its properties are helping children with visual impairments to learn and is giving them joy."

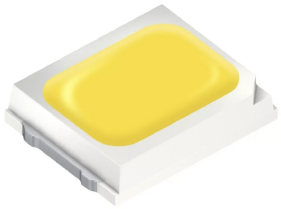
The design and function of the entire LiteScout® system are well received by specialists. Students at the Heidelberg University of Education used LiteScout® in a study on the "effectiveness of using light boxes for the promotion of visual perception" due to its "quality standards with regard to size, illuminants, light dimmability, stability and material durability." The analysis revealed "clear learning effects" when high-quality light boxes were used in a targeted and individualized manner. "Children that practice with the LiteScout® system for around half an hour daily make huge progress in their development," reports Glass. For this reason, he is currently partnering with various early childhood development organizations to create a concept that will allow families of children with visual impairments and multiple disabilities to access rented devices for free. ■

Introducing the DURIS® E 2835 0.2 W SOFTLINEAR LED by ams OSRAM

ams-osram.com

The new DURIS® E 2835 LEDs from ams OSRAM introduce engineering innovations all the way from the package to the emitter. These innovative LEDs boast a specially designed lead frame and improved reliability in the field—and their reduced resistance to bending facilitates their integration into flexible strips.

- ams OSRAM proudly presents the DURIS® E 2835 LED, a revolutionary advancement in lighting technology. Engineered from the package to the emitter, these LEDs feature a specially designed leadframe that enhances durability and flexibility in lighting strips, ensuring superior performance and extended reliability.
- With a high colour rendering index (CRI) of up to 97, the DURIS® E 2835 is ideal for applications requiring accurate and vivid colour representation, such as retail displays and museums. The compact design and high luminous efficacy of 135 lm/W at 3000K make it perfect for space-constrained environments.
- Offering a range of colour temperatures and robust electrostatic discharge protection, the DURIS® E 2835 is versatile enough for indoor, architectural, and waterproof lighting applications.



In addition, a 2400 Kelvin CCT option compensates for the effects of the silicone encapsulant in waterproof applications such as swimming pool or garden pond lighting to achieve a Correlated Color Temperature (CCT) of 3000 Kelvin when completed. The new LEDs also feature a particularly high Color Rendering Index (CRI) of 97, making them ideal for retail-display lighting, museums, and retail premises. This pre-molded PPA 2835 LED, with its standard 2835 footprint, offers exceptional value on both the application and system levels.

The DURIS® E 2835 0.2 W SOFTLINEAR from ams OSRAM is a versatile, high-performance LED designed to meet the evolving demands of modern lighting applications. Its compact size, high CRI, luminous efficacy, and innovative flexibility make it an exceptional choice for a wide range of uses. Whether for indoor, architectural, or semi-outdoor lighting, the DURIS® E 2835 delivers reliability, efficiency, and superior lighting quality, setting a new standard in LED technology. ■

The Beacon of Standards – Insights from CIE's VP on the Evolution of Lighting Technology & Design, Peter THORNS, Vice-President Standards at CIE

Peter THORNS, BSc(Hons) CEng FCIBSE FSLL
"Standards are not just about compliance; they are the bridge between cutting-edge research and practical application, ensuring that the latest advancements in lighting technology benefit everyone, from industry professionals to end users."

In this exclusive interview, we delve into the remarkable journey of the Vice President of Standards at CIE, Peter THORNS. We explore how he transitioned from an electronics background to becoming a key figure in lighting standards. Peter shares his extensive experience, starting with his early days at Thorn Lighting, and provides a detailed overview of the critical role that standards play in the lighting industry. We discuss the scope of CIE's work, the intricacies of various publications, and the importance of international collaborations. Additionally, Peter offers valuable insights into the evolving landscape of lighting design, emphasizing the balance between energy efficiency, human-centric lighting, and ecological considerations. Join us as we uncover the impactful work of CIE and Peter Thorns' vision for the future of lighting standards.

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LED professional: **Peter, thank you for the opportunity to conduct this interview with you. First of all, we would be interested in hearing about your career journey and how you ultimately became the VP of Standards at CIE.**

Peter THORNS: My original qualification was in electronics, and I started working for Thorn Lighting in electronics research and development. This was at the relatively early stages of electronic control gear and there was still a lot of magnetic control gear being developed and produced. Throughout my career within Thorn Lighting I have moved disciplines and worked in software development, optical design, manufacturing test equipment and photometry. I ended up working in lighting applications, so how we use light as opposed to a purely product focus, and my manager started to involve me in standards work, along with industry associations and of course CIE. He volunteered me to the position of Division Editor for CIE Division 3 (somewhat to my surprise), after which I became Division Director and then Vice-President Standards (VPS). In parallel I became chair of ISO/TC 274, the ISO's light and lighting standards committee, which works very closely with CIE.

LED professional: **Can you give us an overview of the scope of work CIE handles, in terms of standards overall and per year? Please also explain the different terms such as Technical Reports, Technical Notes, Standards, etc., so we can use the correct terminology from the beginning.**

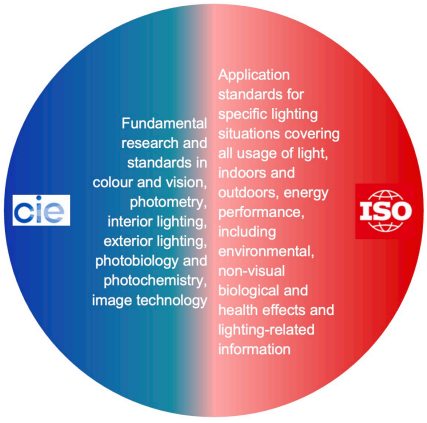
Peter THORNS: CIE presently has about 30 standards it is responsible or jointly responsible for. The number of standards being revised, or new standards being produced can vary, but typically will be two or three per year.

CIE has 3 main types of publication, all of which represent the consensus of international experts on the topic:

- An International Standard provides rules, guidelines or characteristics aimed at achieving an optimum degree of order and consistency.
- A Technical Report documents knowledge, experience and/or best practice within specific topics, including recommendations on how this information should be used.
- A Technical Note is a concise document, maximum 10 pages, summarizing fundamental information of importance to CIE members and other stakeholders but without going into too much technical detail.

LED professional: **To better understand CIE's activities, it would be useful to place them within the general landscape of standardization. There is an ISO-CIE Committee, an agreement with the IEC, and a CEN/CENELEC Agreement. Could you explain these partnerships, their purposes, and how they interrelate? Also, what is the status of the ongoing cooperation updates?**

Peter THORNS: CIE is a standards organization recognized by other standards organizations such as IEC, ISO and CEN. It is also recognized by the CIPM, the International Committee of Weights and Measures, as the body which provides standardization of the action spectra of the human eye, for quantities in photobiology and photochemistry, including V(λ), which is needed for practical implementation of the candela, the foundation of photometry. With IEC and ISO it has memoranda of understanding, allowing joint work and joint adoption of standards (dual logo standards).



CIE has a close relationship with ISO/TC 274, the ISO technical committee for light and lighting. When either CIE or TC 274 starts a new work item a Joint Advisory Group (JAG) with representatives from both organizations discusses this and recommends a development path,

- Route 1 (informative) where one organization is fully entrusted with the work and keeps the other fully informed of progress,
- Route 2 (collaborative) where one organization takes the lead in the work but liaison representatives from the second organization are involved,
- Route 3 (integrated) where each organization appoints a co-leader and both organizations are fully involved in the work.

In principle, CIE is concerned with fundamental work whereas ISO TC 274 is more concerned with application standards, although there will be some blending at the boundaries of this.

LED professional: How do standards serve as the interface between research, knowledge, and good practice in the field of light and lighting design?

Peter THORNS: Relatively few people read publications that give good design advice. Even fewer will look at academic papers and research articles. In the commercial world, time pressures are generally too high to allow more than a cursory glance into these documents as the focus is on what needs to be done. This is generally where standards are used.

So standards have to take inputs from these documents and weave them into requirements, to try and keep lighting practice up-to-date with practice and knowledge.

Of course there is a limit to what standards can do. They have a fairly rigid format and use of language, but they can move practice forward. And of course a standard may be accompanied by a technical report which allows more freedom to discuss and describe requirements and provide more general guidance.

LED professional: In your opinion, how do standards that go beyond merely lighting the task and include aspects like space, modelling, and contrast, impact the quality of lighting design in practice?

Peter THORNS: Standards have developed throughout the years from being purely concerned with a given task to considering the person performing the task. So if we consider a simple task, using a screwdriver, the lighting was effectively specified so the screwdriver could be used correctly. It took little to no account of the person holding the screwdriver; the requirements were for a standard person. As standards have developed they now recognize the wide variety of visual and physical capabilities of individuals and provide advice on how basic requirements should be adjusted depending upon the person performing the task.

Similarly, standards were concerned with lighting the task effectively. If we look at the time when computer screens were new to the workplace and were intolerant of poor lighting, lighting requirements developed to prevent bright images and reflections obscuring detail on the screens. This resulted in luminaires that were optically tightly controlled, creating cave like interiors with dark walls and ceiling. Standards now include requirements for walls and ceilings so that we consider the task being performed, the tools being used, the person performing the task, and the environment they are in.

This can be seen in the latest update to ISO/CIE 8995-1, where requirements are given for the task and the space, and adjustments are also suggested based upon the expected modifiers that will be present within a space. A designer does not need to use the suggested values, they will understand what is likely within the space they are designing in terms of the profile of the population and ease or difficulty of task, but it starts the thought process. [1]

LED professional: How should designers approach standards as a starting point while also knowing when it's beneficial to deviate from them to achieve something special in their designs?

Peter THORNS: The name standards really does define what they are: they are requirements for standardized conditions. This is true from the definition of lighting since the candela is based upon the V(λ) curve for a standardized eye response, through to application where an office task is lit to a given illuminance level, say 500 lx. In itself this is not a bad thing, as having a starting point helps define a direction of travel, but it is too easy for design to become a "tick-box" exercise where compliance to standards is enough.

A good designer will understand the basis of a standard, what assumptions are built into any criteria, and how to apply this in the real world with real people. I suspect many senior school pupils could use lighting design software and produce a standards compliant lighting scheme with only a small amount of training. This does not mean they would design good places to be in, as this takes that extra understanding of light and lit effect. And this is the extra that a designer brings. It may mean ignoring some recommendations within standards but as long as this is done from a position of knowledge and understanding it can create special spaces.

Of course, good design also involves understanding how differing products and product types light a space and change the character of the space, and it is possible to comply with standards and use product selection to create the magic. But we should not be slaves to standards, as long as we have the knowledge and ability to still create comfortable, useable spaces.

LED professional: Can you elaborate on the relationship between standards and legislation, and how disconnects between the two can affect the implementation of effective lighting solutions?

Peter THORNS: Standards reflect the consensus of experts on the given topic. They are recommendations or guidance, but not mandatory unless they are referenced in legislation that specifies that their provisions are requirements. Legislation can also define legal requirements for products and applications. Legislators (and regulators, the public servants who support them) generally lack the technical knowledge to provide the necessary detail about how to measure or verify that the requirements have been met. Standards provide these details.

If legislation defines a requirement for which there is currently no standard then this creates a problem, as compliance becomes dependent upon how the measurement method is interpreted

[1] For further information read: CIE 227 Lighting for Older People and People with Visual Impairment in Buildings.

and values may not be comparable between different products or solutions.

LED professional: How can we better balance the need for energy efficiency in buildings with the need for comfortable, productive environments for occupants?

Peter THORNS: To an extent, legislation and the requirements contained therein take a fairly simplistic viewpoint when considering many topics, including energy efficiency. A simple metric is preferred even if that metric is only one aspect of the problem. To this way of thinking, a building that uses a small amount of energy is better than a building that uses a larger amount.

This logic misses the point. We construct buildings not as energy-using machines, but as spaces to serve a purpose. Of course we don't want to consume more energy than is required for that purpose, but for buildings occupied by people, the energy consumption is not the most important performance metric. A building that creates a productive environment will use energy more effectively than one that people dislike being in because useful work will be performed by people who are healthier and happier.

We need to concentrate on how much energy we use, which is still important, but also how effectively we use that energy. We need to move away from considering installed capacity as a suitable standalone metric. The installed capacity of an appliance or luminaire does not change whether it is turned on or off. We need to consider energy use, i.e. how are building services controlled to optimize the environment whilst minimizing energy use.

We can create comfortable, productive and energy efficient spaces, but to do this regulators will need to recognize that energy use fluctuates throughout the day based on occupancy, daylight availability, the task being performed and the mood of the occupant(s). Designers and facility operators, in turn, need to provide the flexibility that allows spaces to have variable lighting depending upon the task. Smart use of controls, including individual control over local lighting, can help to square that circle.

LED professional: What are the key challenges in promoting integrative or human-centric lighting, and how can the industry better highlight the broader benefits to society?

Peter THORNS: One of the initial problems with integrative lighting is that, as mentioned above, we use installed load as an energy efficiency metric. Integrative lighting requires higher than normal levels of illumination during some parts of the day, requiring a higher installed load. However, true integrative lighting varies the light levels throughout the day, and averaged over the day may be as energy efficient as static lighting solutions. So, the first thing we need to do is to rethink our energy metrics.

After this we need to change our design practice. Placing the luminaires in the ceiling does not allow true integrative lighting as every person is different with differing needs. To address this we need individual lighting. So the ceiling luminaires become ambient lighting, ensuring safe movement and lighting within the space (walls, ceiling, etc.), and personal lighting is supplied via desk lights or individual luminaires, perhaps floor-standing.

There is no universal tick of the circadian clock and except in specific circumstances it is difficult to create one. In areas with relatively fixed populations, nursing homes for example, the residents are relatively fixed and their daily pattern is more regimented. In offices or spaces with a large number of occupants who spend part of the day working and part of the day at home, socializing, etc. this is not possible. The person who goes to a sports event that is lit to 2,000 lx and finishes at 10:00PM will not have the same circadian needs as the person who has a quiet evening and early night. Nor will the under 30 worker have the same circadian entrainment as the over 50 worker in the same space. So we need to forget a one-size-fits-all solution and start providing capability and understanding. If a person can understand the impacts and possibilities from light, and has the facilities to use light to improve their well-being, then they have the potential to thrive. If we give the capability without the training it will be wasted, or possibly used badly to the detriment of the person. If we supply training without the capability it will create dissatisfaction and frustration.

So integrative lighting has great potential but needs careful management and everyone needs to be involved, not just facilities managers or building owners. [2]

LED professional: How can the lighting industry move beyond a reactionary approach to sustainability and adopt a more holistic view that includes both repairability and material efficiency?

