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BY LUGER RESEARCH

Review

LpR 105

Sept/Oct 2024

INTERVIEW WITH CIE'S VP TECHNICAL, TONY BERGEN

COST-SAVING POTENTIAL OF ZONAL LIGHTING

RE-ENTRAINMENT AFTER SEASONAL CLOCK CHANGES

The Global Information Hub
for Lighting Technologies
and Design

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Intelligent Lighting, Global Standards, and Health

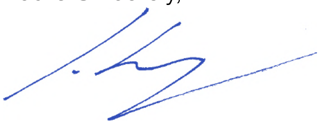
Welcome to the Sept/Oct 2024 issue of LED professional Review, where we explore the latest advancements shaping the future of lighting. As smart lighting technology evolves, it moves beyond automation to become more human-centric. We delve into the limitations of motion sensors and how new technologies like CO_2 and microwave sensors, combined with AI, are creating more responsive and personalized lighting. What role will data and AI play in making lighting more adaptable to human behavior and needs?

In our exclusive interview, Tony Bergen, Vice President Technical of the CIE, shares his insights into global lighting trends. From AI and integrative lighting to sustainability, he discusses the challenges of shaping an industry that balances innovation with human well-being and environmental responsibility.
This issue also highlights the work of Lichtvision Design at the IFC Nanjing Shopping Mall, where lighting design blends functionality and luxury to enhance the retail experience. Lighting becomes a key element in creating atmosphere and guiding visitors through the space.
In office lighting, new zonal strategies are leading the way, reducing energy consumption while improving comfort and productivity. Moving away from uniform lighting grids, these strategies are reshaping work environments.
We also dive into horticultural lighting, where LEDs are transforming the agricultural sector by improving crop quality and reducing production time. With tailored light spectra and higher efficiency, LEDs are helping growers meet modern demands.
Finally, don't miss the article on the upcoming LpS Digital Summit and Awards in December, featuring presentations and discussions on the latest innovations in lighting.

This issue is packed with cutting-edge insights, making it essential reading for anyone invested in the future of lighting technology, design, and sustainability.

Enjoy your read!

Yours Sincerely,



Siegfried Luger

Luger Research e.U., Founder & CEO
LED professional, LpS Digital – Expert Talks on Light & Global Lighting Directory
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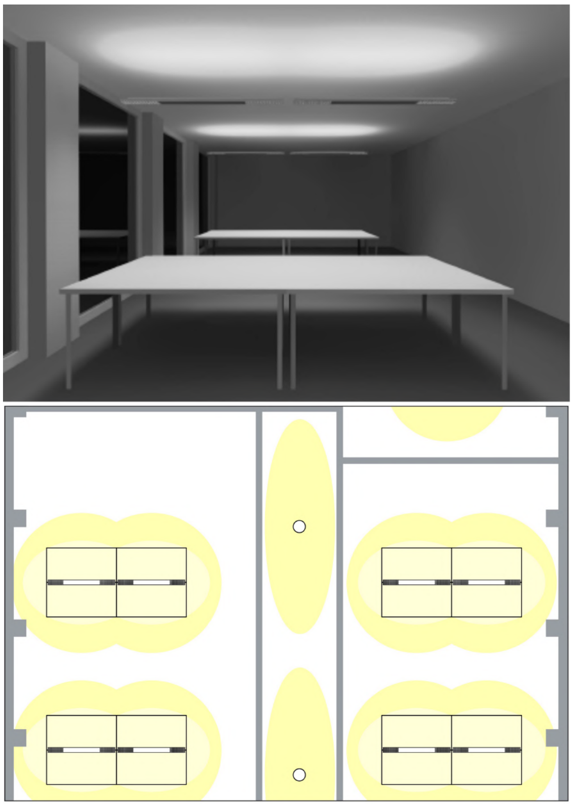
Member of the Good Light Group


ifc mall



ADVERTISING INDEX

Professor Jean-Paul LINNARTZ

Jean-Paul Linnartz is Professor in the Signal Processing Systems group. He focuses on algorithms for intelligent lighting systems and wireless optical communication, e.g. LiFi. He is also an internationally recognized thought leader in the field of security with noisy data.

Jean-Paul Linnartz obtained his MSc in Electrical Engineering from Eindhoven University of Technology (TU/e) in 1986. He did his PhD at Delft University of Technology, graduating in 1991 on traffic analysis in Wireless Networks. As Assistant Professor at the University of California at Berkeley, he worked on autonomous driving and wireless multimedia (Infopad). After being appointed as Associate Professor at Delft University of Technology in 1995, Linnartz joined Philips Research, becoming Senior Director in 2001 and Research Fellow in 2013. From 2018-2024, he was with Signify. In 2006, he returned to TU/e as Part time Professor at TU/e.

www.tue.nl/en

https://www.linkedin.com/in/linnartz/

Will AI Make Research into Human Response to Light Obsolete?

Smart lighting is designed to be intelligent, yet we often see cartoons poking fun at it. Picture an office worker deeply focused on desk work, developing great ideas. Suddenly, the lights switch off, leaving him in darkness because the sensors, detecting no motion, turn off to save energy.

When I entered the lighting field, I was struck by the vast knowledge of how people experience light. I began reading Peter Boyce's book, hoping to use this information to enhance lighting control. While I was aware of the limitations of motion sensors and processors, I saw many new sensor types emerging, like microwave, CO_2, and light sensors, as well as how signals could be processed more efficiently. It seemed that smart lighting could go beyond "IF presence THEN keep lights on" and become more human-centric.
Human perception models are commonly used. For example, digital video relies on such models to avoid noticeable artifacts. The flicker caused by LEDs has also been widely studied. Yet, I realized that most reports on how lighting affects human productivity followed strict hypothesis testing. These evaluations, done in controlled lab settings, determine if lighting effects produce significant differences. However, these studies are less suitable for automated algorithms.

Software teams often had to create their own rules for lighting control, which needed to work globally for all populations, ages, moods, and activities. Advanced lighting control essentially boils down to setting N lamps to meet M people's needs with L optimization criteria. These criteria, like reducing glare, depend on light distribution and human preferences. Testing every possible scenario isn't feasible, but control algorithms operate in real time, making decisions in any situation, well beyond tested lab conditions.

Lighting models must go beyond simple yes/no effects. They need to quantify how much a deviation from ideal lighting impacts performance. Satisfying M * L objectives requires compromise, and it's best when algorithms handle this. As new insights emerge, new criteria can be added. I'm advocating for "forward models" that predict how lighting will be appreciated, rather than "inverse models," which focus on achieving a single objective. Forward models can evolve as lighting requirements change.

With AI's rise, the question is whether it can surpass rule-based lighting control and create better light settings than those built on perception theory. If so, what happens to the decades of research? Can that knowledge be embedded in AI, or will AI need to start from scratch?
To build these models or train AI, real-world data is needed from actual offices with real people in authentic situations. While AI thrives on big data, is lighting experience data truly "big"? People likely won't appreciate being asked constantly for feedback on their lighting experience. "Please rate how you felt about the lights dimming in the last hour" could become intrusive. Constantly seeking feedback, as we see in today's world with satisfaction surveys, feels more like a symptom of fear of failure than progress. Is this constant demand for feedback really the best way to fuel AI for smart lighting?

Lighting control isn't about big data; it's about thin data. Not long ago, the idea of removing light switches and relying entirely on automation seemed plausible. However, feedback interfaces are crucial. The goal is to minimize user interventions as the system learns. But relying on user feedback is risky. People don't always know what's best for them. For example, chronobiology shows that blue light in the evening disrupts sleep, while afternoon light can help stabilize our circadian rhythms. Asking people their immediate light preference may not lead to healthy outcomes. ■

J-P.L.

WEBINAR

THE EUROPEAN LIGHTING FORUM

EPREL: A Demo to Product Registration and Recent Verification Rules

25 October 2024

(10:00 - 11:15 CET)

LightingEurope will host the European Commission for a live demonstration of how to upload products and go through the supplier verification process on the EPREL database according to the latest novelties introduced by the Regulation (EU) 2024/994.

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www.lightingeurope.org

DALI Alliance Lighting Awards Opens with New Categories for 2024

www.dali-alliance.org/awards2024

DALI Alliance, the global industry organization for DALI, the internationally-standardized protocol for digital communication between lighting control devices, announces that the annual DALI Lighting Awards are officially open for 2024 with a number of new categories.

The traditional application categories have been consolidated to five awards: Residential, Commercial Interior, Commercial Exterior, Industrial & Infrastructure, and Horticulture. This year's Awards will also include the following innovation categories:

- Best Use of D4i: Recognizing innovative applications of DALI D4i technology, including enhanced data communication, energy management, and advanced control capabilities.
- Best Emergency Lighting Integration: Celebrating solutions that incorporate emergency lighting, ensuring safety, reliability, and compliance with standards during emergencies.
- Best Human Centric Design: Honoring projects that prioritize human well-being in health, comfort, and productivity through lighting.
- Best Integration into Other Building Systems: Highlighting projects that excel in integrating lighting data with other building systems, such as HVAC, security, and energy management.
- Innovation in Lighting: Recognizing cutting-edge technologies and advancements in lighting control solutions.
- Sustainability and Energy Efficiency: Highlighting projects that excel in sustainability, conservation, and environmental impact.
- Smart and Connected Lighting: Honoring advancements in smart lighting systems, IoT integration, and connected lighting solutions.
- Non-networked Lighting: Celebrating innovative applications in small or stand-alone spaces.

These new categories align with the growth of technologies, advancements, and innovations that are being adopted by the lighting sector.

This year's submissions will no longer be submitted to a specific category. Entries will be placed by judges into applicable categories, allowing the possibility of a single project to win multiple awards.

Paul Drosihn, general manager of DALI Alliance, said: "We are very excited to launch this year's DALI Lighting Awards with a refreshed approach. We are confident these changes will make it more straightforward for those across the lighting industry to enter, and gain recognition for their work."

The awards entry deadline is 7 October 2024. For more information and to enter the awards, visit https://www.dali-alliance.org/awards2024/.

About the DALI Alliance
The DALI Alliance is an open, global consortium of lighting companies that aims to grow the market for lighting-control solutions based on Digital Addressable Lighting Interface (DALI) technology. The DALI Alliance promotes the adoption of DALI-2, D4i, and DALI+ certification programs and supports the use of open, interoperable lighting control systems. ■

Building Technologies Trade Fairs with a New Forward-looking Focus

www.light-building.messefrankfurt.com

The building sector is facing many major challenges: rising construction costs and a shortage of skilled workers are colliding with an urgent need for new housing. Simultaneously, the energy and heating transition, not to mention the rapid pace of digitalization, are creating new opportunities for a sustainable future. Messe Frankfurt has responded to the dynamic challenges in the market with a newly formed management team for its Building Technologies division.

Johannes Möller, who was previously responsible for Light + Building, has been appointed Group Show Director, Building Technologies Shows, with immediate effect. Over the last four years, a really challenging time, he successfully managed the world's leading trade fair for lighting and building-services technology while simultaneously expanding its international network. Against this background, he has been responsible for the management and strategic orientation of the Light + Building, ISH and Intersec brands since August 2024.