Peter THORNS: In fairness to lighting and the lighting industry it is one aspect of the built environment that has made great progress in terms of efficiency. However, energy efficiency is not the same as resource efficiency.

A problem that exists, not just within lighting, is the imperative that we have to be seen to be doing something without necessarily ensuring it is the right thing. An example is if, by default, we need to ensure that a mass-produced product is repairable. To make it repairable we will need to add material content in the form of fastenings and connectors. However if this is a very reliable and durable product it may have a very low failure rate and the overall impact of the material content that is added to all of the non-failed products may outweigh the savings from repairing the few failures. Remember that the material content is not just in the components but in the full manufacturing and supply chain for the components. But politically and publicly it is perceived that it must be repairable.

This is not to say that repairability should be ignored: it should be the default condition. But it should be considered from an informed viewpoint. Similarly, material efficiency should not default to material reduction. If by reducing material content we also reduce durability it is a false saving. So sustainability needs to become a way of life and a way of thinking, and not a reaction to accepted wisdom.

In addition, sustainability should be from cradle-to-cradle, not purely a product characteristic. Where raw materials originate, where they are used, waste within the system, side-impacts in terms of waste requiring special treatment (think paint plants for example), etc. should all be considered. And we also need to remember ethical aspects such as child or slave labor.

[2] For further information read: ISO/CIE TR 21783 Integrative lighting – Non-visual effects.

So the lighting industry, the whole lighting value chain, has to move its thinking. And this will have a cost because sustainable production and products have a price overhead. Cheap products have always been available, and nowadays especially from online shops. Until we demand products that have a sustainable pedigree, in terms of independent and verified environmental product declarations from suppliers with similar environmental standards, we are not taking the issue seriously.

LED professional: **What are the main obstacles to integrating lighting controls as a fundamental part of lighting design rather than an afterthought, and how can we address these challenges?**

Peter THORNS: When a designer plans the lighting in a space they tend to design for the worst-case scenario, or accepted default (think 500 lx for an office) and produce a lighting layout based on this. Lighting controls may then be added to take account of daylight and occupancy. A better way to do this would be to define the lighting needs for the various uses of the space, define control scenarios for these, and then design the lighting to achieve them. This will probably change the proposed layout as the positioning of luminaires will be driven by the scenarios rather than a generic layout for uniform lighting.

LED professional: **How do you envision the future of lighting controls, especially with the potential inclusion of AI to create proactive systems? What are the benefits and challenges associated with this?**

Peter THORNS: Currently lighting controls are reactive. They sense a person, or a quantity of daylight, and adjust to the situation. As modern lighting is an instant response technology this means people can enter a dark space before they are sensed, or spaces go from dark to bright instantly. In long corridors it may mean walking past dark spaces or corridors that run off the main route, which is uncomfortable.

Also, present lighting controls have no concept of the individual. They lack the idea that one person prefers a higher light level to another, or that one person generally performs a different function to another.

If controls could recognize people, understand their normal routines and preferences, then the lighting could proactively respond to a person, frequently using less light and ensuring comfortable spaces based on individual preferences.

Lighting controls can already be used to track space utilization, allowing spaces to be used more effectively both in terms of rental costs and also energy usage. Lighting can also be used to track the movement of people and machinery. An example is tracking movement of people during breaks or at the end of a shift, and also lorries, fork lift trucks, etc. to ensure that movement patterns do not create unsafe conditions. This can be extended to not just track movement but to predict movement, based on historical patterns and changes in behavior, creating safer workplaces.

However, this has a number of issues such as data protection. People may be uncomfortable about being perceived to be tracked and monitored, even if it makes their life easier and safer, and there are privacy issues regarding the use of facial recognition. This is a mixture of ensuring background systems are safe and secure, in terms of cybersecurity, and informing people about such systems so they can understand them better. [3]

LED professional: **How can we develop lighting solutions that balance human needs with ecological considerations, avoiding one-dimensional solutions that may inadvertently harm the environment?**

Peter THORNS: The first thing we have to do is be honest and recognize that the only ecologically friendly light sources are the sun and moon. This is not to say that other lighting is bad, because it addresses the needs of people, but we have to balance these needs against the needs of the planet. We can produce electric lighting that minimizes impacts, not totally remove them, and then only use it when it is required as opposed to during all of the hours of darkness.

The big problem with lighting is that we tend to be very one-dimensional when we consider ecology. For example, one of the biggest problems is that we have protected species that may be affected by the lighting. This directs designers to concentrate on producing solutions that minimize the impact on these species due to their legal status. But this ignores the full ecological food-chain, and if we break this chain at any point then the protected species will be impacted indirectly and either die out or migrate to other areas. For example if we change the flowering pattern of plants then pollinators may not be active during the flowering period. And when the pollinators are active there may be very little to pollinate, impacting food supply. This continues to impact up the food chain, affecting everything in it.

Spaces, whether urban, sub-urban or rural, have patterns of use during the day and throughout the year and we need to understand these and light them accordingly. Too often we light to assumed usage, or even to levels in standards that only apply during the busiest parts of the day, instead of using light that adapts to the patterns of the space. In addition, we need to overcome a general fear of the dark in society. As we have used more and more lighting, people have lost the knowledge of darkness, and this creates an underlying fear of it. Lighting empty roads and streets that remain empty for many hours during the night is not defensible, either ecologically or from an energy viewpoint. We need to give a value to the darkness that has been lost. [4]

LED professional: **How do you see standards evolving to move away from the status quo and start incorporating alternative methods and metrics such as the European standard that specifies the lighting requirements for indoor workspaces to ensure visual comfort and performance (annex B of EN 12464-1:2021)?**

Peter THORNS: This is a difficult process as current metrics and measures are deeply embedded in lighting practice. Even small changes in standards content can start deep discussions.

Using EN 12464-1 as an example, the schedule of requirements (tables) were expanded in the current version. This included information that had previously been in the text of the standard as ex-

[3] For further information read: CIE 222 Decision Scheme for Lighting Controls in Non-Residential Buildings.

[4] For further information read: CIE 150 Guide on the limitation of the effects of obtrusive light from outdoor lighting installations.

perience showed many people do not read standards, only tables of requirements. Context modifiers had existed in the standard since 2002 but introducing these into the tables was very controversial, even though this was done to provide a starting point for the consideration of designed lighting levels and not a design end point. After all, a competent designer knows best which modifiers are sensible to apply and which are not.

In annex B of EN 12464-1 we also introduced information on alternative design metrics and methods. These were mean ambient illuminance from Goven et al, mean room surface luminous exitance from Cuttle, and visual lightness and interest from Loe et al. This was to start a discussion on design, what we were really trying to achieve and how to do this. All of the information is informative, so not a requirement, but it introduces the topics. Ideally one or more of these methods will become a parallel design metric in the future and move from being in an annex to the main text of the standard. Informed designers could then use relevant metrics whilst still complying with the standard. However this is a seismic change and will need to develop momentum before it will gain any hold in general design practice. Just having people understand concepts such as mean room surface luminous exitance, what they are, why they are important, and how to use them, will be a big step.

So standards will evolve, but it is more likely to be through small steps as opposed to big strides.

LED professional: We would also like to take a look at other global and related standards. Where are there international efforts that will impact the lighting industry, such as the WELL Standard and other initiatives? Is the CIE involved in these efforts and coordinating the lighting domain?

Peter THORNS: Realistically coordinating the lighting domain is an impossible task as there are too many other actors within this space. However, the CIE does talk with many of them and CIE members are involved in much of their work, even if they are not directly representing the CIE. In addition, many organizations are commercial business, such as WELL, which are therefore outside the scope of the CIE which cannot be seen to be favoring a commercial organization according to the rules for standards organizations.

So the CIE is involved with many lighting organizations, either directly or indirectly via its members, which helps spread the work of the CIE into standards and guidance.

LED professional: Do you have a general statement on the role that CIE's findings will play in the future development of the lighting industry?

Peter THORNS: The CIE continues to lead many aspects of lighting. In the year that the V(λ) curve reaches its centenary we can look at the other action spectra that the CIE has defined, such as cone fundamentals and the melanopic response curve. The CIE's continuing work in colorimetry updates these standards to keep them relevant with the latest knowledge. So much work of the CIE is in the background, dealing with the fundamentals the lighting industry is built upon.

Of course, the CIE also produces applications guidance and best practice. An example of current work is for a decision scheme to determine lighting requirements. This aims to move away from tables of values to a set of variables that go beyond the type of activity to be performed and include the most relevant influencing factors, such as visual task characteristics, personal variables, and contextual variables. Another example would be work on electric lighting and its impact on the natural environment which aims to provide guidance on ways to minimize the effects of lighting on the natural environment, including impacts on flora and fauna. This will make recommendations on light levels, spectral distributions, and other specific considerations of a broad range of organisms as well as specific habitats.

The CIE is involved in both fundamentals and also application topics that will help guide the lighting industry into the future.

LED professional: Towards the end of our conversation, we are curious about how researchers, developers, designers, and users can access and stay updated on the results of CIE's work. How can one be involved in this flow of information, and are these resources freely available or are there associated fees?

Peter THORNS: The first point of call is the CIE website. Here you can find all the CIE publications, available for purchase, and also the current work items for each of the CIE's six scientific Divisions. To be actively involved you really need to join your national CIE committee or associate national committee, although large organizations may choose to become Supportive Members of CIE . This does have a cost but many academic institutions have membership so it is always worth checking if this exists first.

CIE does publish some free information in the form of Technical Notes and Position Statements, but most publications do have a cost. Members of National Committees have access to substantial discounts.

So like all good things in life, working in the CIE is a commitment, but it is also very rewarding.

LED professional: Standards might initially seem dry, but you have opened a new window and provided new perspectives. Thank you very much for these valuable insights!

Peter THORNS: Thank you for this opportunity. ■

For additional information, please visit https://cie.co.at.

International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

Jil Sander New Bond Street Store, London

Lichtvision Design

Jil Sander's new flagship store reveals an innovative retail concept and lighting design within the context of luxury stores. Designed to make you feel at ease and with an atmosphere of calm and elegance, the products softly stand out under a glowing luminous ceiling, whose light reveals surface textures and intricate details within finely crafted architectural enclosures. At the basement level, the design becomes even more intimate and intriguing. Sculptural domes are dotted around the space like 'indents' in the ceiling. These hide recessed spotlights that light the room as well as give accents to the products.

JIL SANDER NEW BOND STREET STORE, LONDON

Typology: Retail Store
Lighting Design: Lichtvision Design
Scope of Work: Artificial Lighting
Completion: October 2023
Location: London, UK
Client/Owner: Jil Sander
Tenant/User: Jil Sander
Project Team Lichtvision Design: Karen Ihlau (Project Director), Paolo Cocconi (Project Designer)
Design Architect: Casper Mueller Kneer Architects
Contractor: Lamberti Construction
Photographer: (c) Paul Riddle
Lighting Supplier: Linear diffuse pendant lighting above ceiling louvres: Flashaar, Spotlights in ceiling domes and between ceiling louvres: DGA, Furniture integrated lighting: DGA
Lighting Controls: Mode Lighting

Project Contact & Links
studio.london@lichtvision.com
www.jilsander.com

Project: Jil Sander, New Bond Street is the beginning of a worldwide roll out of refurbished stores with a brand new interior concept developed by Casper Mueller Kneer Architects. The materiality is at the heart of the project and stone is the primary element of the store's construction. The luminous ceiling is designed to softly reveal the different surface textures of the travertine marble. The overarching ceiling allows for the gentle highlighting of both Jil Sander products and the architecture underneath. The brief for the lighting was to provide a setting to allow products to really be in the foreground; this in an environment where color, texture and materials are almost constantly changing. It is a space that feels calm and elegant.

The overarching luminous ceiling embraces the visitors with soft diffuse light while revealing the textures and shades of color of the natural travertine stone. Additional spots and furniture-integrated lighting complete the view, softly raising the contrasts and giving the right accent to the products without disrupting the ethereal atmosphere of the space.

At the basement level, the mood changes into a more intimate and home-like environment. The lighting is hidden from sight in domes that seem to be carved out of the ceiling surface. These domes have been dimensioned in such a way that no spill light will hit the internal surfaces, giving the impression that they provide light, without lighting. The first impression is a magical elegance and general feeling of ease.

Innovation: The lighting design concentrated on creating a calm and inviting atmosphere but without the use of obvious decorative design elements was different to other high-end stores and represented more of a hospitality approach. The team quickly honed into the concept of creating intimate spaces and that feeling of ease. The lighting was created as a backdrop to the spaces, gently enhancing textures and allowing the products to stand out softly.

It meant a careful balance of light levels between the ground floor and the basement, contrast values between general lighting and accents (approx. a 1:2 ratio) and careful consideration of surface reflectance's used throughout the store. For example, a slight sheen on the off-white ceiling louvre's paint resulted initially in a big burn from the linear lighting above. Once corrected, the luminous ceiling did indeed create this overarching effect we were after. It was a tiny detail that was the make-or-break for the success of the ceiling lighting solution. At the ground floor level the idea of an overarching luminous ceiling that shows an open grid but conceals the geometries in the perspective was tested. The atmosphere and overall feel is light and bright. In contrast, the basement has low ceilings and the lighting is hidden from sight in domes that seem to be carved out of the ceiling surface. The lower light levels coincide with the more intimate atmosphere desired.

The team developed a new workflow with the architects, using their 3D model not only for lighting calculations but also for the optimization and testing of the overall visual appearance. This reduced the need of site mock-ups to a minimum and also helped on a fast-paced design and construction timeline. The innovative retail concept echoes a commitment to build a durable environment, designed to age well, and over time, integrating natural materials and re-used materials. The space features marble, brass elements and timber pieces while furniture elements are made from recycled plastic from compact disc cases. The lighting elements echo this sentiment by using quality products for long lifetimes, excellent lighting criteria and warranties. Manufacturers have a strategy for recycling and repairing the fixtures without having to fully replace them.

Simple lighting controls allow for three settings during a typical day and night cycle. A curfew time ensures the lighting is switched off in the middle of the night.

https://www.lichtvision.com/en

LICHTVISION
DESIGN


JIL SANDER
JIL SANDER

Illuminating the Future with Sustainable 3D Printed Lighting Solutions

Philips MyCreation - A Lighting Brand by Signify

In recent years, the lighting industry has been undergoing a period of rapid transformation, driven by a range of technological, social, and environmental factors. From the rise of smart lighting systems to the increasing demand for sustainable materials and production methods, the industry is facing a range of challenges and opportunities.

One of the most exciting developments in lighting technologies and design is the use of 3D printing. Philips MyCreation is revolutionizing the lighting industry with this cutting-edge technology. This innovative venture builds on the expertise of its parent company Signify, the world leader in lighting, which has been at the forefront of 3D printing since its inception in 2016.

Philips MyCreation aims to make 3D printing accessible to professionals and consumers, democratizing the technology for all. Signify launched the Philips MyCreation brand, which provides an online platform [1] and intuitive interface for users to configure, and 3D print lighting fixtures that cater to their preferences. The platform's success underscores the importance of agile production methods in meeting customer needs with speed and efficiency.

By collaborating with research institutions and startups, Philips MyCreation continually improves its processes, pushing the boundaries of sustainable design and production. Signify is committed to future-focused climate action and reducing landfills, setting ambitious goals for the future.

"We're committed to staying at the forefront of lighting design and technology. We are constantly exploring new materials, techniques, and technologies that can help us create even more innovative and sustainable lighting solutions. Whether it's experimenting with new 3D printing materials or collaborating with leading designers and architects, we're always pushing the boundaries of what's possible."

— Bart Maeyens, Head of business 3D printing at Signify

The Power of 3D Printing Technology

So, what exactly is 3D printing, and how does it apply to lighting design? In simple terms, 3D printing is a process of creating three-dimensional objects from digital files. It works by laying down successive layers of material until the entire object is created. This technology has been around for decades, but recent advancements have made it more accessible and applicable to a wider range of industries, including lighting design.

Philips MyCreation utilizes cutting-edge 3D printing technology **Figure 1** to produce lighting fixtures that are both aesthetically pleasing and highly functional. With hundreds of printers located in various hubs worldwide, they are readily available for service nearby. Operating on an industrial scale, they are equipped for mass production and can print in a highly automated manner and on demand. Their 3D printers enable them to create intricate designs and complex geometry that would be unattainable using traditional manufacturing methods. This capability allows them to push the boundaries of lighting design, resulting in unique fixtures with a wide variety of colors, textures, shapes, sizes, and mounting options.

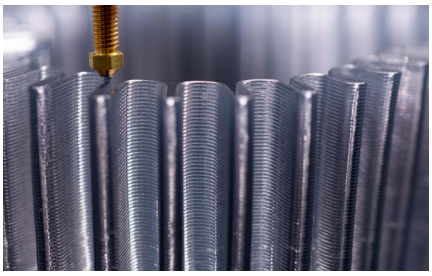


Figure 1: Philips MyCreation utilizes cutting-edge 3D printing technology

When looking for the perfect lighting design to complement your brand or space, it is essential to add a personal touch and uniqueness. At Philips MyCreation, you have two options for finding the perfect custom lighting solution: you can either choose from their pre-designed products or collaborate with the Philips MyCreation team to create a personalized design.

www.philips.com/mycreation

If you opt for pre-designed lighting solutions, you can customize them to fit your specific needs. Whether you are a business, designer, or an individual, there are various options to choose from, such as different shapes, textures, colors, and mounting. The portfolio includes high-quality functional and decorative luminaires, such as downlights, projectors, and pendants, designed internally or in collaboration with external designers like Lex Pott, Basten Leijh, and Sebastian Bergne. An example of pre-designed lighting solutions is the Accent D65 and Essential.

Philips MyCreation also offers the capability to design and produce a truly one-of-a-kind lighting fixture that caters to the specific needs and preferences of its clients **Figure 2**. The 3D printing technology enables its clients to create a personalized product swiftly and effortlessly. The client will collaborate with their top designers through a structured 6-step approach to co-create bespoke designs:

1. Share: Clients initiate the process by sharing their projects and inspirational ideas.
2. Sketch: Collaboratively, the initial rough sketches are created to bring concepts to life.
3. Select: Clients and designers work together to select and finalize the preferred design following the sketch phase.
4. Specify: This phase involves rendering the design and incorporating final prices and specifications.
5. Prototype: The finalized prototype is developed, and clients can provide feedback for any necessary adjustments.
6. Print: Once the prototype is approved, the design is ready for printing and delivery, ensuring a swift and efficient creation process.

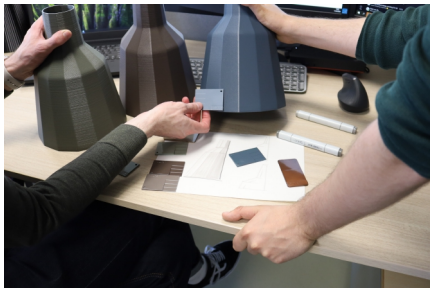


Figure 2: Philips MyCreation also offers the capability to design and produce a truly one-of-a-kind lighting fixture that caters to the specific needs and preferences of its clients.

Accent D65

The Accent D65 lighting family consists of multiple archetypes with consistent light quality in a sleek and subtle design. With a diameter size of 65mm, this versatile lighting solution is highly energy-efficient and offers various color and texture options. It is an ideal choice for fashion retail, hospitality, and residential applications.

"This accent lighting solution family is designed with circularity in mind, just like our other products. What sets this luminaire family apart is that the printed parts, as well as the heat sink, are made with recycled materials. The 3D-printed housing is crafted from at least 55% recycled or bio-circular materials, while the heatsink is made from 85% recycled aluminum. In addition, these luminaires are upgradable, reusable, serviceable, and recyclable, making them a true game-changer in the world of lighting design."

ASHIM KUMAR PAL
Product Manager at Philips MyCreation

Essential

Essential is a versatile lighting fixture in 3 sizes and 4 mounting options that seamlessly integrate into any decor. It offers a VPC (Visible Profile Ceiling) option for easy installation and provides perfect rimless ceiling integration. With a wide range of colors and textures, it complements beautifully designed ceilings while meeting functional office lighting requirements.

"Essential delivers an impressive high energy efficacy of up to 152 lumens per watt (lm/W) and can be connected to other systems to create a smart office lighting solution with integrated sensors. The printed housing is crafted with a minimum of 55% ISCC Plus certified1 bio-circular materials. With this luminaire, you won't have to compromise on style, performance, functionality, or sustainability."

FRANK ZHOU
Product Manager at Philips MyCreation

Sustainable by Design

Sustainability lies at the heart of Philips MyCreation, offering their customers the opportunity to make a positive impact. By opting for their lighting solutions, you can play a role in contributing to a circular economy, cutting down on CO_2 emissions, and minimizing waste. These products are inherently sustainable, crafted for circularity, with sustainability considerations woven into every phase of the production process **Figure 3**.

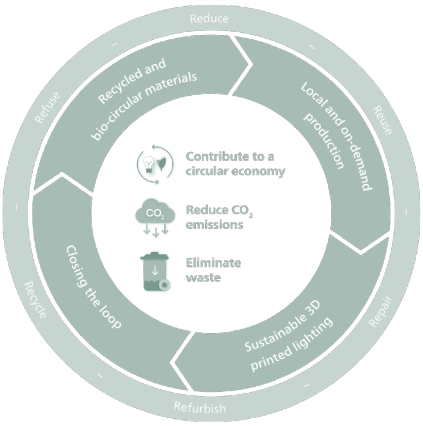


Figure 3: Stages of a sustainable production process.

To create lighting solutions that are designed for sustainability, it all begins with the choice of source materials. That is why all printed parts of the luminaires are made with a minimum of 55% sustainable materials. They strictly avoid using 100% virgin materials in their printing process. The products contain either post-industrial recycled materials, **ISCC Plus certified [2]** bio-circular materials, or post-consumer recycled materials. In the past, they have released several collections made from waste materials, such as old CDs and fishing nets. Since 2023, they have introduced the Spring Oasis collection **[3]** that repurposes water jugs and they continue to explore other post-consumer recycled materials to turn waste into innovative products.

For the packaging, they use at least 80% recycled paper-based boxes. Plus, they have eliminated single-use plastics from all their packages with luminaires: no blisters, no plastic dust protection caps for downlights **[4]**, and no plastic bags.

And it does not stop there. The lighting solutions are also highly energy efficient as they contain advanced LED (Light Emitting Diode) drivers, LED modules, and LED light sources from Signify. The energy efficiency can vary depending on the product series, ranging from 100 lm/W to 180 lm/W. The lamp-based products can reach 210 lm/W when using Ultra-Efficient A-class bulbs. The reason they prioritize energy efficiency in their designs is because energy consumption during the use phase is the largest part of Life Cycle Assessments (LCA) for luminaires. In addition, the products are lightweight, resulting in a lower carbon footprint associated with manufacturing, shipping and transportation **[5]**.

The products have a long and reliable lifetime of up to 100,000 hours and can be connected to multiple lighting management and (building) automation systems. There are wired and wireless solutions e.g.: Interact, DALI and MasterConnect. All connected solutions are certified or at least comply with international communication standards such as Zigbee, Wi-Fi, DALI, POE (Power Over Ethernet) and Bluetooth **Figure 4**. The Interact Ready products comply with the DiiA standard regarding luminaire, energy, and diagnostic data. And, through the integrated sensors, you will avoid ceiling acne and complex installations.

How McDonald's Overcame their Lighting Design Challenge with 3D Printing

In the quest for a unique and sustainable lighting solution, McDonald's faced a significant challenge: they required a custom-designed, hemispherical, translucent pendant light that shimmered like velvet and featured a complex embossed pattern. This design had to be scalable across their 38,000 restaurants worldwide, meet high durability standards, and come at a competitive cost. Traditional manufacturing methods fell short, as they could not produce the intricate mold required for the top pattern of the luminaire. The urgency of the situation was compounded by the need for a quick turnaround and McDonald's commitment to reducing its carbon footprint by 60% by 2030. It was a mission that seemed impossible until Philips MyCreation stepped in with its 3D printing capabilities, offering an innovative and environmentally friendly solution.

"We couldn't find a solution for our specific lighting design until we talked to the co-creation team. The pendant light really shimeers like velvet. The pattern is just stunning."

MARC POCHERT
Senior Director Global Design Integration
McDonald's Corp

Custom-designed 3D printed luminaires for McDonald's. Credentials to McDonald's incorporation.

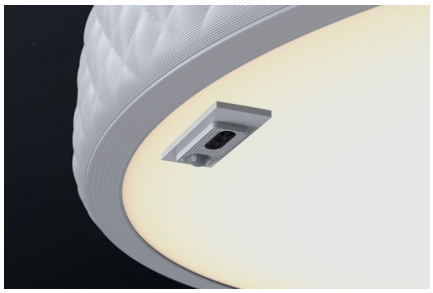


Figure 4: Interact Ready luminaire with an integrated sensor.

Plus, Philips MyCreation strives to provide products that are not only energy efficient but also durable and reliable. That is why they make a Life Cycle Assessment (LCA) for each product series and create an **Environmental Product Declaration (EPD)** to communicate the outcome, the brand can provide the requested environmental data that is usually required for the many hundreds of environmental or green labels and certificates.

Among the several certifications achieved, certain North American products received the prestigious **Declare certification** issued by the International Living Future Institute. This label emphasizes the brand's commitment to creating products with materials that benefit the world.

Reducing Emissions and Waste

Philips MyCreation aims to transition to a fully circular approach in its 3D printing operations. This involves establishing a sustainable product lifecycle. They have set up their production process to enable on-demand manufacturing and local production. This allows them to eliminate the need for holding stock of finished products, reducing the risk of unsold inventory. This approach not only minimizes inefficient capital, energy, and material usage but also eliminates the need for maintaining a warehouse facility. In addition, their production is highly automated and end-to-end digitalized, leveraging advanced software to thoroughly control the entire supply chain.

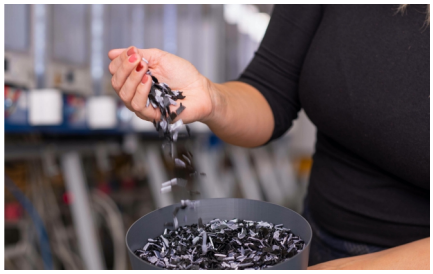


Figure 5: Recycled material as the basis for innovative 3D-printed lighting.

They are also committed to reducing carbon emissions in their operations, so they transitioned to using 100% renewable electricity in all their manufacturing sites from 2020. To reduce their reliance on non-renewable energy sources, they have implemented measures such as using local windmills and solar panels for renewable electricity generation.

Philips MyCreation has a dedicated program called **"Towards Zero Production Waste"** aimed at improving yield and minimizing waste in production. The leftover filament is recycled in-house by chopping it to create new filament, and a granulator has been installed to shred and reuse waste, such as rejected parts that did not pass quality control. These efforts have significantly reduced waste going to landfills. To further minimize the number of end-of-life products ending up in landfills, the company collaborates with numerous recycling schemes and companies across Europe and North America. Additionally, as their products are designed without using glue, paint, potting, and with fewer screws, they can be easily disassembled.

Advancements in 3D printing technology and design rules have allowed the company to seamlessly incorporate multiple functions into a single component. For example, a strain relief can be integrated directly into the housing of a luminaire, eliminating the need for two screws and a separate plastic part in the assembly process. As a result, Philips MyCreation's products require up to 40% fewer components compared to equivalent products manufactured using traditional methods **[6]**.

Printed parts can be recycled to create new products, and the company is currently testing the viability of recycling their own printed materials from End-of-Life products to print new parts again.

To learn more about Philips MyCreation and their product portfolio, visit their website at www.philips.com/mycreation. To gain a deeper understanding of how the lighting solutions of Philips MyCreation can help you achieve your environmental goals, save costs, and create a positive impact, be sure to download their sustainability whitepaper **[7]**. ■

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[1] https://www.philips.com/mycreation
[2] The International Sustainability and Carbon Certification (ISCC, https://www.iscc-system.org/) is a global independent multi-stakeholder initiative and leading applicable certification system supporting sustainable, fully traceable, deforestation-free, and climate-friendly supply chains. With our certification, we contribute to environmentally, socially, and economically sustainable production.
[3] https://pro.mycreation.lighting.philips.com/spring-oasis
[4] For specific projects that require a dust protection cap for downlights a separate box with plastic dust protection caps can be ordered. By doing this we eliminate plastic waste for projects where a dust protection cap is not needed.
[5] Compared to the traditional manufacturing of the Philips GreenSpace Downlight.
[6] Compared to the Philips GreenSpace Accent pendant luminaire.
[7] https://pro.mycreation.lighting.philips.com/download-whitepaper

About Philips MyCreation

Philips MyCreation is an innovative business dedicated to redesigning the lighting industry for a truly circular future. Our mission is to create a world where circularity is the norm, and lighting can meet your every need and desire through advanced technology and manufacturing. With our 3D printed lighting solutions, we are leading the way towards a more sustainable and creative future.
Philips MyCreation is a lighting brand by Signify, the world leader in lighting for professionals, consumers and the Internet of Things. Their Philips products, Interact systems and data-enabled services, deliver business value and transform life in homes, buildings and public spaces.

www.philips.com/mycreation

Adoption of Narrowband Red Phosphor Promises Improved Quality of Light in General Lighting

Adil SIDIQI, Vertical Segment Manager at Future Lighting Solutions, a Division of Future Electronics

From around the middle of the last decade, the display industry deployed a magic recipe that was, at first, little understood by lighting industry professionals.