He continues to report to Iris Jeglitza-Moshage, Senior Vice President Technology. She assumed responsibility for the division 14 years ago and is also a member of the Executive Board of Messe Frankfurt. "Möller's promotion means she will now be able to focus more on her managerial duties, while her many years of expertise will ensure the necessary continuity. By taking this step, we have not only settled the succession for three of our most important brands at an early stage but also reinforced the managerial resources needed for our Building Technologies Industry Cluster," explains Iris Jeglitza-Moshage. Furthermore, she explains, "We are delighted that we have been able to find a successor within the company, especially because Johannes Möller has made an important contribution to the success of our international portfolio of Building Technology trade fairs over recent years. Now, he will be able to concentrate fully on the strategic growth of these brands in both Germany and abroad."

Johannes Möller began his career in the trade-fair industry as a graduate exhibition, congress and event manager in the sales department of Prolight + Sound. He then spent four years as the personal assistant to the CEO of Messe Frankfurt before assuming responsibility as Director of Brand Management and Development, Technology, in 2017. After managing Light + Building, taking on overall responsibility for the Technology division is the next logical step and represents the continuation of his previous successes.

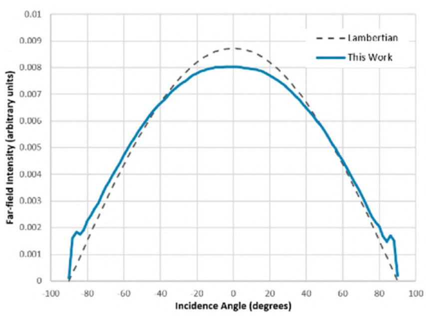
ISH will remain under the experienced management of Stefan Seitz. For the past twelve years, he and his team have been planning and organizing the world's leading trade fair for HVAC and water every two years. The management team for the Building Technologies Shows Group also includes Dominique Ewert, who is responsible for the company's marketing-communication activities in the field of technical trade fairs.

From 1 October 2024, Steffen Larbig will be responsible for the development of Light + Building. Commenting on the new member of the management team at Messe Frankfurt, Ms Jeglitza-Moshage says, "Mr Larbig brings with him extensive international sales expertise, experience in key account management and a wealth of ideas for the future direction of Light + Building." The next chapter in the successful development of the brand will be written in close collaboration with the highly experienced Light + Building team (www.light-building.messefrankfurt.com). ■

Lumileds Addresses MicroLED Efficiency Through EQE and Directionality

lumileds.com

Lumileds has realized significant External Quantum Efficiency (EQE) performance for MicroLEDs in the past years. EQE, is the ratio between the energy contained in the light emitted from the LED and the energy in electrons injected into the semiconductor material.



However, for microLEDs, and display applications in particular, EQE on its own is not a sufficient measure of performance. To properly assess the efficiency of a microLED, one must also be able to measure the directionality of the light. The directionality of light is critical for microLED displays, and for this reason, displays are often characterized by Radiant or Luminous Intensity, as seen from an angle.

"Most LEDs emit the majority of light from their top surface. This is especially true for thin film LEDs. When we shrink the size of thin film LEDs to become microLEDs, the 'side-emitting' surfaces become a significantly greater portion of the overall light-emitting surfaces," explained Brendan Moran, Lumileds' Senior Director of MicroLED Development.

"The thickness of what we described as a thin film for a larger size LED now becomes substantial relative to the length and width of the microLED. This is a key reason why microLEDs emit a large portion of light from their sides, resulting in a wide viewing angle distribution and a reduction of intensity emitted from the top surface. For display applications, even high EQE microLEDs can have relatively low on-axis intensity," said Moran.

The Lumileds R&D team has now developed microLEDs with a highly desirable light distribution that approximates Lambertian distribution. The team's innovation results in brighter displays that consume less energy.

Brendan Moran will present on microLED advances and efficiencies at the PlayNitride MicroLED Technology Forum on September 3rd, 2024.

About Lumileds
Lumileds is a global leader in LED and microLED technology, innovation, and solutions for the automotive, display, illumination, mobile, and other markets where light sources are essential. Our approximately 3,500 employees operate in over 15 countries and partner with our customers to deliver never before possible solutions for lighting, safety, and well-being. ■

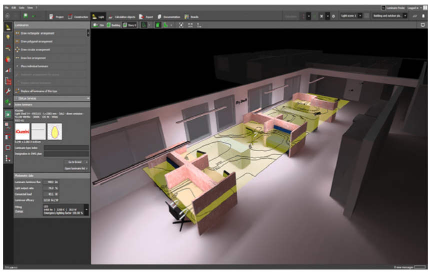
Metaroom and DIALux tie up to Enhance Efficiency in 3D Modelling for Lighting Design

amrax.ai

Metaroom by Amrax, a spatial 3D data capture company, has announced a partnership with the world's largest lighting design software provider DIALux.

The tie-up will enable users to send 3D scan data from Amrax's Metaroom solution directly to DIALux's planning software. This new feature will be available from mid-September with the release of DIALux evo 13. This allows the fast creation of precise and detailed light plans for each room.

Scans* can be made in a matter of minutes on any Apple Pro device with a LiDAR sensor and then instantly imported into DIALux. At this point, users can experiment with scores of different factors to find the most cost effective, aesthetically pleasing, functional and sustainable lighting solution for their space. The partnership between Metaroom and DIALux aims to streamline the spatial design process for professional designers and consequently help to power innovation, sustainable design, and lower costs.



The Metaroom app is an advanced 3D scanning app, driven by the power of AI, LiDAR (Light Detection and Ranging), and SLAM (Simultaneous Localization and Mapping) technologies. The tool enables professionals in spatial planning industries to envision and redefine spaces. The Metaroom solution is a workflow consisting of Metaroom app for capture and Metaroom Studio for optimization before export. Through the Metaroom app users can scan rooms using an iPhone Pro or iPad Pro*. These scans are then uploaded to the cloud, generating true-to-scale 3D models within seconds. Users can then use the web application, Metaroom Studio, to enrich these 3D models with additional information before exporting, ensuring project-specific customization and precision.

DIALux is the global standard in lighting design software, utilized by over 750,000 active users to design, calculate, and visualize lighting for both indoor and outdoor areas. Featuring real luminaires from over 412 DIALux members, users can create unique atmospheres and generate comprehensive project documentation. Available in 26 languages, DIALux supports a worldwide network of lighting professionals and adheres to the open BIM approach. The integration with Metaroom is also based on open BIM and IFC standards.

DIAL always prioritizes the needs of lighting designers in its feature development, aiming to streamline their workflows and simplify their tasks. By using Metaroom, lighting designers can save significant time when designing and placing luminaires. Projects can be conveniently downloaded from Metaroom Studio and imported into DIALux. The planning results can then be exported as an IFC model for the Open BIM process or other programs, significantly reducing the workload.

Martin Huber, CEO of Amrax, said: “Advances in 3D modelling, software and AI are combining to democratize design. Lighting designers and electrical planners now have access to powerful tools that significantly enhance efficiency, enabling them to serve more customers in less time. This is going to lead to a revolution in how buildings are designed and how we all interact with our built environment. ”Partnerships between cutting edge solutions like Metaroom and DIALux are key to powering this change. By creating an extensive ecosystem of lighting design solutions, we will significantly improve accessibility, reduce costs and bring spatial design to the mainstream.”

Dieter Polle, CEO at DIALux, said: “Simply scan the room with your smartphone and start planning right away. Wouldn’t that be fantastic? By integrating Metaroom into DIALux, this is now possible. The time-consuming task of constructing the geometry before starting the actual lighting design is eliminated. Martin’s team and their solution have convinced us. The integration follows our Open BIM strategy technologically. With this integration, we’ve made life a bit easier for lighting designers.”

Over 11.000 Metaroom users, including key players in the lighting, wireless planning and AEC industries, have registered through the Metaroom app and joined the Amrax B2B ecosystem dedicated to spatial design and 3D modelling.

*Metaroom app’s scanning functionality is currently compatible with all LIDAR-enabled Apple devices (starting from iPhone 12 Pro and iPad Pro 2020 generation devices). However, you can view or download shared 3D models directly in any web browser through Metaroom Studio. The digital twin is created with the Metaroom app within minutes by using RGB and depth sensors from an iPhone or iPad Pro together with deep-learning neural networks. The accuracy of LiDAR sensors of the iPhone 14 Pro model is at 0.5-1%. The recognition range is approximately 5 meters.

About Amrax
Amrax, the technology platform behind Metaroom, was founded in 2020 to explore new ways to digitize and design spaces using 3D technology. It offers fast, inspiring, and user-friendly solutions for space planning and interior design. Amrax’s team of 25 experts in computer vision, AI, software development, and marketing use interdisciplinary collaboration and virtual reality to create groundbreaking innovations. Headquartered in Salzburg, Austria, Amrax also operates in Vienna and the USA.

About DIAL
DIAL is the company behind DIALux. The company is based in Lüdenscheid, the city of light, and has offices in America, Asia and Italy. DIAL has been operating in the field of lighting design and building automation since 1989. The focus is the development of DIALux evo. DIAL believes that good software leads to good results, so the company provides lighting designers with all the tools they need to simplify their work. ■

Gewiss Becomes a Member of LightingEurope

www.gewiss.com

Gewiss, a leading company manufacturing solutions for home & building automation, energy protection and distribution systems, smart lighting and e-mobility has joined LightingEurope together with its brand focused on Lighting: Performance iN Lighting | powered by Gewiss.

“It is with great pride and anticipation that we announce our membership with LightingEurope, the esteemed voice of the lighting industry. Our commitment to innovation, sustainability, and excellence in lighting design aligns perfectly with the values and objectives of LightingEurope.

Joining this influential Brussels-based organization, which represents 32 companies and national associations, marks a significant milestone in our company's journey. We are eager to collaborate with our peers, contribute to the shaping of industry standards, and advocate for policies that support the growth and evolution of the lighting sector.

LIGHTINGEUROPE
THE VOICE OF THE LIGHTING INDUSTRY
GEWISS
PERFORMANCE iN LIGHTING | powered by GEWISS

We believe that our unique insights and expertise in the field of lighting will complement the collective knowledge of LightingEurope's members. Together, we can illuminate the path towards a brighter, more efficient, and sustainable future for all.

We look forward to actively participating in the dialogue and initiatives that drive our industry forward, and we are committed to being a proactive member of this dynamic community", declared Alfonso D'Andretta, Managing Director - Business Unit Lighting of Gewiss.

Elena Scaroni, Secretary General of LightingEurope, warmly welcomed Gewiss to the organization, highlighting the company's significant contributions to the lighting market, standards bodies and European trade associations. "Gewiss' full engagement with LightingEurope from day one demonstrates their commitment to the organization's mission" , Scaroni added. "Their expertise will be invaluable in our discussions on sustainable and connected lighting, and we look forward to working with them. We also appreciate their willingness to advocate for better enforcement to ensure that the industry operates in a fair regulatory environment. This is a key issue for the lighting industry.