TriGain® technology, originally developed by GE Lighting and now a property of Current [1], is a patented potassium fluorosilicate (PFS) phosphor formulation that produces a narrowband emission profile in the red part of the spectrum, resulting in higher quality of light and a more vibrant rendition of red colors than traditional phosphors used in white LEDs provide (Figure 1). The technology is sometimes called a 'red-line emitting phosphor' [2].

The display industry was the first to embrace the benefits of TriGain technology, deploying it in LED backlighting systems to produce superior image quality.

But TriGain phosphor's superior color rendition at high efficiency is a valuable combination of benefits for lighting applications as well: a reliable rule of thumb is that TriGain technology provides 90 CRI color quality at 80 CRI efficacy, as well as making reds appear more vivid.

It has taken several years for TriGain technology to find its way into the broader LED industry because of highly restricted licensing. Now, however, Current is providing access to the technology widely, both by providing TriGain phosphor directly to LED manufacturers, and by licensing the recipe to enable LED manufacturers to produce their own TriGain phosphor.

Manufacturers that have taken advantage of the new licensing arrangements to make or start development of TriGain-based LEDs include Bridgelux, Lumileds, Luminus, Nichia, and Seoul Semiconductor.

So should lighting equipment manufacturers be rushing to replace the conventional white LEDs in their product designs with new TriGain-based 90+ CRI LEDs for an instant uplift in quality of light without sacrificing efficacy? As we shall see, the commercial opportunity is compelling, but care must be taken to ensure that implementation does not risk disappointing customers' expectations for color point accuracy and color consistency.

OEMs Can Improve Value of Luminaire Portfolio

The basic numbers leave no room for doubt: TriGain-based light sources with a minimum 90 CRI provide better quality of light than 80 CRI conventional LEDs, while matching them for efficacy (**Figure 2**).

How might this affect a lighting manufacturer's product strategy?

Most obviously, in any tender that requires the high efficacy normally provided by 80 CRI LEDs, OEMs can substitute TriGain-based 90 CRI LEDs, giving customers an increase in quality of light without entailing increased power consumption. This approach can be particularly attractive in settings that place a high value on wellbeing and the health and comfort of users, such as educational establishments, hospitals, and offices. The provision of superior quality of light potentially justifies a price premium, helping OEMs to raise their average selling prices.

The use of TriGain-based LEDs can also enable OEMs to streamline inventory and production operations. Today, lighting manufacturers typically stock separate inventories of 80 CRI LEDs (for applications requiring higher efficacy) and 90 CRI LEDs (for applications requiring higher quality of light). A single TriGain-based LED can replace both sets of 80 and 90 CRI LEDs, enabling the OEM potentially to satisfy both sets of application requirements with a single stock-keeping unit (SKU).

The supply chain for TriGain technology is already well populated, and TriGain-based LEDs at all the important ANSI CCT values are widely available, making them suitable for use in both single-color and tunable white lighting equipment.

https://www.futureelectronics.com/our-solutions/lighting-solutions

Implement Red-line Phosphor LEDs with Care

Therefore, the commercial case for using TriGain-based LEDs in luminaire designs that would previously have used conventional 80 CRI or 90 CRI LEDs is clear.

Nevertheless, OEMs need to take care over the implementation of LEDs with PFS red-line phosphor to ensure that they meet the customer's specification for color point and color consistency. The reason for this is the marked variance in color in PFS phosphor as temperature and drive current vary. This is illustrated in **Figure 3**.

Changes in humidity also affect the color point of PFS phosphor-based LEDs. Since LEDs also tend to fail faster, the more humid the operating conditions, control of humidity in the application is always an important design consideration when using TriGain LEDs.

The high quality of light provided by TriGain-based LEDs is a feature required in interior rather than exterior lighting. In interior lighting, where ambient temperatures are controlled by heating and ventilation systems, it will normally be possible to specify the LED's junction temperature within a narrow range for any given application.

However, operating temperature will vary widely between applications: a downlight densely populated with LEDs and intended for mounting in a ceiling void will typically run hotter than a pendant linear light, for instance. OEMs therefore need to be aware that LEDs from a single manufacturer's single bin might emit light at different points in CIE 1931 color space in a downlight as compared with a linear light.

This color shift behavior of the PFS phosphor is particularly troublesome for OEMs responding to tenders that require tight color consistency between different fixtures in a single lighting scheme.

So how should OEMs' implementation of TriGain-based LEDs account for the color shift behavior?

There are, in fact, information resources and tools that OEMs can use to accurately model the color behavior of their chosen LED in the application's conditions. The first step is to specify precisely the operating conditions application by application. This calls for accurate testing or modeling of each intended application's drive current and junction temperature. (If humidity is expected to vary widely in the application, this parameter should also be built into the design models.)

The second step is to survey the product offerings to find the right selection or combination of LEDs to meet the OEM's requirement. The manufacturers of TriGain-based LEDs supply their products, and the test data which characterize them, in color bins for various junction temperature values – typically 25°C, 65°C and 85°C.

OEMs can manually research and sort the datasheet read-outs for every PFS LED in each manufacturer's datasheets. This is a laborious task – but helpfully, Future Lighting Solutions has created a set of proprietary tools that automate the product search function. They enable the OEM to specify a color point, junction-temperature range and drive current. The tool then gen-

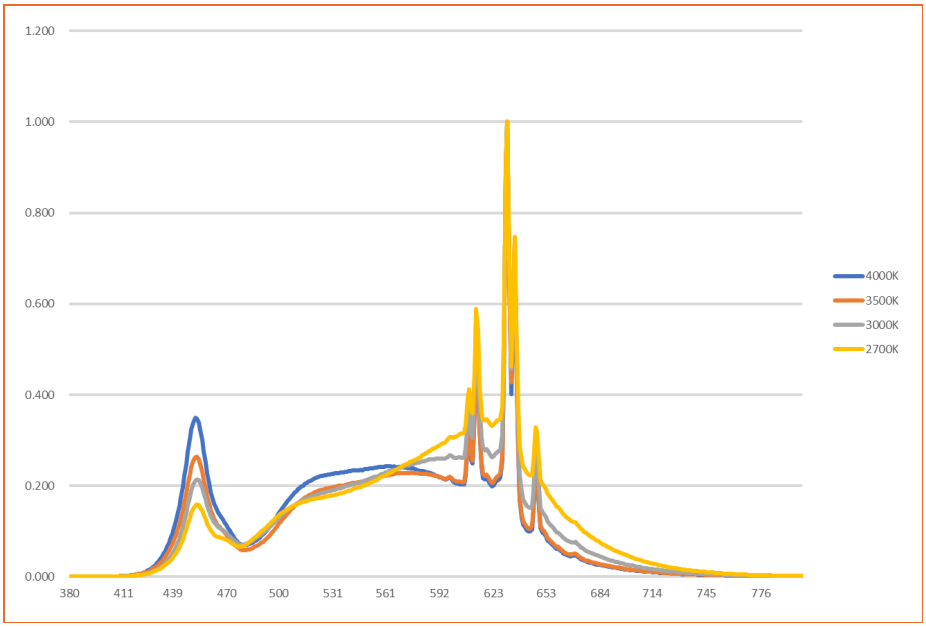

Figure 1: The emission spectrum of LEDs that feature TriGain phosphor. The plot shows a pronounced peak in the red part of the spectrum, and almost no wasted emission outside the visible spectrum. (Image credit: Future Lighting Solutions).

Figure 2: Comparison of efficacy (lm/W on left axis) of typical TriGain-based emitters with conventional emitters at 90 CRI and 80 CRI. (Image credit: Future Lighting Solutions).

erates a list of the PFS LEDs that most closely match the specification. The tool can tell which LEDs' output stays within a 3 Macadam ellipse over the specified junction-temperature range.

The third step is to review the proposed product selections for each fixture type/application that the OEM intends to build. At this stage, the OEM might need to trade off color consistency (which might call for multiple LED SKUs for different applications) against inventory cost and production efficiency (which would normally call for one, rather than many SKUs).

Since the Future Lighting Solutions tool looks across the market at products from Bridgelux, Lumileds, Luminus, Nichia, Seoul Semiconductor and more, OEMs can expect to find LED products that meet any color point requirement in any application. The portfolio of TriGain-based LEDs on the market today includes mid- and low-power LEDs in industry-standard footprints, CoB LEDs, and LED modules.

The products are available to enable lighting manufacturers to take advantage of the high quality of light of TriGain-based LEDs without sacrificing efficacy. With prudent use of resources such as the tools provided by Future Lighting Solutions, OEMs can, at the same time, maintain the required color consistency between fixtures and applications. ■

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[1] https://www.currentlighting.com/
[2] https://www.ge.com/research/sites/default/files/project/brochures/2019-05/murphyetalSID2015paperfinal.pdf

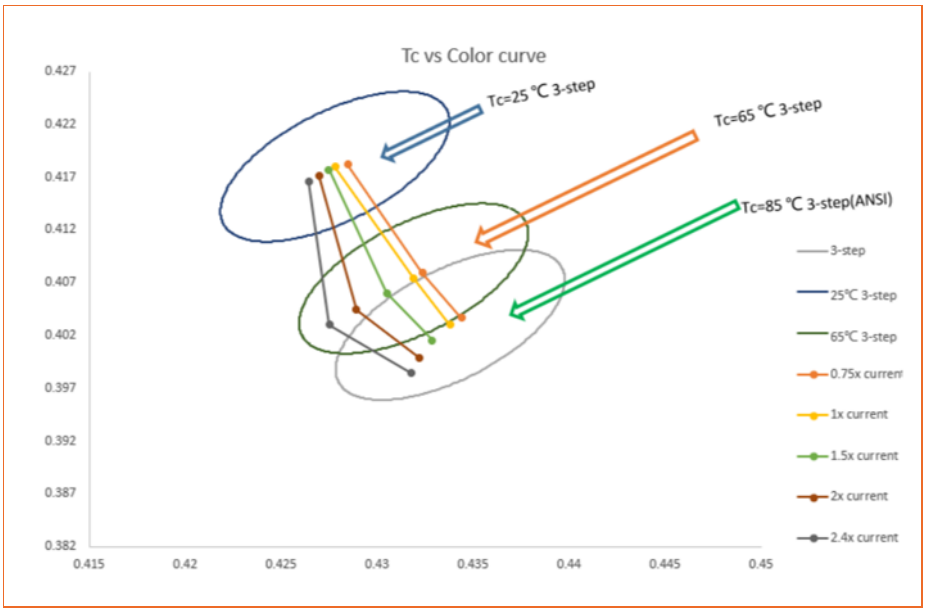

Figure 3: The color of PFS phosphor-based LEDs shifts away from the blackbody curve as the LED's junction temperature changes. (Image credit: Bridgelux).

Figure 4: Comparison between a TriGain-based LED light source (left) with a conventional LED light source.

Author Adil SIDIQI, Vertical Segment Manager at Future Lighting Solutions, a Division of Future Electronics

Adil Sidiqi, is a lighting Vertical Segment Manager at Future Lighting Solutions based in the UK. With over a decade of experience in the field, Adil has contributed to the advancement of energy-efficient lighting solutions. He specializes in the design and development of lighting technologies that are not only sustainable but also innovative, catering to commercial, residential and industrial needs.

Adil began his career as an Electronics Engineer at Future Lighting Solutions in 2010. His innovative solutions and deep understanding of electronic helped propel the company to the forefront of the lighting industry. His work focused on offering lighting solutions that helped FLS to become a one stop shop for major lighting OEMs across EMEA. Adil's support in lighting designs have been pivotal in large-scale projects, including the retrofitting of lighting systems in commercial buildings and outdoor lighting in major cityies with focus on increasing the luminaire manufacturing and energy efficiency while reducing the environmental impact.

About Future Electronics

Future Electronics Ltd. distributes electronic components. The Company sells semiconductors, passive, interconnect, and electro-mechanical components for use in analog and power, communication, development tool hardware, and microcontroller sectors. Future Electronics markets its products to customers internationally.

FUTURE ELECTRONICS

In. Licht *pro*
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Lighting Recipe Studio

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- Lux
- CCT
- EML
- Visual Contrast
- Uniformity
- LRS Lighting Recipe™ Technology
- Monitoring circadian lighting

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Official Website

In. Licht at amazon

available at amazon

Recognizing the Excellence：
In. Licht X Works with WELL in HCL

Lighting Recipe Studio (LRS) is a professional light research institute and also a leader in the development of forward-looking light products. It has the most advanced light environment monitoring technology, combined with life science research, to create various advanced algorithms to provide the highest light quality for human health.

Game Changers to Reshape the Lighting Systems

Before, the researches of light & health were not well understood and applied without the regulations; recently, as we adapted light concept from the WELL standard, we discovered most of the lighting environments are not healthy enough for humans. Until now, with In. Licht portfolio, lighting data are visualised and able to interact with the dynamic lighting system, finally, we are able to build an adaptive lighting environment for a higher quality of health.

People-Oriented Design plus Works with WELL

Combined with the WELL standard by the International WELL Building Institute (IWBI) for healthy buildings, the advanced life science research results from the LRS team in light, emotion and brain cognition, allows them to establish the premium professional-level light meter for light quality and HCL - **In. Licht Ultra** and **In. Licht pro**, the 1st and 2nd lighting fact sensor to be listed by IWBI "Works with WELL" program.

INTERNATIONAL WELL BUILDING INSTITUTE MEMBER CORNERSTONE

From In. Licht pro to In. Licht Ultra

In. Licht pro is the most compact EML sensor by far recognized by Works with WELL and designed for better practical field application experience. In. Licht pro lighting sensor monitoring 5 key lighting indexes: Lux (Illuminance), EML (Equivalent Melanopic Lux), CCT(Correlated Colour Temperature), Visual Contrast, Uniformity

It provides real-time monitoring of light data in a super light-weight (40 g) device. Unlike any other light meters, In. Licht pro captures the key index of circadian rhythm, the Equivalent Melanopic Lux (EML), which can truly reassure residents in a healthy lighting environment. although In. Licht pro meets the needs of lighting industry personnel, but LRS is not satisfied just with this achievement.

Laboratory-grade Spectrum Meter to be Reveal

In higher-end professional spectrum analysis, many experts have to work in the lab for their tasks. Some equipment that can perform spectral analysis in the field are bulky, heavy, and requires handholding. In response to the needs of professionals, the team has developed a lab-grade spectrometer that is hands-free (might be the world's lightest, again) and also Works with WELL certified.