About Gewiss
Development as a constant in management is the philosophy that has guided GEWISS's choices from its foundation to today. Established more than fifty years ago, GEWISS has made development and the research for quality the principles that have guided every action and every choice. Guided by the values of integrity, excellence and sustainability, GEWISS offers innovative and scalable solutions for buildings, industries and infrastructures, capable of connecting people and things and improving safety and quality of life. The constant investments aimed at research and development, the training of all personnel and the strengthening of production facilities have allowed GEWISS to establish itself as a reference point for the market in the production of solutions and services for home & building automation, for the protection and energy distribution, for e-mobility and smart lighting. The year 2023 marks a significant milestone in the Group's growth journey with the acquisition of PERFORMANCE iN LIGHTING, a historic leader in the lighting industry. The inclusion of the PERFORMANCE IN LIGHTING brand "powered by GEWISS" has allowed the entire Group to expand the range of services available to the market through platform synergies and organizations, offering even more integrated solutions and technologies. All the proposals are designed and produced to meet every lighting need, representing the perfect synthesis of aesthetic design and technical performance. The constant drive towards innovation, a hallmark of the entire Group's history, further positions lighting solutions as a solid global reference in the world of design and architecture. ■

DALI Alliance to Host Inaugural DALI North America Summit in New York City

www.dali-alliance.org/events

The DALI Alliance, the global industry organization for DALI, the internationally-standardized protocol for digital communication between lighting control devices, is elated to announce the first-ever North American DALI Summit, set to take place on October 30, 2024, at the Metropolitan Pavilion in New York City.

The Summit promises a dynamic agenda featuring a range of topics surrounding sustainability, smart buildings, DALI-2 certification, D4i use, and the integration of DALI with building management systems.

Attendees will benefit from expert-led presentations, interactive workshops, and panel discussions designed to address the current challenges and opportunities within the lighting industry.

Key Highlights:

Explore the Latest DALI Technologies and Applications: Gain insights into cutting-edge innovations and practical implementations in the field of DALI lighting control.

Network with Leading Figures and Peers: Connect with industry experts and fellow professionals to exchange ideas and build valuable relationships.

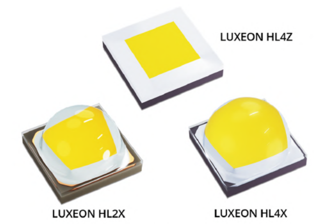
Earn Continuing Education Units (CEUs): Participate in selected sessions to earn CEUs and enhance your professional development. To learn more and to register, please visit https://www.dali-alliance.org/events/dali-north-america-summit-2024.html.

Paul Drosihn, general manager for DALI Alliance, said: "This is the first time we have brought the DALI Summit to North America, and we are excited to connect with our peers and friends in the industry to share knowledge and best practices. We have listened to the feedback from our members and we are committed to open up our knowledge base and share expertise on DALI technology. The summit is a key part of our efforts to expand the educational opportunities available to our members and other stakeholders. We are looking forward to sharing this special event with members of the lighting industry." ■

LUXEON High Power 3535

lumileds.com

We'd be stating the obvious if we said that there are few, if any, one-size fits all solutions in this world. But there you have it. Starbucks proves this in a claim on their website that there are more than 170,000 ways for patrons to customize their beverages. While we've not counted all the ways to use an LED with a 3535 footprint, we suspect the number is high.



LUXEON High Power 3535 LEDs

Since Lumileds introduced its first 3535 package in 2013, the format has become a de-facto standard, widely adopted in a variety of outdoor, industrial, and portable applications and solutions.

Recognizing that OEMs need different optical, power, thermal, and efficiency options in this format, Lumileds has developed three high-power LUXEON options that make it more straightforward for OEMs to offer tiered performance in a single luminaire, offer a range of luminaires with differing value propositions, or replace another 3535 LED with any one of Lumileds' options as a way to expand an existing line and/or ensure leading reliability and performance.

When Lumileds undertakes the development of a new LED, it does so with specific applications in mind. Chip and package design, optical and thermal performance, output and efficacy are all engineered to produce the best in-application results. As a result, the optical performance, quality of light, color over angle, thermal characteristics, ability to withstand the elements, output, efficacy, and more contribute positively to the finished luminaire's performance.

The LUXEON "3535" Team When introduced in 2020, the LUXEON HL2X found immediate traction in street and parking lighting. Thanks to its high light output, superior color over angle, and optical efficiency that maximized the lumen output for the application, the LUXEON HL2X immediately offered an efficiency advantage at the luminaire level. With life testing at both mild and severe conditions covering many thousands of hours at its launch, LUXEON HL2X increased the confidence level for long term application color and light output stability.

More recently, Lumileds introduced both the LUXEON HL4X and the LUXEON HL4Z. Both LEDs share the 3535 footprint with LUXEON HL2X and can even use the same optics in some cases, thereby making it extremely easy to upgrade a luminaire's performance or to quickly create multiple performance levels for a luminaire.

LUXEON HL4X, like the LUXEON HL2X is a domed emitter intended for outdoor, industrial, and portable applications. The LUXEON HL4Z is un-domed power LED, so it doesn't share the optical characteristics of the other two. Instead, it shines in applications that require very high intensity and superior efficacy. Typically, engineers must make a tradeoff between optimizing optical design and achieving high efficacy. LUXEON HL4Z addresses this dilemma. At maximum current and in application conditions, the undomed LED delivers tremendous intensity – over 1400lm – from its surface and can operate at an impressive 189lm/W.

Perhaps the simplest example of how these three LEDs can support a single application is the case of a torch or flashlight. In the example below it is easy to see how the performance of an identical torch and reflector can result in three distinct performance envelopes. Depending on the desired performance, cost and market targets, a single solution design could be supported by this team of LEDs.

Certainly, a powerful case for the use of this trio of LEDs in torch lighting is easy to make. The significant advantages this team offers to OEMs, and ultimately end-use customers, is in the more complicated and nuanced world of high-power lighting in stadiums, on roadways, pathways, and industrial lighting such as high and low-bay environments. In use cases like these, the ability to utilize LEDs with a common footprint and achieve optimal application performance can lower design and manufacturing costs and speed time to market.

Lumileds high-power LEDs that share the 3535 footprint are essentially "starters", top-notch options that perform individually and that provide OEMs the flexibility to address opportunities that lead to greater success with their clients. ■

Seven Innovative Lighting and Components Solutions from Acuity Brands Selected for the 2024 IES Progress Report

www.acuitybrands.com

Acuity Brands, Inc. (NYSE: AYI) announced that seven Acuity Brands lighting and components solutions were selected for the 2024 Illuminating Engineering Society (IES) Progress Report, which showcases the year's most significant advancements in the art and science of lighting. Selections were made by an impartial committee that evaluated submissions based on uniqueness, innovation, and significance to the lighting industry.

2024 IES Progress Report inclusions:

A-Light™ Lino luminaire, IVO™ Shallow Recessed Downlight from Gotham® Lighting, Hydrel® Tierra Ingrade Family, IOTA ILD Series Emergency Drivers, Juno® 2" Canless Wafer Downlights, and the Lithonia® FRAME LED Lay-in from Lithonia Lighting®.

A-Light Lino is available in 2.16" and 3" apertures, and the small profile housing and no visible hardware ensure that the fixture subtly integrates into a variety of interior and exterior environments. With an IP66 rating, Lino luminaires are particularly well-suited for outdoor applications with harsher weather conditions. Designers can mix and match from numerous suspended or surface mountings to maintain a consistent design aesthetic. Suspended mountings include catenary or pendant stem. Ceiling, wall, channel or mullion block can be selected for surface mountings. Direct illumination is available with batwing, flat blade louver, HE Tech™, wall grazer or asymmetric distribution types, each meeting specific lighting needs. Designers may choose indirect illumination for the mullion block mounting option. Available in up to 8-foot standard lengths, luminaires can be trimmed to specific sizes in increments of 1/8 inch. Luminaires may be joined with L-, T-, or X-corners for creative patterns. Sustainability is a key element of the design, including fixtures that contain 60% recycled aluminum extrusions. Lino luminaires are enabled with the nLight® network control system.

Cyclone Crosswalk Optics solution takes into account the two main contributing factors to pedestrian visibility, including contrast and vertical illuminance. With asymmetrical forward and asymmetrical right side light distribution, the optics provide a high positive contrast that make pedestrians look brighter than the background. They also enhance vertical and horizontal illuminance to help motorists clearly and effectively detect the crosswalk and the pedestrian well in advance. They are designed based on the guidance in IES RP-8; Recommended Practice: Lighting Roadway and Parking Facilities, with particular attention paid to the recommendations focused on pedestrian crosswalks. They are available in lumen packages ranging from 3,100 lm to 11,600 lm and all versions are IP66 rated for harsh weather.

Gotham IVO Shallow Recessed Downlight addresses spatial limitations, fitting into spaces as shallow as 2 inches, while delivering exceptional performance. Boasting up to 3000 lumens from a 4-inch aperture and up to 5000 lumens from a 6-inch aperture and delivers up to 120 lumens per watt. Designed for field-serviceability, the downlight features interchangeable trims and optics that can be effortlessly serviced from below the ceiling with a simple twist and lock mechanism. The IVO downlight's design uses 17% less steel, 44% less aluminum, and 28% less plastic compared to standard downlights. Perfect color consistency is achieved with a 0.5 MacAdam ellipse from fixture to fixture. Proprietary optics coupled with an advanced light engine and Bounding Ray™ Optical Design delivers a true uniformed, batwing distribution for smooth illumination and a comfortable experience for occupants in the space. They offer color temperature options from 2700K to 5000K. The downlight supports universal dimming to 1% through 0-10V, 120V Triac, and ELV protocols. Integration with nLight® wired or wireless lighting controls further enhances control options.

Hydrel Tierra offers higher delivered lumens, more color temperatures, and more options than the average ingrade - in a compact design. With only 4.4" and 6.38" diameters, the Tierra series is an ingrade that combines impact and corrosion-resistant materials, optimal beam control and superior performance. Delivers exceptional uniformity and on-target illumination. Its precision optical system offers excellent controlled beam angles. Modular design allows for easy installation, driver replacement, and light source updates as technology advances. Tierra incorporates innovative sealing capabilities, superior materials, and long-lasting finishes, promising decades of use with minimal maintenance. Its structural integrity is unmatched.

IOTA ILD Series Emergency Driver is a UL Listed LED emergency driver that allows the same LED fixture to be used for both normal and emergency operation. In the event of a power failure, the ILD 10 switches power from the normal AC Driver and operates the fixture for 90 minutes in the emergency mode from the unit's battery supply. The Quick-Disconnect wiring connectors provide installation flexibility and optimization, allowing for snap-in field replacement. The unit contains a battery, charger, and converter circuit in a narrow profile enclosure for installation within the channel space or wireway. The ILD 10 will operate an LED load at 10 watts with constant power at a rated output voltage of 10V-55V. The Constant Power design of the ILD 10 maintains the output wattage to the LED array even as the system voltage diminishes, providing a consistent illumination level for the full 90-minute runtime. It features lithium battery technology for significantly decreased form factor, automatic monthly and annual self-testing capability, and AC Activate battery activation circuitry.

Juno 2" Canless Wafer Downlight has an innovative, slim design that installs quickly and easily into as little as 3" of plenum allowing for it to fit into ceiling spaces where most traditional recessed housings do not. No housing required to install. Once installed, the Wafer provides an all-in-one design featuring switchable white color temperature and adjustable lumen output technology. This technology gives distributors, contractors and homeowners the ultimate in flexibility by providing the equivalent of 15 static fixtures in one. These technologies are controlled by switches located directly on the fixture. Simply toggle each switch to the desired settings: 2700K, 3000K, 3500K, 4000K, or 5000K for color temperature adjustment and low, medium, high for lumen adjustment.