In. Licht Ultra equipes with the best-in-class CMOS linear IC and Flicker sensor, provides 8 key modes to capture the light data:

- Spectrum
- Illuminance
- Flicker
- S/P Ratio
- HCL indexes (EML, mEDI, CS, CAF)
- Quality of Light (CRI, Ra,TM-30 Rf & Rg & vector,
- SDCM, DUV,CQS)
- Flicker Risk (frequency, percent, index, SVM)
- Blue light hazard

Those key modes contains 27 plus indexes with further upgrade services, and the product will certainly provides the best lighting inspection experiences for the expertise.

In. Licht Ultra- which is expected to be launched in Q3 2024.
The lighting industry will look forward to it. ■

The Impact of Lighting on the Visual Perception of Material Surfaces

MMag. Martina ASCHER[1,2], Researcher at Bartenbach and Dipl.-Ing. Johannes WENINGER[1], Team Leader Research at Bartenbach

The type of illumination plays a central role in the perception of surfaces, as intensity, spectral composition, and light direction significantly influence the appearance of materials. Given the vast variety of material surfaces, this aspect presents a considerable challenge for lighting planners and designers, as there are currently no concrete guidelines for using materials in conjunction with different lighting concepts.
In response to these challenges, two systematic laboratory studies on the visual perception of materials and their properties were conducted as part of a 3-year research project. The studies aimed to develop a systematic model for predicting the aesthetic effect of material surfaces, considering both the perception of intrinsic properties of the materials and the confounding influences of external lighting factors. The results represent a significant first step towards the objective planning of the subjective appearance of surfaces in relation to lighting conditions.

Introduction

Visual perception of material properties plays a fundamental role in how we perceive and interact with the world around us [1]. From the comfort of a soft fabric to the coolness of smooth marble, our subjective experiences are heavily influenced by visual appearances. As materials are essential components of both the physical environment and products, understanding the relationship between their inherent features and the perceived aesthetic effects is critical to design, architecture, and product development. Moreover, given the increasing availability of computer vision technologies, subjective experiences are currently gaining importance in other application fields, such as process automation [2] and quality control [3], e.g., food inspection [4], which are mostly defined by the same basic problem of a perceptual characterization of the visual appearance of materials.

In recent years, significant progress has been made in unraveling the intricate connections between material attributes and human perception [5,6,7,8]. Researchers have explored various aspects, including texture [9], roughness [10], color [11], and glossiness [12], as potential predictors of the perceived aesthetic appeal of different materials. However, while numerous studies have focused on individual material types, e.g., stone [13], ceramics [14], parquet [15], and fabric [16], the need for a generalized model that can transcend material boundaries and predict aesthetic effects for various materials remains ever-present.

In addition, lighting situations are largely ignored in current modeling approaches. However, the perception of material-specific properties depends not only on the reflection behavior of the material (intrinsic material property) and the reaction of the human eye (sensor), but also significantly on the lighting conditions (external factor) [17]. Intensities [8], color temperatures [18] and light directions [19] have a potential impact on material perception (cf. **Figure 1**), which is why lighting-related factors should be given increased importance.

In addition, the process of seeing is a mental process that includes cognitive processing, memory functions and evaluation functions. The perception of our environment is based on an intrinsic model of reality. Physically recorded sensory stimuli are therefore supplemented by perceptual psychology with individual aspects such as personal experiences and innate mechanisms. A holistic model of the visual perception of material surfaces cannot, therefore, be reduced solely to the characterization of the physical setting, e.g. the image information, but must also consider psychological translational influencing factors. Considering the resulting complexity, it is not surprising that there are currently no concrete guidelines for the use of materials in combination with different lighting concepts and that currently the use still depends exclusively on the experience of lighting planners and designers.

In the following, we provide insights into the results of two systematic perception studies that were carried out as part of the 3-year research project “Light and Material” at Bartenbach. The results represent a first step towards the objective predictability of the subjective impression of material surfaces and can serve as a basis to improve future decisions by architects, designers and manufacturers in the material selection and design process. Moreover, this research contributes to the broader field of human perception and cognition, bridging the gap between material science and human psychology.

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Figure 1: Exemplary representation of different material and spatial effects depending on different lighting concepts in the studio of Bartenbach's World of Light in Aldrans.

The Research Project Light and Material

The 3-year FFG Early Stage Project "Light and Material" (Classification and Evaluation Method of Materials under Different Light Conditions - Modeling for Prediction) aimed to develop a foundational model that links material properties to aesthetic evaluations under varying lighting conditions. The goal was to gain insights into the interaction between light and complex material structures that could enhance the visual appeal of materials or prevent undesirable effects. These findings are crucial not only for traditional lighting design but also for various design fields, including interior design.

The project included two consecutive laboratory studies, each with distinct objectives. The first study focused on evaluating a wide range of materials under a fixed lighting condition to identify materials with similar perceived properties. From this, base models were derived that predict the aesthetic impact based on perceived inherent properties of the materials. The second study examined how different lighting factors (brightness, color, and distribution) affect the aesthetic evaluation of selected material surfaces, thus expanding the base models to incorporate light-related factors.

The culmination of these studies was the derivation of a comprehensive perception model, which is intended to describe the relationship between perceived material properties and resulting aesthetic impressions across various materials and lighting conditions, regardless of the underlying material type.

Perception Study 1: The Derivation of the Material-related Base Models

Study Description

To assess the perceived material properties and the aesthetic impressions of material surfaces, 612 different material samples were systematically rated by 50 test subjects under reference illumination (5,000 K, Eh 2,800 lx, CRI 93) in a controlled, block-randomized laboratory study. The study was conducted in two identical rooms, each of which was equipped with two evaluation stations in the central area. The stations (**Figure 2**) consisted of two light gray, height-adjustable desks at a height of 1.00 m and two lighting prototypes for direct illumination of the material samples that were mounted diagonally across both tables. Additional up-lights were installed on the lighting prototypes for both general room lighting and the provision of diffuse light components on the material samples.

Figure 2: Frontal view of an evaluation station with the diagonally arranged lighting prototypes and the applied material positioning.

During the material evaluation, the participants occupied different evaluation stations at which different materials of the same block were presented in randomized order. Before the evaluation of a material, the participants had about one minute in which they could move freely to look at the material from different angles to experience any glossy behavior of the surfaces. The evaluation itself was then carried out from a fixed observer position. To reduce confounding factors, the material thickness was concealed by an aluminum frame and touching the material surfaces was generally not permitted.

Each participant rated each material in a total of 28 bipolar pairs of adjectives, of which 13 verbally described material-inherent properties and 15 verbally described aesthetic material effects (**Table 1**). The duration of the evaluation of all materials was approximately 25 hours per person and was therefore divided into several participation days on which different blocks of materials were randomly presented.

The individual evaluations were then adjusted for outliers and material-related parameters were derived at the mean level. The pre-processed data was then used to classify the materials. To do this, the 13 material-inherent evaluations were reduced in their dimensionality using a principal component analysis and then divided into distinct material groups using a k-means clustering procedure. The resulting division into 6 classes **[20]** with materials with similar properties was used as a variable for stratification in the further modeling process in order to prevent a type-related bias.

Subsequently, prediction models for the aesthetic material effects were derived based on the perceived material-inherent properties. For this purpose, the preprocessed data set was divided into a training and a test data set in a ratio of 80:20. The modelling was carried out separately for each aesthetic item using a linear regression method. The generalized applicability of the derived models was determined by the determination coefficient R^2, which denotes the proportion of variation in the test data that can be explained by the derived regression model. Finally, the obtained regression coefficients of the input variables in the individual models were normalized in relation to the respective determination coefficients and examined with regard to their influence on the aesthetic effects using an ANOVA.

Results

The 15 specifically derived models for the prediction of the individual aesthetic effects of the materials basically showed a very high quality with an R^2 of 0.80 ± 0.12 (cf. **Figure 3**).

The Bonferroni-corrected post hoc tests performed as part of the ANOVA were able to identify three distinct groups of input features (**Figure 4**) with varying influence on aesthetic ratings. Both the group with low (1.91 ± 2.06%) and high influence (10.91 ± 8.77%) had 5 items each. The group with medium influence (5.25 ± 3.84%) accounted for the remaining 3 items. While all groups differed significantly among themselves (all $p < .001$), the items included within the groups showed no significant differences (all $p > .05$).

Summary

The derived models for the prediction of the aesthetic material effect by means of perceived material-inherent properties showed a very high level of accuracy. The resulting confirmation of a simple and direct connection between the objectively assigned and subjectively perceived qualities of a material surface accordingly suggests the existence of an intrinsic perception model. This means that subjectively perceived material qualities are not subject to stochastically intersubjective characteristics but are systematically formed from underlying visually extracted characteristics.

Further, the accuracies achieved by the regression models are limited to the impact of a few material-inherent properties on closer inspection for all aesthetic items. Although a complete depiction of the material-related sensation is necessary to predict all aesthetic effects, this nevertheless opens the possibility of a greatly

bipolar pairs of adjectives to evaluate material-inherent properties			bipolar pairs of adjectives to evaluate the aesthetic effect of the material		
smooth structure	-	deep structure	attractive	-	unattractive
coloured	-	colourless	modern	-	classic
matte	-	glossy	public	-	private
natural	-	artificial	high-quality	-	cheap
dark	-	bright	dismissive	-	inviting
soft	-	hard	pleasant	-	unpleasant
smooth	-	rough	calming	-	exciting
warm	-	cold	unobtrusive	-	noticeable
regular	-	irregular	usual	-	individual
quiet	-	restless	interesting	-	boring
low contrast	-	high contrast	real	-	fake
plain	-	complex	elegant	-	not elegant
harmonious	-	inharmonious	cozy	-	uncomfortable
			diverse	-	monotonous
			relaxing	-	stressful

Table 1: Bipolar pairs of adjectives used for material evaluation separated according to material-inherent properties and aesthetic material effects. All pairs were evaluated on a scale ranging from -100 to +100 with a step size of 1.

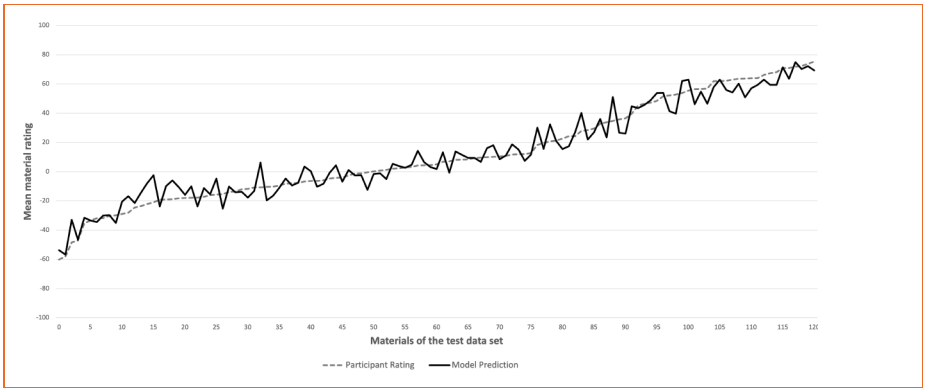

Figure 3: Exemplary representation of the comparison of the real evaluations to the calculated predictions (R^2 = 0.95) of the mean values of the aesthetic item diverse (-100) – monotonous (+100) for the test data set of 120 materials.

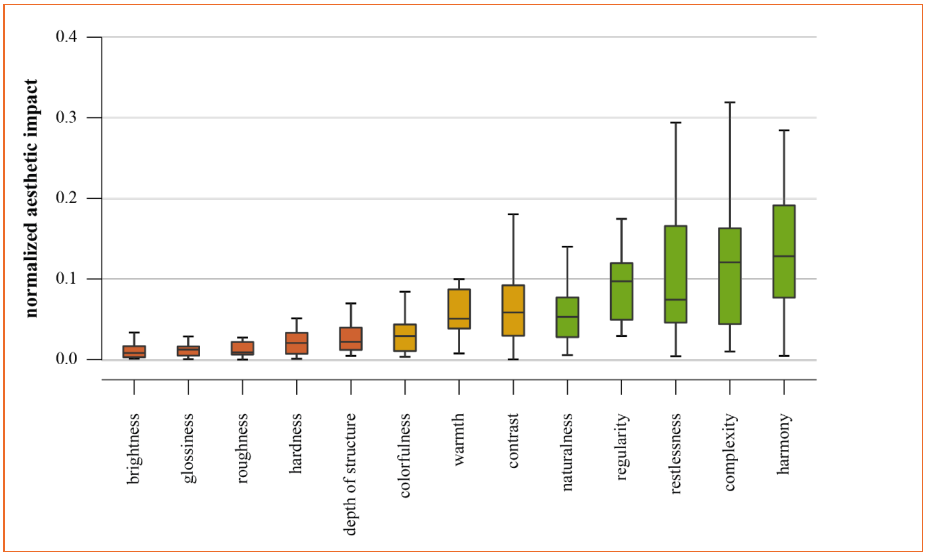

Figure 4: Boxplots of the normalized impacts of the individual material-inherent input features on the aesthetic ratings of the materials, sorted in ascending order based on their respective mean value. The impact groups derived from the analyses are color-coded in the diagram (red: low influence, yellow: medium influence, green: high influence).

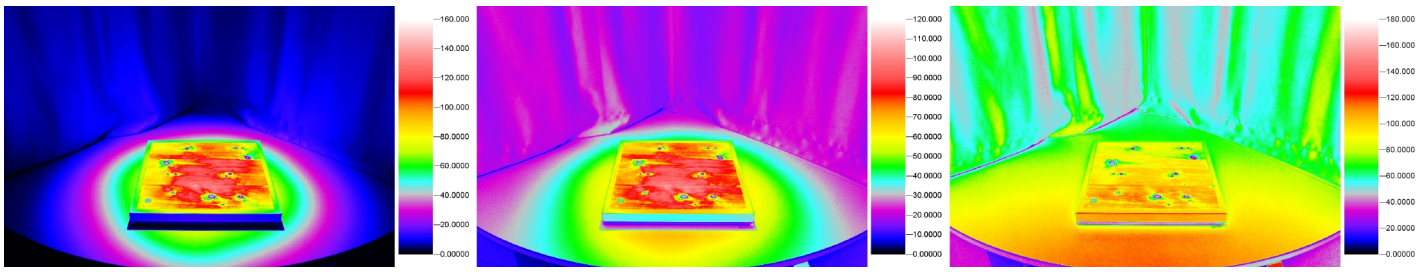

Figure 5: Luminance images from the observer position defined for material evaluation at an illuminance of 500 lx and a color temperature of 2,200 K (left: direct lighting, middle: mixed lighting, right: indirect lighting).

simplified consideration of materials if a targeted prediction of a specific aesthetic parameter (e.g., attractiveness) is desired. In the long term, this can simplify the applicability of the predictive models and potentially make them easier to put into practice.