Lithona FRAME by Lithonia Lighting offers a modern, upscale aesthetic with functionality and performance to match. At the heart of the FRAME design is the 'snap' together assembly which provides unrivaled value in shipping, storage and installation costs. Featuring Switchable color temperature and adjustable lumen technology, the FRAME allows the user to fine tune the look and feel of their space. The FRAME is designed with the latest optical technology to provide the same efficiency and output as a traditional LED flat Panel, for a fraction of the weight and cost.

About Acuity Brands
Acuity Brands, Inc. (NYSE: AYI) is a market-leading industrial technology company. We use technology to solve problems in spaces, light, and more things to come. Through our two business segments, Acuity Brands Lighting and Lighting Controls (ABL) and the Intelligent Spaces Group (ISG), we design, manufacture, and bring to market products and services that make a valuable difference in people's lives.

We achieve growth through the development of innovative new products and services, including lighting, lighting controls, building management solutions, and location-aware applications. Acuity Brands, Inc. is based in Atlanta, Georgia, with operations across North America, Europe, and Asia. The Company is powered by more than 12,000 dedicated and talented associates.

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Bartenbach GmbH Announces New Leadership with Helmut Guggenbichler as Managing Director

www.bartenbach.com

Helmut Guggenbichler was appointed as the new Managing Director, bringing with him a fresh perspective and extensive experience in daylight and artificial lighting design. He is well-positioned to lead Bartenbach into the future.

Bartenbach GmbH recently announced the departure of its esteemed Managing Director, Matthias Sporer, following three years of dedicated collaboration. His invaluable contributions and commitment played a key role in shaping Bartenbach into the company it is today.

The leadership team at Bartenbach GmbH underwent a strategic realignment, with Helmut Guggenbichler joining forces with Daniel Föger, Head of Research and Development, and Christian Jenewein, Head of Finance and Administration. Together, they continued to drive innovation and uphold the company's high standards of quality.

Helmut Guggenbichler views his new role as an exciting challenge and looked forward to exploring new avenues while continuing Bartenbach's success story. The company remains focused on its vision: creating visibly better light for people and the environment.

Bartenbach GmbH began this new chapter, anticipating successful projects in collaboration with its partners. ■

Yongjiang Laboratory Orders Reactive Ion Beam Trimming Equipment from scia Systems

www.scia-systems.com

The scia Trim 200 system provides precise surface correction in film and wafer materials using ion beam trimming. The film thickness uniformity can be adjusted up to 0.1 nm.

scia Systems GmbH, the industry leader in advanced ion beam and plasma process equipment for microelectronics, MEMS, and precision optics industries, announced that Yongjiang Laboratory (Y-LAB), a non-profit research and innovation center, established in 2021 in Zhejiang province, China, has purchased a scia Trim 200 system.

High-Precision Surface Correction with scia Trim 200 The scia Trim 200 guarantees high-precision film thickness trimming in wafer processing. Typical applications are frequency and thickness trimming in the manufacturing of acoustic-electrical devices and filters like bulk (BAW) or surface acoustic wave (SAW) filters, localized pole trimming of thin film head (TFH) applications, and dimensional correction of MEMS structures.

Designed for high-volume production and R&D applications, the system is equipped with a standard semiconductor cassette handling robot that accommodates wafers up to 200 mm in diameter.

The film trimming is performed by a focused broad ion beam with a sufficiently small focal point. The ion beam is directed to the substrate surface, causing a physical sputtering effect to remove material. During trimming, the wafer gets moved in front of the ion source by an x-/y-stage.

A metrology system detects the exact frequency topography map of each wafer area and converts this topography map into a coating thickness map. Based on that, the thickness of the coating that needs to be trimmed is calculated. Afterward, the internal control software of scia System calculates the corresponding dwell time map and follows the velocity scan profiles for the trimming process. By adjusting the local dwell time of the ion beam at specific positions, the system can control the local removal and etch non-uniformities, resulting in an impressive homogeneous film.

While ion beam trimming is done with noble gases like Argon, reactive gases can also be used for complex device structures to increase selectivity (reactive ion beam trimming, RIBT).

"We are proud that Y-Lab has opted for ion beam equipment provided by scia Systems for its laboratory. The scia Trim 200 offers a high degree of variability and is a good basis for future-oriented innovations and applied research thanks to its maximum flexibility in processing wafer materials without any restrictions and its ability to adjust the film thickness uniformity down to the atom level of 0.1 nm." stated Dr. Michael Zeuner, CEO of scia Systems.

More information on the scia Trim 200 system can be found at www.scia-systems.com/products/ion-beam-trimming/scia-trim-200

About scia Systems GmbH
Founded in 2013, scia Systems is the technology leader in thin-film process equipment based on advanced ion beam and plasma technologies. The systems are used for coating, etching, and cleaning processes with nanometer accuracy and have been successfully implemented in various high-tech industries worldwide, including microelectronics, MEMS, and precision optics industries. ■

Prominent Southern California Lighting Reps Merge to Form LINX LIGHTING & CONTROLS

westernlightingandenergycontrols.com/

Western Lighting & Energy Controls and Forman & Associates have announced the merger of both companies to form one of the largest lighting rep agencies in the Southern California Region.

Currently, Western Lighting & Energy Controls serves as the representative for 90+ lighting brands across Southern California and is best known for representing Lutron. Lutron is the market leader in high-quality lighting, controls and automated window systems. Together, Western and Lutron have advanced the technology of lighting control in Southern California while maintaining top market position by focusing on exceptional service, quality and design.

Forman presently serves as the representative for 100+ lighting brands in Southern & Central California, Signify is its flagship manufacturer, with a robust portfolio of professional lighting solutions for commercial, industrial and entertainment projects, in addition to stock and flow demand. Signify's Genlyte Solutions portfolio encompasses lighting controls and IoT platform brands, Philips Dynalite and Interact; global architectural lighting brand Color Kinetics; Philips LED lamps, EvoKits and Advance electronics; as well as indoor luminaire brands Alkco, Chloride, Day-Brite, Ledalite and Lightolier; and outdoor luminaire brands Gardco, Hadco, Lumec, and Stonco. Forman also represents Signify's entertainment lighting brand Vari-Lite and emergency lighting brand Bodine.

By merging the extensive resources of two of Southern California's top lighting rep agencies, the two companies are forging a powerful connection to create an unparalleled synergy in the marketplace. The new company, rebranded as LINX Lighting + Controls, will provide comprehensive solutions for lighting and controls, along with dedicated customer service & field service support across all aspects of electrical, lighting, and control requirements for any project, linking our customers (specifier, channel, installer, end-user) together in success.

This strategic expansion reflects a commitment to the Southern California Lighting Community as well as to all our valued manufacturing partners. With offices in Van Nuys, Costa Mesa, and San Diego, the new company is positioned to service the region.

About Western Lighting & Energy Controls:
https://westernlightingandenergycontrols.com

Established in 1996, Western Lighting & Energy Controls represents top manufacturers across Southern California. The company is committed to thorough understanding in manufacturer processing, development, and technical product support. ■

Zhaga Consortium and DALI Alliance to Exhibit at 2024 Street and Area Lighting Conference

www.dali-alliance.org

The Zhaga Consortium and the DALI Alliance are pleased to announce that they will be exhibiting in adjacent booths at the upcoming 2024 IES Street and Area Lighting Conference (SALC), set to take place 22-25 September, 2024 in Atlanta, GA. The collaboration between two of the leading organizations in the global lighting industry highlights their shared commitment and synergy to advancing the future of street and area lighting through innovation, interoperability, and sustainability.

The Zhaga Consortium, a global lighting-industry organization with over 600 members, will, at this year's conference, emphasize the transformative potential of the Zhaga-D4i standard, which is setting new benchmarks for smart, energy-efficient, and future-proof outdoor lighting solutions.

One of the key themes for Zhaga at the event will be extending the useful life of streetlights through circular lighting practices. This includes promoting modular luminaire designs that allow for easy upgrades, repairs, replacements, and servicing—critical elements for achieving greater sustainability in urban environments.

Visitors to the Zhaga booth (#606) will have the opportunity to explore the Book 18 platform, an ecosystem of interoperable components for outdoor lighting that showcases the power of the Zhaga standard in delivering smart and future-proof lighting solutions. Attendees are encouraged to visit the Zhaga booth to see live demonstrations of the Book 18 platform and to engage with Zhaga experts, who will be on hand to discuss details around the platform and product certification.

The DALI Alliance, the global industry organization for DALI, the internationally standardized protocol for digital communication between lighting control devices, will use the 2024 IES Street and Area Lighting Conference to demonstrate its innovations in smart street and area lighting. DALI Alliance members will showcase solutions that highlight the interoperability, scalability, and sustainability of DALI-based lighting systems. The DALI-2 and D4i standards, which are pivotal in the advancement of smart, energy-efficient street lighting, will be at the forefront of these demonstrations.

Key highlights for the DALI Alliance booth (#608) at SALC 2024 will include live demonstrations of a D4i system, which offer enhanced interoperability and connectivity for street lighting applications. Additionally, the DALI Alliance will present the advantages of D4i and Zhaga-D4i certification for intelligent, data-rich luminaires that enable advanced asset management and predictive maintenance, contributing to the long-term sustainability of urban lighting infrastructures.

Attendees are encouraged to visit Zhaga (#606) and DALI Alliance (#608) booths to see live demonstrations, learn more about our innovations, and engage with our experts to discover how Zhaga and the DALI Alliance are shaping the future of street and area lighting. ■

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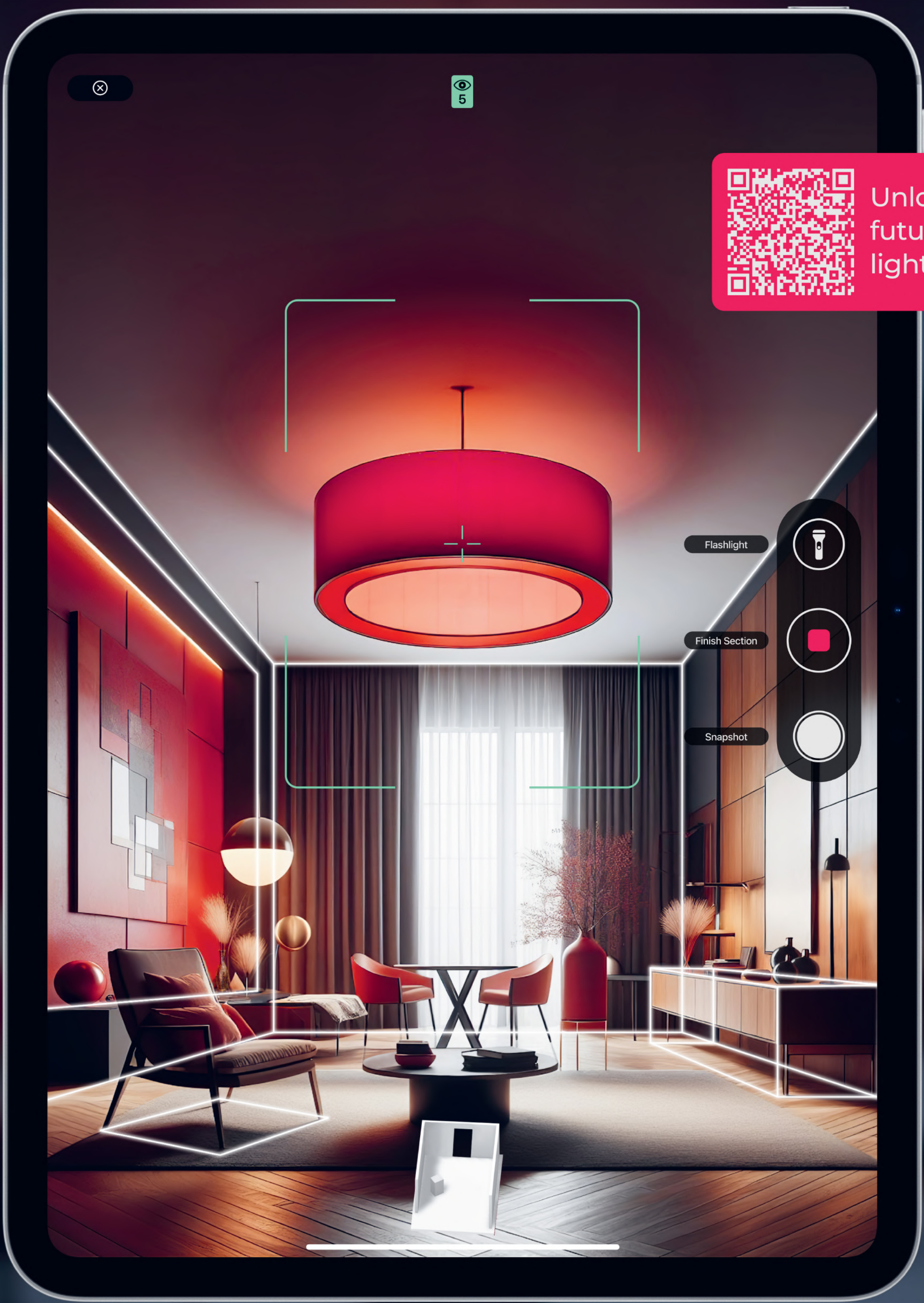

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Global Leadership in Lighting – CIE's Role in Driving Technology, Tony BERGEN, Vice-President Technical of CIE

Tony BERGEN
"We realize that light is so much more than just how we see things: that it influences processes connected fundamentally to our behavior, physiology, health and wellbeing, including circadian regulation. All of these processes happen throughout the body, in parallel, at once, and so we use the term integrative lighting."

In this compelling interview, Tony Bergen, Vice President Technical of the International Commission on Illumination (CIE) and Chair of the Technical Management Board (TMB), shares his remarkable career journey and pivotal role in shaping global lighting standards. As a physicist and leader in photometric and radiometric measurement, Tony provides powerful insights into the evolving landscape of lighting technology. He discusses the CIE's restructuring, the integration of cutting-edge trends such as AI, integrative lighting, and sustainability, and the challenges of steering the future of illumination. This conversation is a must-read for anyone invested in the future of lighting innovation.

https://cie.co.at

LED professional: **Tony, 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 Technical of CIE and chair of the CIE's Technical Management Board (TMB).**

Tony BERGEN: Thank you, Siegfried, for the interview.

I am a physicist and directly involved in two inter-related companies, both based in Melbourne, Australia. Photometric Solutions International, in which I am Technical Director, is a manufacturer of custom testing and measurement equipment. Through this company I have installed equipment in all continents around the world[1]. In parallel, I am Managing Director of the Australian Photometry and Radiometry Laboratory, an accredited public testing and calibration laboratory and consultancy service. Additionally, with some partners, we are currently forming a new company to work on miniaturized sensors for personal dosimetry and lighting controls. All of these roles have given me a good grounding in measurement and laboratory practice.

I started in CIE at the Beijing Session in 2007 and became actively involved in CIE Division 2 (D2), which deals with the physical measurement of light and radiation. I have served as D2 Secretary (2013 to 2019) and D2 Director (2019 to 2023) and, as you mentioned, I am presently CIE Vice-President Technical. I also chair CIE TC 2-78, which deals with goniophotometry, and TC 2-77, which is a D2 social committee.

I have also served as Australia's D2 Division Member since 2010 and was President of CIE Australia from 2015 until earlier this year.

LED professional: **As the Vice-President Technical of the CIE and the Chair of the Technical Management Board (TMB), we are interested in learning about the responsibilities these roles entail and how the technical work is managed by the TMB. How is the TMB integrated within the CIE structures?**

Tony BERGEN: The TMB is a relatively new entity within the CIE: established last year when the upper levels of governance of the CIE had a restructure. Previously, there was the CIE Board of Administration, which included the President, Vice-Presidents (with and without portfolio), Treasurer, Secretary, the six Division Directors and the CIE General Secretary. From September 2023, this was effectively split into two separate entities:

- The Governing Board (GB), which consists of the President (chair), Vice-Presidents (with portfolio), general members and the CIE Secretary General; and
- The Technical Management Board (TMB), which consists of the Vice-President Technical (chair), Vice-President Standards, the six Division Directors, the CIE Secretary General and the CIE Technical Manager.

The GB is responsible for overall governance, strategic planning, financial management, and external relations. The TMB is responsible for the scientific and standards work program of the CIE, including approval of new Technical Committees (TCs) and TC chairs, review and approval of publications, organizing of plenary scientific events, etc. Having been a Division Director in the previous Board of Administration, I can say that I think that this is a very positive change as the TMB members can focus on the scientific aspect of the organization without needing to be involved with decisions regarding financials, policies, strategy, etc.

LED professional: **Before we delve into the individual technologies, it would be important to understand the scientific divisions within the CIE and the topics they each address. Could you provide a broad overview of these thematic areas?**

Tony BERGEN: There are six scientific Divisions of the CIE:[2]

- Division 1: Vision and Color
- Division 2: Physical Measurement of Light and Radiation
- Division 3: Interior Environment and Lighting Design
- Division 4: Transportation and Exterior Applications
- Division 6: Photobiology and Photochemistry
- Division 8: Image Technology

Each Division is led by a Division Man-

[1] Well, almost all, still trying to get to Antarctica.

[2] For more details see: https://cie.co.at/technical-work/divisions

agement Team consisting of a Director, Secretary, Editor, and Associate Directors. The scientific work of the Division is performed by Technical Committees (TCs), which write the CIE publications under the leadership of the TC Chairs, and Reporterships, led by a reporter, which write a (usually internal) report on a topic of relevance to the Division and often forming the forerunner of a future TC. There are also Liaison Representatives and Division Correspondents with other (external) organizations.

But most importantly, the scientific program of the Division and its publications are commented and approved by representatives of each of the CIE's National Committees. This underpins the international nature of the CIE: that we have a truly global breadth across all six continents.

LED professional: **We had the opportunity to interview Jennifer Veitch, President of the CIE, where we particularly focused on the new research strategy of the CIE. Which elements of this strategy bring significant changes and also influence collaboration with research institutes?**

Tony BERGEN: Thank you for the interview with Jennifer, which was an excellent read. The research strategy (**Table 1**) itself isn't new, but it did undergo a substantial revision and reformatting last year. It has two overarching themes: *Digital transformation of metrology, science, and industry*; and *Towards inclusive, equitable lighting*; as well as six topical themes covering areas such as measurement, health, agriculture and aquaculture, photobiology and color. Significantly, each of these topics and themes are linked to the United Nations 2030 Sustainable Development Goals (SDGs), and surprisingly when writing the document we found that light and lighting touches 12 of the 17 SDGs! It's a great read for anyone interested in light and lighting and can be downloaded freely.[3]

The purpose of the research strategy is to inspire researchers to investigate important topics to shape the next generation of guidance and standards. Particularly important is the emphasis on diversity and inclusiveness, which is a theme that permeates the strategy. We also support research funding applications that align with our scope and priorities, and can issue Letters of Support for relevant research endeavors contributing to the ongoing work of CIE – further details can be found at the link to the research strategy given above.

LED professional: **Now we would like to address a few content areas that, in our view, are highly relevant and impactful for both the industry and the planning sector. Could you name the key trends in each of these areas from a technological perspective and explain what the CIE is currently undertaking in these fields, namely: Quality of Light, Aesthetic and Architectural Lighting; Integrative Lighting; Sustainability and Energy Efficiency; Lighting Intelligence with Smart Lighting, IoT, BMS, and Controls; and Wireless with Li-Fi, Wireless Power Transfer?**

Tony BERGEN: Lighting quality is fundamental to the work of the CIE and encompasses individual well-being, economics and architecture. Two of our Divisions in particular (Division 3 and 4) incorporate aspects of lighting quality and aesthetics into many aspects of their work. Lighting is not just concerned with the ability to see. It satisfies visual needs and creates experiences that sit at the very core of our evolutionary journey. Even before modern technology, we needed basics such as heat, light and security. As technology has advanced, among the things that have not changed are these visual experiences that humanity took for granted when daylight, firelight, and moonlight were the primary light sources.

The more that we study the human vision system, the more that we realize that light is so much more than just how we see things: that it influences processes connected fundamentally to our behavior, physiology, health and wellbeing, including circadian regulation. All of these processes happen throughout the body, in parallel, at once, and so we use the term integrative lighting[4] to describe this. We have had several publications on this topic, and our recently updated position statement on integrative lighting, recommending proper light at the proper time, freely downloadable from the CIE website[5], provides more information on this. Note that the term "human centric lighting" is also used to describe a similar meaning as integrative lighting, but it is not sufficiently precise.

I think that sustainability and energy efficiency are intricately linked to lighting quality which we discussed above. This topic was also discussed in your earlier interview with our Vice-President Standards Peter Thorns, and he emphasized the need to not get too focused on just the one aspect of lighting at the

CIE Research Strategy	Themes
Overarching Themes	* Digital transformation of metrology, science, and industry * Towards inclusive, equitable lighting
Topical Themes	* Advances in Measurement & Calibration * Integrative lighting for people * Ecologically respectful, high-quality exterior lighting * Fundamentals of photobiology for agriculture and aquaculture * Enabling the application of safe & beneficial optical radiation * Measuring, modelling, perceiving and reproducing color

Table 1: The CIE Research Strategy inspires researchers to investigate important topics to shape the next generation of guidance and standards.

[3] CIE's Research Strategy: https://cie.co.at/research-strategy

[4] Integrative Lighting: https://cie.co.at/eilvterm/17-29-028

[5] Updated position statement on integrative lighting: https://cie.co.at/publications/cie-position-statements

detriment of all others. It is possible to make a lighting installation very efficient so that it meets the standards and minimizes energy use, but if it creates a lit space which is not pleasant to work in or which does not take into account the integrative lighting aspects then it is not necessarily fulfilling its purpose.

LED professional: **What role does artificial intelligence currently play, or will it play in the future, in the lighting sector and lighting technology?**

Tony BERGEN: I think that it is very clear that AI already plays a role in the lighting sector. Lighting designers use AI to optimize their designs and save time. Researchers are using AI to analyze large amounts of data to achieve greater insights.

AI will be used in the future to control buildings and accept multiple inputs from weather data, occupancy data, task data (probably linked to areas in use and people present) to control building and public services. This will allow buildings and the urban environment to "plan" for needs as opposed to reacting to current events, thereby increasing efficiency.

In my own field of measurement, there are devices available which use cheap sensors with limited properties, machine learning, and tables of data produced from more complex and higher quality measurement equipment to produce a synthesized measurement result. It's not always clear whether this is actually measurement or "guesswork", and it makes aspects such as calibration, measurement uncertainty and documented traceability far more complicated!