Perception Study 2: The Investigation of Lighting-related Influencing Factors

Study Description

To evaluate light-specific effects on the assessment of both material-inherent properties and aesthetic material effects, a second controlled laboratory study was conducted. In this study, the material evaluations were conducted by 65 study participants under varying lighting conditions as part of a block-randomized protocol.

In order to allow for the greatest possible variance in lighting conditions for the study, only a reduced number of 72 materials were used compared to the first perception study. When selecting the materials, the most representative materials from the clusters derived in the first study were taken into account (short distance to the cluster center), and care was taken to integrate as many different materials as possible into the study. The lighting conditions used for the study were defined in terms of illuminance (150 lx, 500 lx, 1,500 lx), color temperature (2,200 K, 3,000 K, 5,000 K) and light distribution (direct, mixed, indirect). The three different gradations specified for each of the three lighting-related parameters were combined to create a total of 27 different lighting conditions.

Three identical cabins were used for the study in a controlled laboratory environment in the absence of daylight. To ensure comparability of the lighting settings between the evaluation booths, all settings were measured separately for each booth with regard to illuminance, color temperature and direct/indirect components. In addition, all lighting conditions in combination with all materials used for the investigation were documented using luminance images (**Figure 5**).

The material samples were given in randomized order within a light condition and placed horizontally on the table surface and in the center of the table segment of the booths (**Figure 6**). The observer position was defined by means of chairs fixed to the floor at approx. 0.85 m from the material sample (middle chair to middle material sample). To reduce confounding factors, the material thickness was concealed by an aluminum frame and touching the material surfaces was generally not permitted.

Figure 6: Frontal view of an evaluation station with the material samples centrally arranged in the table segment and the curtain elements located in the surrounding area to separate the evaluation booths.

Each participant rated 36 materials under each of the 27 lighting conditions in a total of 18 bipolar pairs of adjectives (due to time constraints, the evaluations of the material-inherent properties were reduced to the items depth of structure, brightness and warmth, cf. **Table 1**). The duration of the evaluation of all materials was approximately 25 hours per person and was therefore divided into several participation days on which different lighting conditions were randomly presented.

The individual evaluations were then adjusted for outliers and material-related parameters were derived at the mean level. The light influence on the perceived material-inherent properties were derived using an ANOVA. Further, the prediction models derived in the first perception study were extended by the three lighting parameters. For this purpose, the evaluations of the material-inherent properties collected in the first study were expanded with the aesthetic evaluations of the second study, taking into account the light-specific properties.

In accordance with the first study, the data set was then divided into a training and a test data set in a ratio of 80:20 and the modelling was carried out separately for each aesthetic item using a linear regression method. The generalized applicability of the derived models was determined by the determination coefficient R^2 and the obtained regression coefficients of the input variables in the individual models were normalized in relation to the respective determination coefficients and examined with regard to their influence on the aesthetic effects using an ANOVA.

Results

Influence of lighting on the perception of material-inherent properties

All three of the investigated material-inherent properties (depth of structure, warmth, brightness) showed a significant dependence on the applied light conditions in all three lighting-related factors (all $p < .001$). However, some of the significant influences were found to be negligible on closer inspection. A minimum of 5% of the maximum scale width, i.e. a minimum shift of 10 evaluation points, was assumed as the cut-off value for evaluating the relevance of the differences.

The perceived warmth of the material surfaces was significantly dependent on the factor color temperature (p <.001), whereby the surfaces under consideration were perceived significantly warmer with decreasing color temperature (**Figure 7**).

Similarly, the perceived brightness of the material surfaces showed a significant dependence on the lighting-related factor brightness (p <.001), with the surfaces under consideration being perceived as significantly brighter with increasing illuminance levels (**Figure 8**).

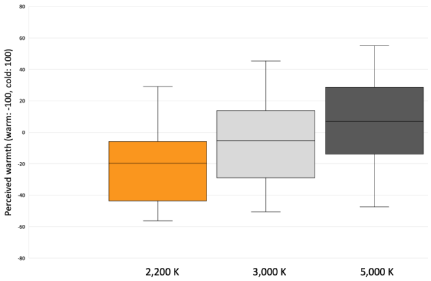

Figure 7: Boxplots of the mean values of the perceived warmth (warm: -100, cold: 100) of the 72 materials tested according to the color temperature of the lighting condition.

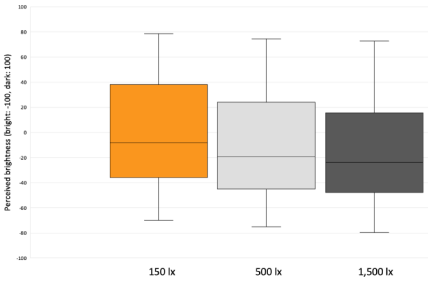

Figure 8: Boxplots of the mean values of the perceived brightness (bright: -100, dark: 100) of the 72 materials investigated according to the brightness of the lighting condition (orange: 150 lx, light gray: 500 lx, dark gray: 1,500 lx).

In relation to perceived structural depth, all three factors of the lighting condition show significant main effects (all $p < .001$). However, the pairwise comparisons showed that the effects of lighting on perceived structural depth can be considered negligible.

Influence of lighting on the assessment of the aesthetic material effect

The 15 specifically derived models for predicting the individual aesthetic effects of the materials, which were extended to include the lighting conditions, basically showed a very high quality with an R^2 of 0.75 ± 0.07, which corresponds very well with the mean prediction accuracy of the material study. However, except for a few isolated models (e.g., high-quality/cheap +0.03, elegant/not elegant +0.26), most of the models experienced a reduction in accuracy compared to the basic models.

Despite the high prediction accuracies that could be achieved in the linear regression models, the influence of light-related parameters was found to be negligible in the analysis of the regression coefficients.

The coefficients of the factors illuminance (0.02 ± 0.01) and direct/indirect components (0.03 ± 0.01) proved to have the least influence on the overall accuracy of the models. The influence of color temperature (0.06 ± 0.04) also proved to have no contribution to the explanatory power of the models.

Summary

As expected, clear lighting effects could be demonstrated in relation to the perceived warmth and brightness of the materials. Interestingly, changes in the perceived depth of structure in relation to the direction of light, which are currently assumed to be certain [19], could not be confirmed in the study presented. On the one hand, this could be due to the insufficient shadow cast by the direct light condition and, on the other hand, the insufficient structural depth of the majority of the material surfaces (artificial replicas). To fully clarify the extent to which human perception of surface structures depends on lighting conditions and material properties, further research is necessary.

Although the calculated models for prediction decreased slightly compared to the material study, partly due to the reduced variety of materials, they again proved to have a very high prediction accuracy. Surprisingly, the study showed no influence of the lighting situations on the perception of the aesthetic properties of the material surfaces despite the change in material perception.

As potentially the strongest and most direct influencing factor on material perception, lighting continues to be of paramount importance in this area. However, as lighting effects on an aesthetic level proved to be unquantifiable in the context of this study design, the relevant interactions are potentially much more complex than originally assumed. Although the decoding and modeling of the interactions between light and material are still considered necessary and promising, further laboratory studies in controlled environmental conditions are necessary before the investigations can be transferred to an extended context.

Discussion

Especially in relation to the perceived inherent material properties, a clearly pronounced and light-dependent main effect was found, which also largely corresponds to current research [9,18]. Thus, regardless of their materiality, the samples were significantly influenced by the lighting condition in terms of both their perceived warmth (**Figure 7**) and brightness (**Figure 8**). Lower color temperatures are therefore suitable for conveying a feeling of warmth regardless of the material, while higher illuminance levels lead to a brighter perceived appearance. The objectivity of the changed evaluations of the material-inherent properties can be substantiated by the fact that the changes in perception occurred consistently across all materials and test subjects, i.e., a shift in the evaluation in the same direction regardless of inter-individual or material-specific factors.

The high accuracies of the prediction models achieved in the second study also support the assumption of an existing intrinsic perception model resulting from the first study. Interestingly, the material properties that have a strong influence on the predicted aesthetic ratings are very similar to those of the first perception study. On the one hand, this suggests that the models derived from both studies refer to similar effect models in which the same inherent

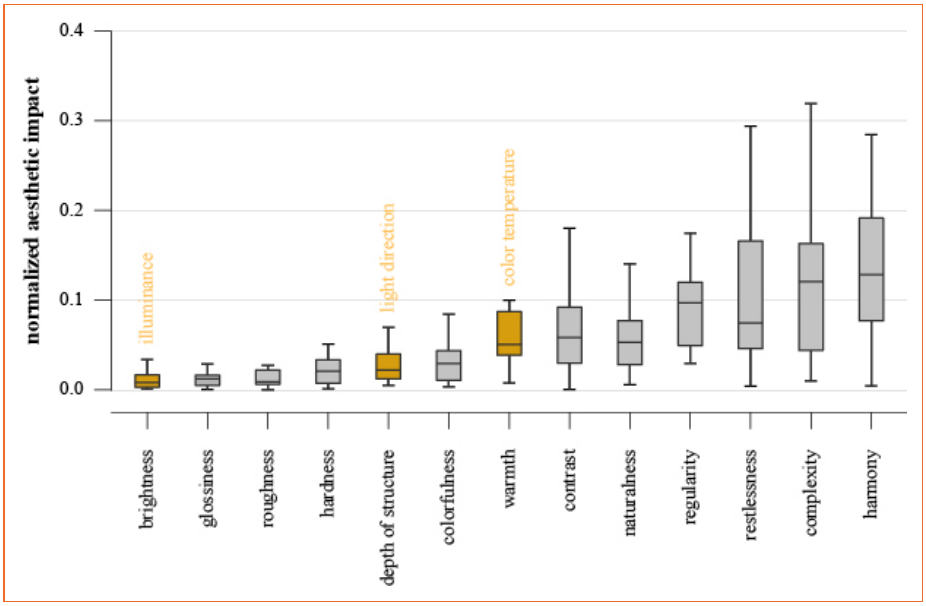

Figure 9: Location of material-inherent properties that can be significantly and verifiably influenced by lighting properties in relation to their influence on the aesthetic material evaluation.

properties are assumed to have a similarly strong influence on aesthetic evaluation. The models therefore prove to be transferable to different groups of people, different spatial settings, and, due to the lack of light influence, even to different lighting conditions.

The lack of light influence on the aesthetic perception of materials can also be explained in more detail by considering the regression coefficients of the derived models (**Figure 9**). Properties such as harmony and complexity prove to be far more influential than typical properties (e.g., warmth or brightness), which have already been proven to be influenced by light and lighting. From this point of view, light-induced changes in material perception do not simultaneously result in a change in the aesthetic effect of the material. The assumption in this case suggests that materials are evaluated per se and the visually perceived change in the observed material surface is cognitively excluded from the evaluation.

This type of constancy performance is not entirely unfamiliar. It refers to the phenomenon where objects are perceived as stable and unchanged despite variations in environmental factors like color or brightness of the lighting. This mechanism allows for a consistently perceived environment, enabling objects to be recognized as the same under different lighting conditions, thus facilitating cognitive processing. For example, due to the variety of lighting conditions throughout the day, interior design materials appear in constantly changing luminance levels and color nuances. Nevertheless, their basic properties appear to be largely constant, e.g., their materiality is referenced based on specific material properties, without including the changing lighting conditions in the cognitive evaluation process.

In principle, such cognitive effects are only possible under certain and known conditions, such as a change in lighting conditions within the natural dynamics of daylight. Consistency performance is therefore dependent on empirical values, which allow us to exclude variable characteristics from the assessment. The essential recognition criteria of an object (size, shape, color) seem to be more important than the facets of its appearance.

Limitations

Despite the inclusion of 612 materials in the first study and 72 materials in the second study, which aimed to ensure the broadest possible applicability of the results, it is important to note that the selected materials may not represent the full range of potentially available material properties. In particular, the inclusion of the larger number of woods in the study may have led to certain biases in the results and may affect the accuracy of the prediction models when making predictions from other material classes. The choice of materials in the second study may also have contributed to the reduction of light-specific effects in addition to affecting the accuracy of the prediction models.

Furthermore, it is important to recognize that aesthetic material effects are not inherently fixed, but are influenced by contemporary trends and socio-cultural backgrounds. Unfortunately, these factors could not be taken into account in the present study, making it difficult to argue for the universal validity of the derived results.

Finally, the validity of the results presented can only be guaranteed in the context of people with normal vision, as all types of visual impairment have been excluded. For example, color blindness can significantly impact the visual appearance of objects or materials. It is also well documented that age-related weaknesses of the visual system, such as age-related macular degeneration, also have a significant impact on both visual acuity [21] and color vision [22]. A corresponding mapping of such groups of people would require an extension of the existing basic model through experimental studies.

Conclusion

Aesthetic sensations cannot be understood independently of neural systems or physiological sensors, as they are primarily influenced by perceptual and cognitive processes. They arise from an interaction of recognition and evaluation of emotion and meaning [23], which, due to their subjectivity, make an objective evaluation complex and demanding. Since international research is currently still trying to derive a general mathematical model of human aesthetic appreciation [24–28], the present results offer the potential to make a significant contribution to solving a currently challenging problem.

Due to the complexity of the underlying processing mechanisms and perception processes, the derivation of a generalized model within the framework of a single study proves to be impracticable. However, the presented models can be considered comprehensive base models created under well-documented lighting situations, making them suitable for multidimensional extension. In the long term, further validation regarding the potential influence of different lighting conditions could enable lighting planners and designers to mutually optimize key performance indicators of buildings, such as energy efficiency or melanopic illuminance levels, for the first time, considering the aesthetic effects of the material selection made.

However, this requires further research that should also take up long-term and intercultural tendencies, to rule out a personal exclusion of fringe groups. In general, the presented results confirm the potential that can result from more objective material planning for future-oriented lighting practice. ■

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Acknowledgements
The study presented was funded by the Austrian Research Promotion Agency (FFG) as part of the project Light and Material (FFG No. 882556).

The authors would especially like to thank Isabel Arnst and Maximilian Dick for their contributions to project management, data curation and data analysis of both studies. They also thank the interns Chiara Dietz, Tobias Fischer, Claudia Konrad-Soare, Simone Sommerfeld, Lukas Zircher, Lara Pfeiffer, David Freitag and Sophie Cherdron for conducting the studies.

Bartenbach
THE LIGHTING INNOVATORS

About Bartenbach
Bartenbach is a pioneering lighting design and engineering company based in Aldrans, Tyrol, Austria. Founded by Christian Bartenbach, the company is renowned for its innovative approach to lighting technology and its commitment to creating high-quality, sustainable lighting solutions.