Another application of AI is the concept of "digital twins", which are like digital replications of a real-life object or process. There are already projects looking at modelling products such as LED packages and luminaires to predict how they will operate in the real world.[6] In terms of people, this could involve mapping an individual's vision system and their color perception.

LED professional: **It is evident that lighting experts from both industry and design should engage with the results of the CIE. This foundational work is essential for any development in the lighting sector. How can interested parties stay informed about the results? Where can they access the publications, and how can they participate to ensure they don't miss any relevant findings?**

Tony BERGEN: CIE is recognized by other international standardizing bodies such as ISO and IEC as being responsible for producing fundamental standards in our fields. Experts are welcome to join our technical committees to take part in the writing of our publications, which includes not only standards but also technical reports (which provide more background information than standards) and technical notes (which are more brief documents usually written to address an urgent topic).

But there are also situations where research on emerging topics is not established enough to support the creation of a TC to write a CIE publication. While we don't actively undertake research as such ourselves, we do create research fora to coordinate work on such topics. These can be found on the CIE website[7], and we highly recommend that researchers apply to join a research forum to contribute to the knowledge so that new TCs can then write the publications for guidance or standardization purposes.

CIE publications are available for purchase through the CIE website, and we also have newsletters in which we publicize new publications, events and other news. CIE also has a translation policy which allows our National Committees to lead translations of our publications into other languages, and hence many of our publications are available in multiple languages.

Anyone can sign up to receive the quarterly CIE Newsletter to stay informed about new TCs seeking experts, new publications, and other CIE updates.[8]

LED professional: **Next year, the CIE Midterm Meeting will take place in Vienna. Could you please explain what this event is, how one can participate, and if there is still an opportunity to submit papers or abstracts?**

Tony BERGEN: Every two years the CIE holds a plenary event where all of our Divisions meet along with our National Committees and other governance structures. The most significant of these are our CIE Quadrennial Sessions, where in addition to holding a scientific conference and other meetings we also have a "changing of the guard" – transition of CIE President as well as Board members, Division Directors, etc., who all serve four-year terms. In the middle of each quadrennium we then hold a CIE Midterm Meeting, and that is what will be happening in Vienna in July 2025.

At the CIE Midterm Meeting, there are face-to-face meetings of the GB and TMB; a General Assembly attended by representatives from our National Committees; a three-day scientific conference; and three days of Division and Technical Committee meetings. The new CIE President-Elect, who will lead the CIE in the 2027-31 quadrennium, will also be announced.

The website for the scientific conference[9] is already up and running, and I am pleased to share that our three keynote speakers have already been announced. There is still plenty of time to submit a short paper (what in previous conferences we used to call an extended abstract): The close of submissions will be 10th December 2024.

As I mentioned earlier, my first experience in the CIE was at a CIE plenary event and for me it was a life-changing experience. To have such an opportunity to learn, to be around the best minds in our field, to meet people from all around the world, was simply amazing and I have been to every one since! Vienna is such a beautiful city and I'm also really excited by the social programs that are planned.

LED professional: **Moving towards the end of our interview, we would like to ask how you foresee the future development of the CIE's work. Are there significant new trends that have already been incorporated into the work and potentially new approaches?**

Tony BERGEN: I think that the digital transformation will continue to impact our lives as it has done over the past decade or more. Since COVID we have become used to online meetings, and

[6] Digital Twin project example: https://ai-twilight.eu/

[7] CIE's Research Fora: https://cie.co.at/research-strategy/research-forum

[8] CIE's Newsletter Registration: https://cie.co.at/about-cie-0/newsletter

[9] Scientific Conference Website of CIE's Midterm Meeting 2025: https://vienna2025.cie.co.at/

I feel that our work has become more efficient as a result, since our Technical Committees can meet more frequently to progress the work rather than just meeting face-to-face once per year as typically happened in the past. I think that we will also see increasing use of collaborative programs to coordinate our technical work.

We now have all of our main datasets freely available from the CIE website in a machine-readable format (csv dataset with json metadata file and checksum), from color matching functions to spectral distributions of reference illuminants. If anybody has had the fun job of typing a table from a book into a spreadsheet, as I have done in the past, I invite you to go to our website[10] and check out the list of datasets that are now available and can be easily downloaded.

Several of our recent publications have also had spreadsheets available – both as toolboxes and as example calculations. I think that this is likely to be more common in future.

LED professional: Would you like to give a final statement to our readers regarding lighting technologies?

Tony BERGEN: As I mentioned earlier, my main involvement with the CIE has been in Division 2 which deals with measurement and measurement devices. Although I have seen a lot of developments in the technology used in measurement over my career, one of the recent innovations that I have been incredibly impressed with is personal light dosimeters (**Figure 1**). These are miniaturized measurement devices, usually performing (quasi) spectrally resolved measurements, which people can wear as they go about their daily routine, and which log their light "diet". I have analyzed some of these devices in our lab and I am really impressed with their quality of measurement in terms of accuracy and dynamic range.

We had a workshop earlier this year to celebrate 100 years of the V(λ) function that underpins photometry. The CIE has published work on cone fundamentals, which offers not only a more accurate match to our photopic vision, but also the ability to adapt this to a person's age and the field-of-view of what they are looking at.

[10] CIE's list of datasets: https://cie.co.at/data-tables

Figure 1: Examples of wearable light dosimeters that are used to capture an individual's personal light "diet" over the course of a day. *Note: the products being shown here are a selection only and do not imply endorsement by the CIE.*

The miniaturized measurement devices I just mentioned have the ability to provide adaptability of measurement: to link photometry and integrative lighting and cone fundamentals, and I think that this will be an exciting development over the next decade.

LED professional: Belated congratulations on receiving the de Boer Gold Pin Award! It was a pleasure and an honor to speak with you about the CIE and lighting topics. Thank you very much for your time, valuable insights, and contributions to the lighting sector!

Tony BERGEN: Thank you! It was a great honor to be presented with the de Boer Gold Pin Award at our Quadrennial Session in Ljubljana last year. It is also an incredible honor to serve as Vice-President Technical of the CIE. Although it means a lot of very late nights (for me, living in Melbourne, meetings are often not so convenient) and a high level of responsibility, it has so-far been very rewarding and I look forward to the challenges of the future.

Thank you very much for the interview. ■

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

International Commission on Illumination
Commission Internationale de l'Eclairage
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6-star Hospitality Approach for the Shopping Mall Nanjing in China

Lichtvision Design

Lichtvision Design had the exciting opportunity to redefine luxury retail for the IFC Nanjing Shopping Mall. Lead8, as the retail planner and interior designer for this development, adopted a unique 6-star hospitality approach for this prestigious landmark in Nanjing. Lichtvision Design developed an elegant and integrated lighting design solution to enhance the contemporary classic version of a vintage art nouveau interior style.

The goal was to weave light into the mall's identity, using it to tell a story, evoke emotions, and guide visitors. The design process began by highlighting the mall's architectural elegance with gentle yet dramatic lighting, transforming columns, staircases, and facades into captivating focal points. The lighting design featured ceiling-recessed downlights and direct linear lights for general illumination, while decorative cove luminaires provided accent lighting. LED solutions were selected to prioritize energy efficiency, balancing beauty with sustainability and aligning with the mall's operational goals.

Nanjing, IFC – Nanjing, China

Typology: Shopping Mall
Lighting Design: Lichtvision Design
Scope of Work: Artificial Lighting
Completion: 2024
Location: Nanjing, CHina
Size (i.e. GFA): 93,000 m²
Client/Owner: Sun Hung Kai Properties
Tenant/User: Sun Hung Kai Properties
Project Team Lichtvision Design: Sunnia Cheng, Jane Tsai, Jeff Hung, Jenny Chan
Design Architect: Lead8
Local Architect: Lead8
Additional Planning Partners: Dop Design
Contractor: Guangzhou Pearl River Decoration Engineering Co.,LTD
Photographer: (c) Lichtvision Design
Lighting Supplier: WAC, Ricardo
Lighting Controls: Dalitek

Project Contact & Links
hongkong@lichtvision.com

The project presented significant challenges, particularly with the high-gloss and dark materials integral to the mall's brand. Combining diffuse lighting with these materials required special care to avoid glare and reflections. Determining optimal illumination levels was critical, involving numerous tests, verifications, and mock-ups. This process established a standard model for the brand's illumination levels. The lighting was designed to evolve throughout the day, enhancing the shopping experience from bright and energizing mornings to relaxed afternoons and magical evenings. Seamlessly integrated fixtures ensured a cohesive modern decor. Through this meticulous approach, Lichtvision Design turned light into a storyteller, making the IFC Nanjing Shopping Mall a memorable destination.

The basis of the design for the Nanjing IFC project focuses on a comprehensive approach to lighting that balances aesthetic, functional, and energy efficiency considerations. During the development of the schematic design, key areas within the project were evaluated for their specific lighting needs, appropriate lamp sources, and the achievement of target average illuminance levels. Each space was assessed to ensure compliance with maximum allowable power densities, aligning with energy efficiency goals. The design also accounted for the uniformity of lighting (Uo), color rendering (Ra rating), and visual comfort (UGR).

This structured approach ensured that the design met both the functional requirements and the aesthetic aspirations of the project while adhering to cost estimates and sustainability benchmarks.

https://www.lichtvision.com/en

LICHTVISION
DESIGN

Nanjing has a special place in Chinese history. The city was the capital of several great kingdoms and governments. That's why Nanjing is essential in understanding China's history. The city delicately balances the old and new, the traditional and the modern. Its impressive 14th century city wall can still be seen today, together with several monumental city gates. Nanjing boasts many impressive sites from different historical periods, including the famous Nanjing Decade. When it comes to modern architecture, Nanjing doesn't disappoint either.

Nanjing's official name literally means Southern Capital. The word Nan means the south, and the word Jing means capital. The Ming Dynasty gave Nanjing its name in 1403 to distinguish it from its northern capital, Beijing. In fact, from 1403 to 1644, the Ming Dynasty ruled China from both capitals. However, Nanjing had other names throughout its history. Jiangning, for instance, is made of two abbreviations. Jiang is short for Jiangsu, the encompassing province, and Ning short for Nanjing. When Nanjing was the capital of the Republic of China, people called it Jing, meaning capital.

Nanjing is China's eight-largest city, ahead of Wuhan and Xi'an. According to the latest information, the urban population of Nanjing is 8.5 million people.


DIOR
LOUIS VUITTON


POLO RALPH LAUREN
DIOR
CHAUMET
CHANEL

city'super
clé de peau
BEAUTÉ
消火栓
灭火器


GUERLAIN
JO MALO
LONDON


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从心开始 延续美丽传奇


EVERY WAY, LEGEND IS DESTINED TO SHINE
始 延续美丽传奇

Transforming General Lighting – The Cost-saving Potential of Zonal Lighting

Matthias Boeser and Dr. Thomas Schielke, ERCO

Unlocking the Potential of Zonal Lighting: 5 Steps to Transform General Lighting

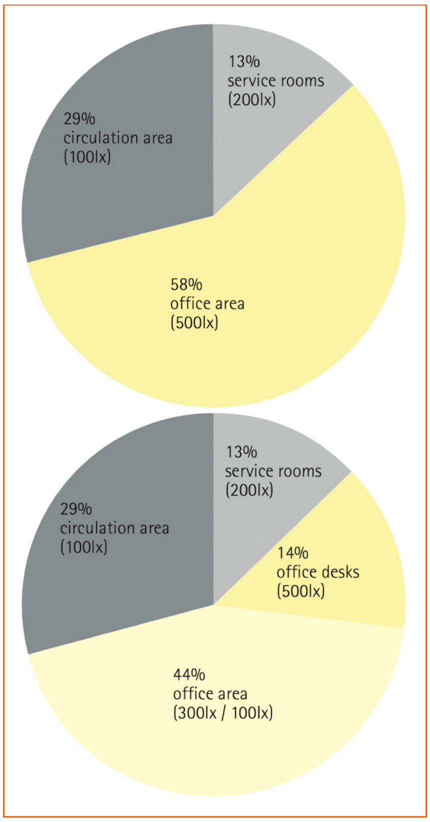
1. **Analyse Space and Lighting Needs**
   Assess the lighting requirements for different areas considering task performance and visual comfort.
2. **Select an Appropriate Lighting Strategy**
   Evaluate the benefits of a zonal scheme and vertical lighting in comparison to a grid layout.
3. **Prioritize Energy Efficiency and Quality**
   Don't let high lm/W values take the place of space efficiency metrics and long-term quality benefits.
4. **Integrate Advanced Controls**
   Implement daylight dimming and occupancy sensors to maximize energy savings.
5. **Plan for Long-Term Value**
   Opt for solutions that balance upfront costs with long-term benefits in energy savings and reduced maintenance.

In today's push for resource efficiency and energy savings, the effectiveness of lighting is more critical than ever. Investing wisely in lighting goes beyond mere illumination; it encompasses creating a human-centered environment that improves well-being and ensures long-term economic efficiency. This paper specifically looks at general lighting strategies for offices. An application where traditional uniform lighting approaches often lead to inefficiencies in energy use and workplace satisfaction.

Today, LED downlights allow different concepts such as that of zonal lighting, a strategy that tailors light distribution to specific areas within an office, optimizing both energy consumption and visual comfort. In contrast to uniform lighting grids, zonal lighting strategically reduces the number of luminaires needed, resulting in significant energy savings and lower investment costs. These savings allow for investment in higher- quality, durable downlights, which offer longevity and minimal maintenance, ultimately reducing total operating costs.

This win-win investment not only enhances the quality of light in critical work areas but also promotes a healthier, more productive workplace.

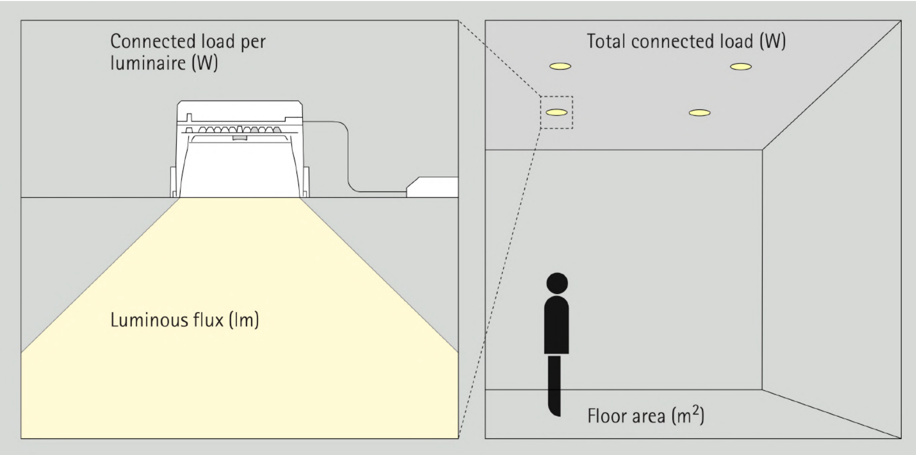
Different stakeholders interpret economic efficiency in varied ways. Building services engineers seek standard-compliant solutions, architects prioritize visual design, and clients focus on low operating costs and long-term visual appeal. They will all gain insights into smart lighting planning, the role of advanced control systems, and the importance of considering ecological and social factors in your investment decisions. Comparing four general lighting methods, we will guide you through energy efficiency metrics, highlighting the shortcomings of conventional practices and showcasing the advantages of effective zonal lighting.



Grid lighting approach (top). Zone lighting approach (bottom). Zoning the floor plan in this case study reveals that office desks, requiring the highest lux levels, constitute only 14% of the office space. Without zoning, the office area with 500lx would make up 58% of the floor plan. This highlights a significant, often underestimated potential for cost savings in general lighting.

Balancing Efficiency Metrics and Lighting Quality in General Lighting

The push for energy efficiency has led to the widespread adoption of metrics like lumens per watt (lm/W) or watt per square meter to evaluate lighting systems. While these metrics provide valuable information about energy consumption, they often fail to account for the overall quality of the lighting environment. This creates a



Luminaire-based vs. application-based efficiency metrics: Although green building standards and public funding often require high luminous efficacy, lm/W is a luminaire-based metric which simply measures a light source's efficiency in converting power to light. In contrast, application-based metrics like W/m2 evaluate the efficiency of the entire general lighting system within a specific space, considering distribution and usage patterns. A high lm/W is therefore no guarantee for an effective and resource-efficient lighting scheme.

Metric	lm/W	W/m²	W/(m²·100lx)	kWh/(m²·a)	kWh/a
Comparison Basis	Luminaire Efficiency	Application Energy Use	Application Energy Use, Normalised	Application Energy Use per Area per Year	Application Energy Use per Year
Label	Luminous Efficacy	Electrical Power Density	Normalised Power Density	Lighting Energy Numeric Indicator (LENI)	Annual Energy Consumption
Purpose	Efficiency comparison of different luminaires without reference to space, application or lighting concept	Comparison of different lighting systems based on a room or building, dependent on lighting requirements	Efficiency comparison of lighting systems for both identical arrangements with different luminaires and different concepts. Value is space-related but independent of lighting requirements	Efficiency comparison of electrical systems for a building with potential savings from sensors and controls. Value depends on the usage profile	Energy consumption for a building with potential savings from sensors and controls. Value depends on the usage profile
Pro	Value available on product data sheets	Number of luminaires adjusted to lighting requirements	Normalised to 100lx to better compare lighting solutions with different illuminance levels	Considers usage profile and daylight. Energy consumption is based on area for better comparability, independent of building size	Considers usage profile and daylight. Energy consumption captures the entire building
Con	Visual comfort (e.g., UGR) not considered. Whether a specific light distribution is suitable for an application and how many luminaires are needed is irrelevant	Room lighting quality irrelevant. Area reference is only to the floor. Wall lighting is not considered	Room lighting quality irrelevant. Area reference is only to the floor. Wall lighting is not considered	Room lighting quality irrelevant. Area reference is only to the floor. Wall lighting is not considered	Room lighting quality irrelevant. Area reference is only to the floor. Wall lighting is not considered
Evaluation	Higher value is more energy-efficient	Lower value is more energy-efficient	Lower value is more energy-efficient	Lower value is more energy-efficient	Lower value is more energy-efficient
Standard Reference	EN 12665	EN 12665, EN 15193, DIN 18599		EN 15193	

Comparing lighting efficiency – key metrics explained: Commonly used efficiency metrics focus on energy consumption and do not address lighting quality aspects like visual comfort and distribution. W/sqm, for instance, compares energy efficiency across different schemes or manufacturers but has limitations. It doesn't account for varied lighting usage or the benefits of lighting controls, focusing only on total connected load. In contrast, kilowatt-hour per year (kWh/a) reflects annual energy consumption and the advantages of lighting controls. Therefore, kWh/a offers a more comprehensive evaluation especially when making use of daylight and presence sensors.

dilemma: designers must balance the pressure to meet efficiency standards while also ensuring that lighting quality is not compromised.

For instance, high lm/W values indicate a luminaire's efficiency in converting electrical power to visible light. However, this metric does not consider how well the light is distributed across a workspace or its impact on visual comfort and productivity. Proper light distribution, glare control and color rendering are essential aspects of lighting quality that significantly affect user experience and overall satisfaction.

Lighting quality remains largely the responsibility of the designer. Effective lighting design must consider various factors, including the specific needs of the space, the tasks performed and the well-being of the occupants. For example, an office environment requires different lighting solutions than a foyer or a circulation area in an airport. Factors such as uniformity, contrast ratios and the ability to control light levels play crucial roles in creating a comfortable and efficient workspace.

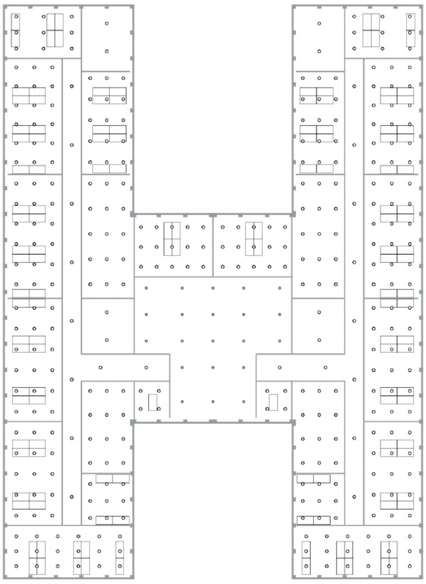
Moreover, the long-term benefits of high-quality lighting systems often outweigh the initial cost savings of less expensive options which may have higher lm/W ratings on paper. Factors that contribute to the total cost of ownership (TCO) include not just the investment and installation but also energy costs, maintenance and replacement. In addition, there are indirect costs associated with employee performance and health. Superior lighting can enhance employee productivity, reduce eye strain and even improve mood and well-being, leading to lower absenteeism and higher overall performance.

Although to some extent insufficient, we must acknowledge the importance of today's efficiency metrics. They are widely used and provide a standardized way to compare different lighting systems. Understanding and working with these metrics is essential, even as we strive to advocate for a more holistic approach that includes lighting quality as a critical component of energy efficiency. Recently published methods like "lighting application efficacy" might be capable of filling this gap.

Choosing the Right General Lighting Strategy: A Comparative Analysis

Building and Reference Floor Description

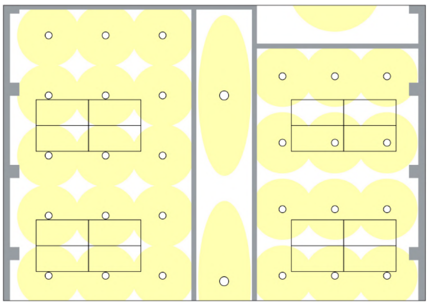
In this case study, we analyse the general lighting strategies for a typical office building designed by a project developer. The building features an H-structure that maximizes daylight access with group offices and a conventional layout with a central corridor. The reference floor has a height of 2.7 meters and a suspended ceiling. One floor is designed to accommodate 147 desks, taking up 25% of the total office area of 767 square meters. Each lighting strategy was calculated using recessed downlights with 4000K CRI82 LED modules and DALI control for daylight dimming.



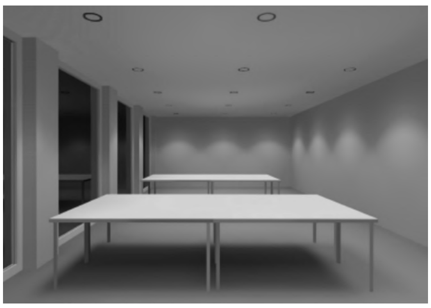
The building features an H-structure that maximizes daylight access with group offices and a conventional layout with a central corridor.