History and Philosophy: Since its inception, Bartenbach has been at the forefront of lighting innovation, merging scientific research with creative design. The company's philosophy centers around enhancing human well-being and environmental sustainability through intelligent lighting.

Expertise and Services: Bartenbach offers a comprehensive range of services including lighting design, daylight planning, and the development of custom lighting solutions. Their expertise spans various sectors such as architecture, urban planning, and art installations, making them a leader in both functional and aesthetic lighting projects.

Research and Development: The company invests heavily in research and development, operating its own state-of-the-art laboratory to test and refine new lighting technologies. This dedication to R&D ensures that Bartenbach remains at the cutting edge of the lighting industry.

Notable Projects: Bartenbach's portfolio includes a wide array of prestigious projects worldwide, from office buildings and museums to public spaces and private residences. Each project showcases their ability to blend technical precision with artistic vision.

Sustainability: Committed to sustainable practices, Bartenbach prioritizes energy efficiency and the use of environmentally friendly materials in their designs. Their innovative solutions not only enhance spaces but also contribute to reducing the ecological footprint.

Awards and Recognition: Bartenbach has received numerous awards for its groundbreaking work in lighting design and technology. These accolades reflect the company's influence and reputation in the global lighting community.

For more information, visit
www.bartenbach.com

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The Intersection of Innovation: Xavier Denis Discusses the Convergence of Architectural and Automotive Lighting

Xavier DENIS, Head of Technical Support & Marketing at Nichia

Xavier DENIS
Xavier DENIS, Head of Technical Support and Marketing at Nichia, Europe, brings 20+ years of expereince in the fiewld of lighting and optics. He has held various management positions at Nichia, GE Lighting, Optis etc. Xavier holds a Bachelor of Science in Applied Physics from Georgia Institute of Technology and an Executive MBA from Corvinus University. He contributes valuable insights to the industry on next light source technologies from Human-Centric solutions to microLEDs.

xavier.denis@nichia.com

Today, many car manufacturers view vehicles as 'the third living space,' following homes and offices. This perspective has led to the application of key principles from lighting design and technological innovations found in architectural lighting to automotive lighting, and vice versa. We asked Xavier Denis of NICHIA to explain how all lighting designers can gain from this convergence.

Can You Help Us Envision the Future of Lighting in Vehicles?

Picture this: The soft glow of light from luminaires enhancing the ambiance in a restaurant setting, smoothly transitioning into a spectrum of colors to set a cozy mood for patrons, all controlled with just a touch on a smartphone by the bistro's staff. Now, visualize that same intuitive, comfortable experience within your vehicle.

Moving beyond the necessity of the driver shining an adaptive beam on the road ahead to avoid dazzling other road users, the automotive lighting guides the driver, and enhances visibility within the vehicle without being a distraction and overpowering the senses. Additionally, lighting is used to communicate with drivers, such as alerting them of a nearby cyclist via a gentle glow near the side mirror. Furthermore, it allows front and rear passengers inside the cabin to comfortably read or relax.

How Has LED Technology Transformed Both General and Automotive Lighting?

LED technology, renowned for its substantial energy efficiency, quality of light, reliability, and longevity, has revolutionized interior lighting in our homes and offices. It has also notably enabled lighting designers the freedom to sculpt light in a variety of ways, curating atmospheres that range from functional brightness to subdued, moody hues. With smart technology, LED lighting has also transcended its practical purpose to enable various programmable scenarios and scenes to become an interactive element within a space.

In the automotive world, these advances are not just being utilized in exterior vehicle lighting. The trends in general lighting, particularly those focused on human-centric applications designed to enhance the comfort, health, and well-being of individuals in spaces, are especially influencing automotive interiors.

Are Specific Innovations in Automotive Lighting Inspired by General Lighting Trends?

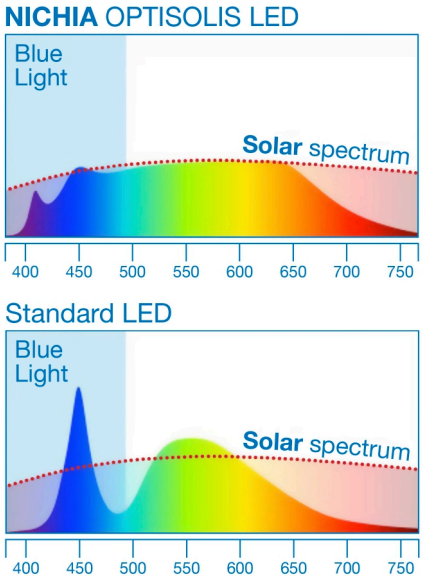
Inside cars, human-centric lighting involves using high Color Rendering Index (CRI) lights for reading lamps and ambient lighting. This allows the true colors of a vehicle's interior to be more easily perceived, improving the chance to notice and appreciate the craftsmanship and seamless fusion of refined materials chosen to signify premium car brands.

For example, Optisolis™ technology, ultra-high color rendering index LED emitters developed by Nichia, provides a spectrum to match sunlight. With a CRI higher than 98, this innovative solution provides an

www.nichia.co.jp/en

Forvia envisages instrument panels which are based on modular architectures allowing OEMs' platforming and upgradability through the life cycle. They integrate sustainable materials and surface activation innovations including image projection for an enhanced life on board. Photo courtesy of Forvia.

accurate representation of different hues in fabrics used within door panels, seating, dashboard, and center console.



This high CRI is a vital characteristic in the concept of the 'cockpit of the future', where the quality of light will contribute to the overall experience in a space that functions as a 'mobile living room'. With the advent of autonomous driving, passengers will spend more time reading, eating, sleeping, viewing entertainment, and communicating inside cars, necessitating a lighting environment that can adapt to these activities and more.

How are These Lighting Innovations Enhancing Vehicle Exteriors?

For the exterior of vehicles, a higher CRI light source could also be beneficial as it aligns with camera detection systems, improving the interaction between vehicles and their surroundings, including the detection of pedestrians and obstacles.

Echoing interior design trends, adjustable mood lighting within vehicles allows drivers and passengers to curate their environment, transitioning from a calm, soft glow during a relaxed drive to a bright, alert ambiance during a focused journey. With LED styling lights, everyone can design a personal lighting atmosphere for the complete cabin or a particular zone within the car.

What About the Role of Colored LEDs and COB Technology in Automotive Lighting?

The use of colored LEDs is another trend that has evolved from general lighting, utilized both for aesthetic and functional purposes. For example, cyan lighting can indicate autonomous driving conditions, helping to communicate the status of the vehicle to passengers and other road users. Green and red LEDs, in comparison, can display charging port status, providing clear and intuitive signals for electric vehicle users.

The technology of Chip on Board (COB), known for emitting a high level of light within a miniaturized package, is another innovation from general lighting finding its way into automotive applications. COB allows LED chips to be mounted closer together, which is especially advantageous for technologies like Adaptive Driving Beam (ADB) applications. This creates more uniform lighting with less glare, enhancing safety through better road illumination without blinding other drivers, as well as miniaturizing and enhancing the overall efficiency of the head lamp module for better sustainability.

Of course, COB LEDs already prove useful in architectural applications to deliver even lighting in rooms without harsh glare thanks to adjustments to the spatial distribution of light.

How Does Smart Lighting Integrate into Automotive Applications?

Smart lighting systems represent the integration of smart city concepts into vehicles. These systems can enable vehicle-to-vehicle communication through light signals, allowing for the exchange of information and enhancing road safety. Additionally, they contribute to reduce power consumption and can be part of broader energy-efficient strategies in vehicle design.

How are Trends Seen in General Lighting Influencing Automotive Lighting?

There are many trends in automotive lighting which are also evident in architectural lighting. Today, interior car lighting does

more than simply allow you to see controls or find a USB port. Beyond guiding you, light responds to you and communicates with you. Car lighting has moved from being merely illumination to being an integral, interactive component within the vehicle's design and function.

Much like smart home devices, LEDs within vehicles now adapt to various driving conditions, enhancing visibility during foggy mornings or dimming to reduce glare during a serene night drive. Indeed, Nichia's micro-Pixelated Light Solution (µPLS) is a pioneering light engine solution which integrates microLEDs (µLEDs) ideal for high-definition (HD) adaptive driving beam applications. The technology delivers the brightness, high pixel density with individual pixel control, and flexible connectivity required to enable it to be smoothly integrated into modern electric/electronic E/E car architecture.

Additionally, unique Smart LEDs featuring an ASIC (Application Specific Integrated Circuit) design, making inroads within automotive lighting could be useful in general lighting. Combined with integrated sensors, drivers and software control, these pioneering Smart LEDs already monitor vehicles (detecting their speed, direction, and presence) and the movement of pedestrians to activate lighting when people or cars enter a specific area and issue alerts and warnings to enhance road safety and traffic management. Some car parks already use smart LEDs for real-time vehicle tracking, aiding in finding available spaces and streamlining traffic flow within the facility. As communication tools, smart LEDs can provide public announcements, interactive displays, and safety alerts. For example, in disasters, using Li-Fi technology (useful if networks are overloaded or unavailable) smart LEDs can convey evacuation information to direct people to safe zones.

What are the Challenges Architectural Lighting Designers Face when Transitioning to Automotive Lighting?

In architectural applications, controllability is a very important feature for interior and exterior lighting. It provides the capability to present light within a fast response, particularly useful for digital signage or light panels displaying animations. For example, smart LEDs can eliminate the need to rearrange retail lighting as brightness, color temperature, and focus can be adjusted remotely without physically moving fixtures. Dynamic spotlights can also be deployed that vary the intensity and direction of light, highlighting products or specific areas in a store. This flexibility enhances the shopping experience and reduces the need for manual adjustments, providing greater efficiency and flexibility.

Also, lasers used within automotive lighting that enhance vehicular safety, can reliably project intricate graphics and images for architectural lighting purposes. For example, for ultra-thin and intense beams of illumination applied or integrated directly to structures and materials on and within buildings, a fiber optic coupled with laser could be used instead of conventional luminaires.

The transition of architectural lighting designers applying their wisdom in the world of automotive lighting presents a complex challenge, primarily due to lighting in cars being technically demanding in distinctly different ways. One significant obstacle is the contrast in product lifetime expectations. Architectural lighting typically demands a lifespan of at least 60,000 hours, a standard that far exceeds the average 5,000 to 15,000-hour lifespan found in automotive lighting. This disparity also highlights a major divergence in design philosophy and endurance requirements, meaning different approaches to material use and package structure design.

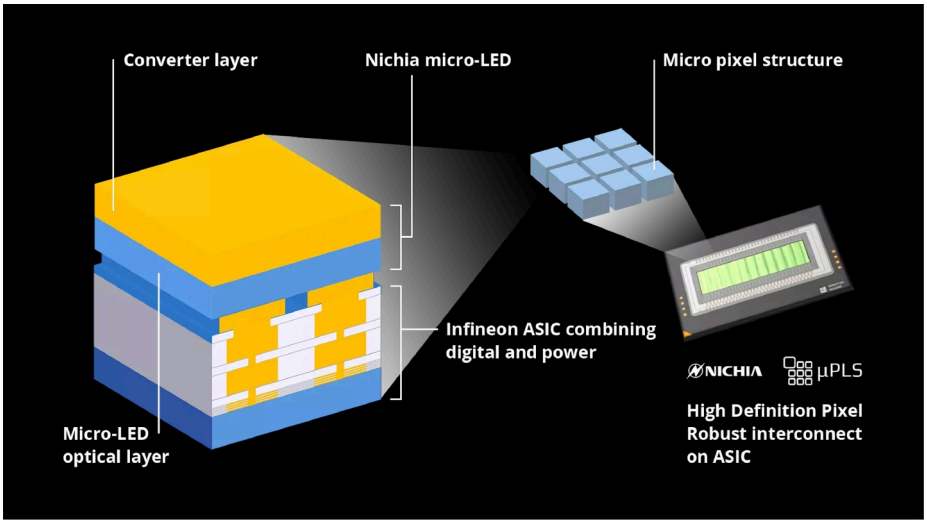
Another critical aspect is a disparity in LED driver capabilities. The electronic specifications in automotive lighting are markedly different from those in general lighting, involving more rigorous standards for power efficiency, size, and heat management. These technical requirements are tailored to the unique demands of automotive environments, such as vibration resistance and rapid on-off cycling, which are less prevalent in architectural contexts. Conversely, DALI, 0-10V and switch-dim compatibility are key in general lighting drivers.

Moreover, the issue of standardization presents another obstacle. While architectural lighting benefits from more established industry-wide standards, the automotive sector exhibits less standardization at LED light module level. This lack of uniformity can pose significant challenges for designers accustomed to the more regulated environment of architectural lighting, requiring them to navigate a landscape where customization and proprietary solutions are more common.

Additionally, LED reliability and robustness are paramount in automotive lighting due to the harsher operating environments. Automotive lighting components are engineered to withstand extreme conditions, such as vibrations, temperature fluctuations, and moisture, which are not as critical in architectural lighting. All of this necessitates a higher level of engineering and material science expertise in car design, making the transition from architectural to automotive lighting more challenging.

Can Architectural Lighting Designers Significantly Impact Automotive Lighting?

Architectural lighting designers hold the potential to contribute meaningfully to the automotive lighting field. Their expertise in aesthetic design, human-centric lighting, and spatial illumination can offer fresh perspectives to automotive lighting, which is increasingly focusing on enhancing user experience and safety. Architectural lighting designers can also benefit from observing and integrating automotive lighting trends, such as the use of dynamic lighting and advanced control systems, into their



Nichia's µPLS™ (micro-Pixelated Light Solution), a pioneering light engine solution integrating pixelated microLEDs ideal for high-definition (HD) adaptive driving beam applications.

Advanced modularity, coupled with proficiency in integrating sustainable materials and smart functionalities into surfaces as well as Nichia's lighting technologies, empowers Forvia to craft tailor-made interiors that offer heightened comfort, sustainability, and digital sophistication. Photo courtesy of Forvia.

practices. The cross-pollination of ideas between these two domains can foster innovation, pushing the boundaries of creative and scientific thinking in both, as we move to a future where autonomous vehicles will redefine our transport experience.

In summary, while the complexities and technical differences between architectural and automotive lighting present significant challenges, they also offer a unique opportunity for knowledge exchange and invention. Architectural lighting designers, with their rich experience in creating ambient and purposeful lighting, can bring new insights into the automotive world, which in turn can inform and enrich architectural lighting practices.

Moreover, the convergence of general and automotive lighting trends, particularly through LEDs, is palpably evident. LEDs have proven that lighting is not merely a functional element; it is an integral component in crafting an experience, curating an atmosphere, and even enhancing safety and comfort. Indeed, in a world where technology, design, and sustainability converge, LED lighting stands out as a beacon that not only illuminates our spaces and our drives but also guides us towards a future where our environments, be they our homes or our vehicles, are intuitively, beautifully, and sustainably lit. ■

About Nichia

"The origin of Nichia came from the inspiration of Nichia's founder, Nobuo Ogawa, to utilize limestones in his hometown of Tokushima, for the production of calcium compound used in pharmaceutical materials. Nichia has strived for monotsukuri with its original technologies, while expanding its product range from calcium compound to phosphors, LEDs, Laser Diodes, cathode materials for Lithium-ion batteries, and magnetic materials. Despite many obstacles and difficulties, Nichia has succeeded in developing several of the world's best products based on the unfaltering foundational belief, "creating the world's best products by working earnestly and utilizing the technology, full of wisdom, and expertise of all Nichia employees." In keeping with this belief, Nichia's monotsukuri* is now concentrated in two main fields: light and energy. Since its successful development of the world's first high luminous blue LED, Nichia has been an innovator in the field of LEDs.*

Nichia believes that the potential for the next innovation beyond all imagination must include the understanding of the fundamental nature of light and luminous/optical mechanism, "Light behaves as a particle and as a wave at the same time". With this belief, Nichia has already started developing and selling new LEDs which pursue the ultimate quality of light. Nichia's goal is to continue to contribute to society without ever forgetting the spirit that brought the company here: "Ever researching for a brighter world."

— President & CEO, Hiroyoshi Ogawa

* The Japanese word describing creating, manufacturing, and developing activities that are not only focused on the simple process of manufacturing inside a factory but also include the creation, utilization, and combination of ideas, technologies, and expertise.

Nichia will be showcasing its Sustainable Innovation and Technical Leadership at SIA Vision held from October 16-17 in Paris, France.

Aligning with the automotive event's theme of 'Vehicle Infrastructure and Safety Improvement', Nichia will exhibit a range of products designed to enhance vehicle safety and performance – especially in adverse weather conditions.

NICHIA

Expert Talks on Light – Time Matters, Shining Light on Metabolic Health

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Dr. Charna Dibner – Moderation

Charna Dibner completed her PhD in Medical Sciences under the supervision of Professor Dale Frank in the Department of Biochemistry at the Technion Israel Institute of Technology, headed by Nobel Laureate Professor Avram Hershko. She next moved to Geneva where she completed her postdoctoral training at the Faculty of Science, University of Geneva, with Professor Ueli Schibler, working on the mechanisms of transcriptional and temperature compensation of the mammalian circadian clocks. In 2009, she was appointed as a Group Leader of the Laboratory of Circadian Endocrinology at the Faculty of Medicine, acquired her Private Docent degree, and was nominated Associate Professor in 2021. Her work centers upon the implication of circadian oscillators in regulation of metabolic processes in mammals. In particular, she is interested in intricate interplay between the islet cellular clocks, and in the inter-organ desynchrony upon metabolic diseases, unraveling the roles of the circadian clocks in human metabolic diseases. Charna's work has been awarded with several prestigious Swiss prizes including Roche Research Foundation prize, Takeda prize for diabetes research, the awards by French Swiss Foundation of Diabetes Research, and Leenaards and ISREC Foundation awards for translational research.

Dr. Kathryn Reid – From the Real World to the Lab: Why Light Matters for Metabolic Health

The impact of light is dependent on when it occurs relative to the internal biological clock, and as such the timing of when we get light or dark across 24-hours matters. Light exposure patterns are a modifiable factor that can have significant impact on health and wellbeing. Results from real world and laboratory-controlled studies that examine the impact of light exposure on health will be discussed. From pregnant women to older adults, data from real-world monitoring of light levels suggests that higher levels of light exposure in the few hours before and during sleep are associated with poor metabolic health. The mechanism underlying these findings are supported by controlled laboratory-based studies examining the impact of light on cardio-metabolic function. Together these studies suggest that interventions to optimize the pattern of light-dark exposure across the 24-hour day could be beneficial to health in vulnerable populations.

Dr. Jan-Frieder Harmsen – Diabetes in the Daylight: Metabolic Benefits Through Natural Office Lighting?

He talks about a recently completed study, in which he tested if natural daylight during office hours is more beneficial for metabolic health outcomes of type 2 diabetes patients compared to constant artificial lighting.

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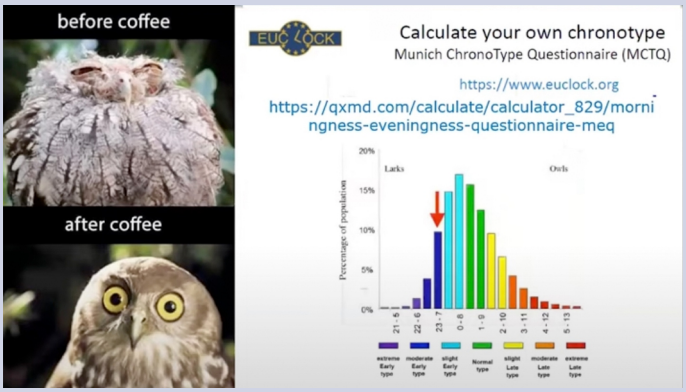

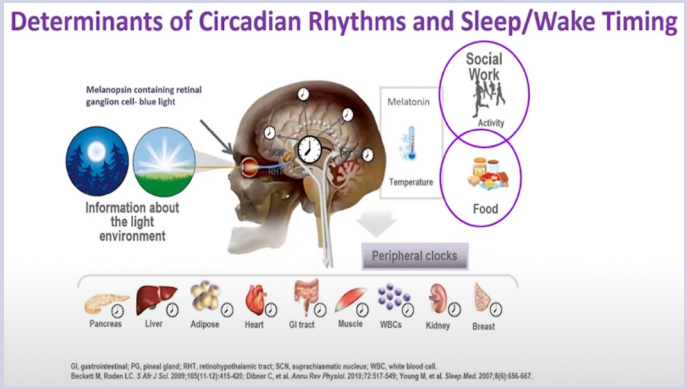

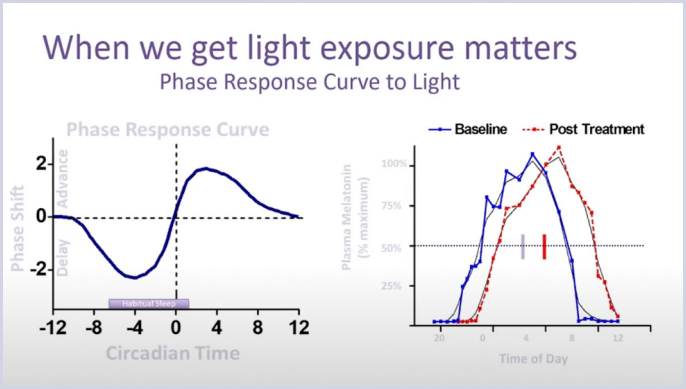

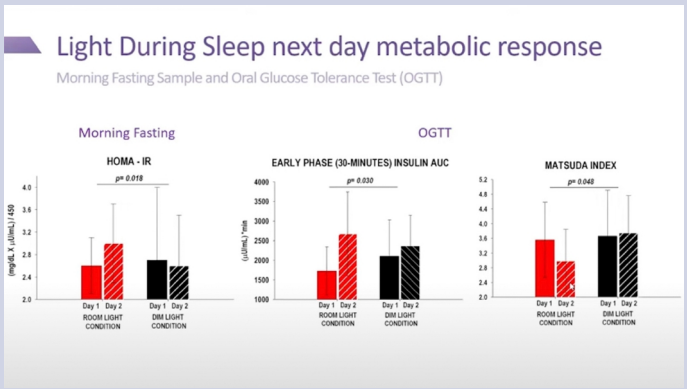

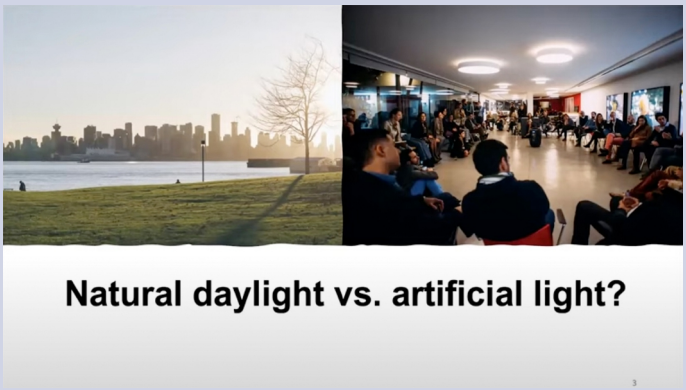

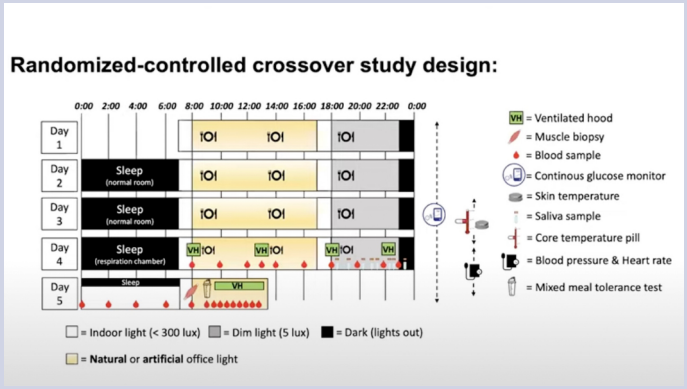

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Lighting Intelligence

Including Electronica Special
This upcoming edition will be packed with cutting-edge insights and research. It will feature a White Paper from the Good Light Group on wellness lighting and its benefits. Readers will discover a detailed introduction to the Energy Performance of Buildings Directive (EPBD) and its implications for sustainable building practices. The expert commentary will delve into the latest trends and future directions in lighting technology. There will be an exploration of the newest advancements in horticulture lighting with the latest research. Additionally, readers will learn about the DALI+ lighting control system, its features, and integration. Finally, there will be a sneak peek at Electronica 2024, with the latest LED and control updates in anticipation of the event in November in Munich. This edition of LpR, filled with valuable information to keep you informed and inspired is something to look forward to!

* *Subject to change without notice.*

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Cover Page: REFLEX² transfers the principle of the classic REFLEX luminaire to today's technology and aesthetic sensibilities. The precursor already presented a convincing lighting solution at the central ceiling connection in a space by employing a special ceiling reflector. REFLEX² now opens up this formerly closed body and further develops it into a delicate, elegantly rounded frame structure that contains the LED boards. Their light hits a prismatic reflector surface of the same basic dimensions.
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Imprint

LED professional Review (LpR)
ISSN 1993-890X

Publishing Company
Luger Research e.U. | © 2001–2024
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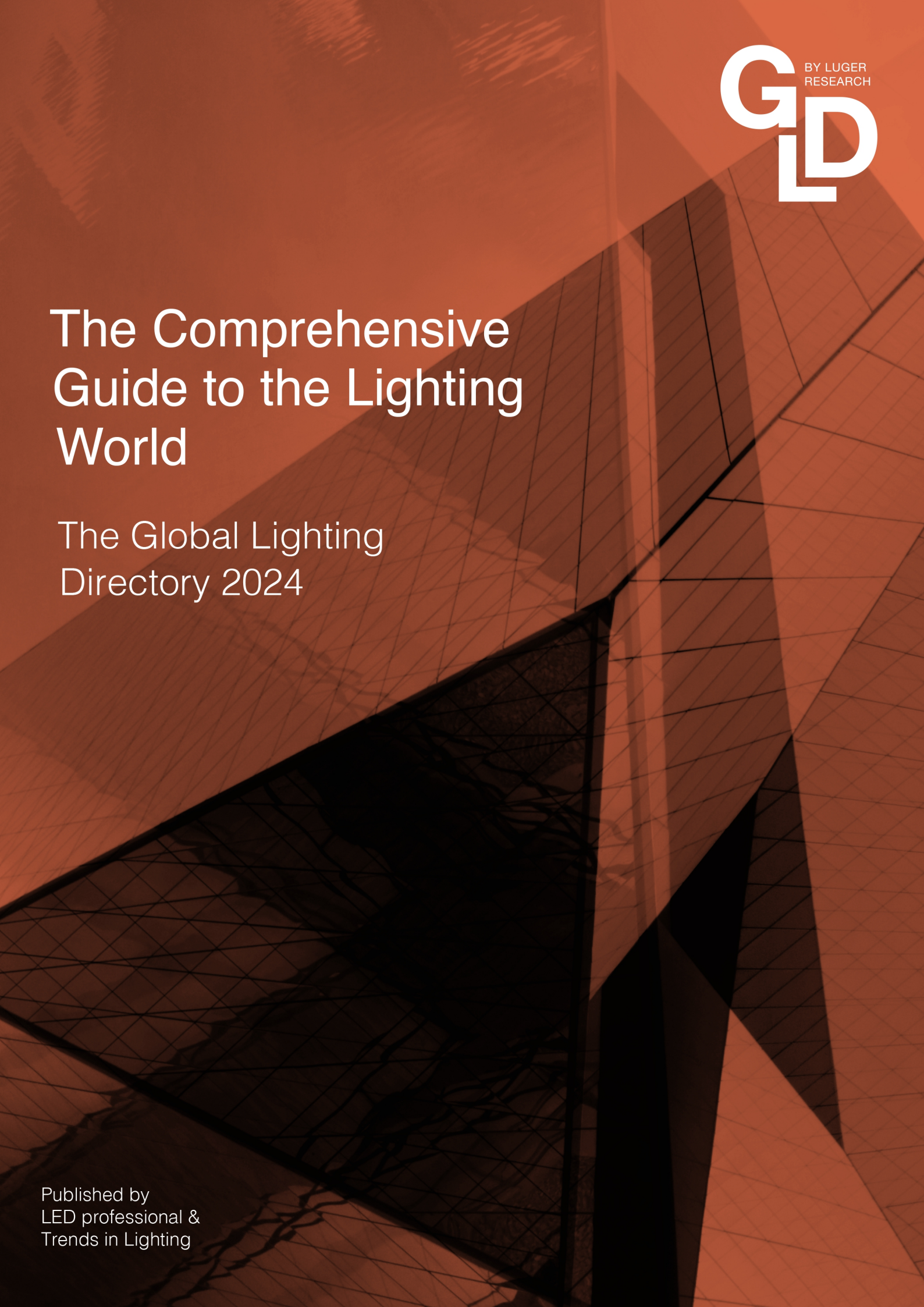

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The Comprehensive Guide to the Lighting World

The Global Lighting Directory 2024

Published by
LED professional &
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Showcase in LpR #105

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