Grid Layout – Simplicity with Higher Energy Costs

The grid layout employs a uniform arrangement of luminaires throughout the office space. This approach simplifies planning and implementation, offering a universal light distribution that is independent of specific furniture layouts. However, it results in high energy consumption due to uniform high illuminance across the entire area, making it inefficient for spaces with varied lighting needs and potentially leading to over-illumination.



Schematic lighting layout.

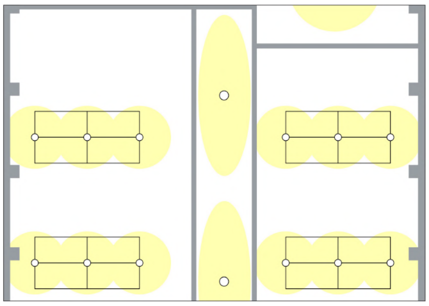


Visual appearance.

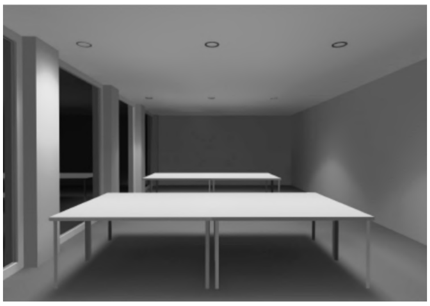
- Pieces installed: 381 pcs
- Energy consumption: 3.2 W/m2
- LENI (with controls): 64 kWh/m2·a
- ERCO solution: 59 €/m2

Zonal Lighting – Efficiency Through Precision

Zonal lighting tailors illumination to specific areas based on their requirements. This strategy provides significant energy savings by using downlights with dedicated light distributions. Lighting only the necessary areas reduces the number of luminaires needed and lowers both energy consumption and the initial investment. On the downside, it requires detailed planning to accommodate furniture and layout, and there is a potential for uneven lighting if not carefully designed.



Schematic lighting layout.



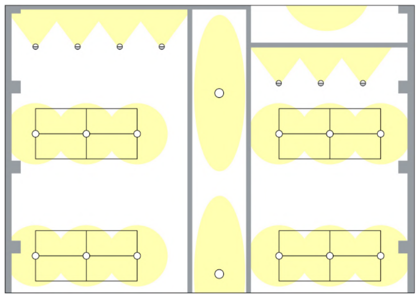
Visual appearance.

- Pieces installed: 245 pcs
- Energy consumption: 2.4 W/m2
- LENI (with controls): 29.4 kWh/m2·a
- ERCO solution: 47.40 €/m2

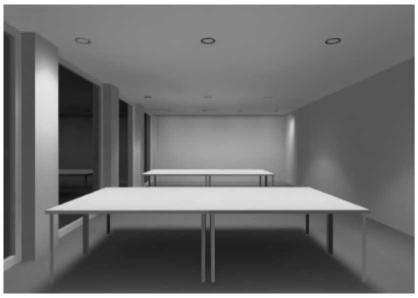
Zonal Lighting with Wallwashing – Efficient Visual Comfort

This strategy enhances the zonal lighting approach by adding wallwashing to improve visual comfort and aesthetics to their highest levels. It combines energy efficiency with improved visual comfort and meets the new EN12464 standard for balanced light distribution. A higher initial investment due to the additional luminaires needed for vertical illumination is offset by high visual and amenity quality.

- Pieces installed: 314 pcs
- Energy consumption: 3.3 W/m2
- LENI (with controls): 39.3 kWh/m2·a
- ERCO solution: 66.62 €/m2



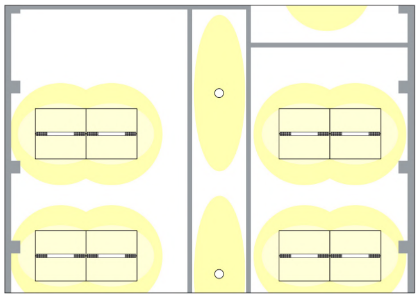
Schematic lighting layout.



Visual appearance.

Pendant Downlights with Indirect Lighting – Combining Direct and Indirect Light

Using pendant downlights with an indirect lighting component provides zonal and efficient lighting. This strategy is energy-efficient by focusing light where it is needed and enhancing visual comfort with indirect light, which reduces glare. However, it requires meticulous planning to ensure adequate indirect lighting, and it may involve higher complexity and potentially higher initial costs.



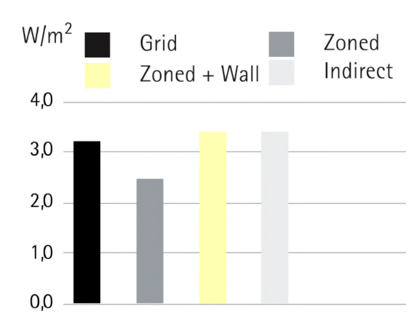
Schematic lighting layout.

Visual appearance.

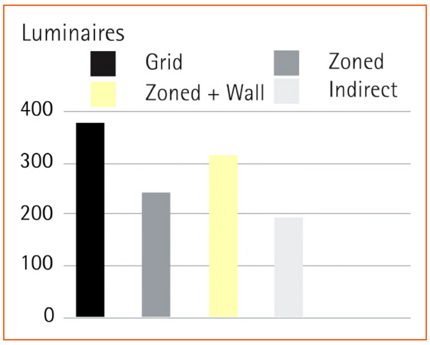
- Pieces installed: 197 pcs
- Energy consumption: 3.4 W/m2
- LENI (with controls): 58.4 kWh/m2·a
- ERCO solution: 70.49 €/m2

Summary

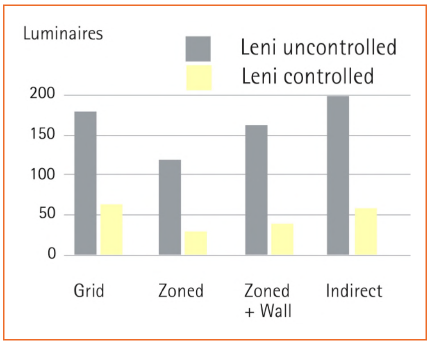
This case study compares four distinct general lighting strategies for a typical office setting, each offering unique advantages and challenges. The analysis underscores the substantial impact that thoughtful lighting design can have on both energy efficiency and visual comfort. The grid layout, while straightforward and easy to implement, results in high energy consumption and inefficiencies due to its uniform illumination across all areas, regardless of specific lighting needs.



In contrast, zonal lighting, which customizes illumination based on the requirements of different areas, significantly reduces energy usage and the number of luminaires needed. This approach not only reduces the initial investment costs but, together with durable, high-quality downlights, leads to lower maintenance and operating costs over time. The added complexity in planning can be mitigated with careful design and implementation. Wallwashing takes this a step further by incorporating vertical illumination to enhance visual comfort and aesthetics.
This strategy meets the latest EN12464 standard for balanced light distribution, providing a well-rounded lighting solution that supports economic, functional and aesthetic needs.



The findings from this case study emphasizes the importance of integrating energy efficiency metrics with a holistic view of lighting quality. Understanding the strengths and limitations of each lighting strategy allows for better decision-making and optimized lighting solutions. These insights highlight the value of investing in high-quality, durable luminaires with dedicated light distributions.



By leveraging advanced lighting strategies, everyone can achieve superior energy efficiency, enhanced visual comfort, and long-term economic benefits, making a compelling case for the adoption of innovative lighting solutions in future projects. ■

	Grid layout	Zonal lighting	Zonal lighting with vertical illumination	Pendant luminaires direct/indirect
EN 12464 compliant lx levels & uniformity / spatial light distribution	• / –	• / –	• / •	• / •
Fast luminaire arrangement	•	–	–	–
Improved spacial perception	–	–	•	•
Pros / Cons	- simplified planning - independent of specific furniture layouts - high energy consumption - high potential for over-illumination	- significant energy savings - reduced the number of luminaires - requires detailed planning - uneven lighting if not carefully designed	- combines energy efficiency with improved visual comfort - meets the new EN12464 standard - higher initial investment - complexity of planning and installation	- energy-efficient - enhanced visual comfort - requires detailed planning - higher complexity and potentially higher initial costs

Downlighting strategies compared.

About ERCO
ERCO is an international specialist for high-quality and digital architectural lighting. The family-owned company, founded in 1934, operates globally in 55 countries with independent sales organizations and partners.
ERCO understands light as the fourth dimension of architecture – and thus as an integral part of sustainable building. Light is the contribution to making society and architecture better and, at the same time, preserving our environment. ERCO Greenology® – the corporate strategy for sustainable lighting – combines ecological responsibility with technological expertise.

At the light factory in Lüdenscheid, Germany, ERCO develops, designs and manufactures luminaires with a focus on photometric optics, electronics and sustainable design. The lighting tools are developed in close collaboration with architects, lighting designers and electrical designers. They are used primarily in the following applications: Work and Culture, Community and Public/Outdoor, Contemplation, Living, Shop and Hospitality. ERCO lighting experts support designers worldwide in transforming their projects into reality with highly precise, efficient and sustainable lighting solutions.

www.erco.com

ERCO

Matthias Boeser: Matthias Boeser, a lighting design trainer and application specialist at ERCO, started with professional stage lighting and has been working in architectural lighting design for more than 20 years. He has been a lecturer for lighting design and lighting technology in various degree programes for more than 15 years.

Dr. Thomas Schielke: Thomas Schielke, a trainer at ERCO for architectural lighting, has been working at ERCO for more than 20 years. His extensive contributions include an online guide, workshops, and international articles on lighting. The co-authorship of the ERCO book “Light Perspectives” reflects his expertise. He has presented lectures at various international universities.


DALI
Alliance

The IEEE Sustainable Smart Lighting Conference comes to Eindhoven

LS24
Sustainable
Smart Lighting
Conference

November 12-14, 2024

Prof. Jean-Paul Linnartz I Local Host of LS24 Conference
Prof. Georges Zissis I Chair of the International Program Committee

SSLEindhoven.com

Event photo : Bart van Ove[illegible]rafie BVOF

November 12-14, Eindhoven University of Technology (TU/e) hosts the IEEE Sustainable Smart Lighting Conference LS24. This conference has a long track record and is regarded as a flagship conference in the international lighting community. This 19th edition has a broad scope, ranging from light technology, systems, and controls to the effect of light on living species, to applications, ecosystems, and business models. Light has a profound effect on humans, animals, and plants. This continues to be a highly relevant research area. With ubiquitous connectivity, the collection of vast amounts of data opens new opportunities. In fact, with more than 100 Million light points connected, lighting forms the largest Internet of Things and many luminaires have integrated sensors.

LS24 coincides with Glow Light Festival, that attracts 750,000 visitors that week to Eindhoven.
LS24 coincides with the ILIAD outreach event of the Intelligent Lighting Institute (ILI). In ILI, several departments join forces in multidisciplinary research with a strong focus on human-centric real-life test beds located at the TU/e campus and public spaces in Eindhoven.

Lighting continues to go through transitions. Artificial Intelligence approaches in lighting fundamentally differently than the traditional controlled lab experiments to derive insights on the effects of light and how lights can be controlled to achieve certain objectives. Anyhow, the step from creating insights into implementing algorithms has its challenges, thus these are interesting topics for a multidisciplinary conference.

All in all, a conference that initially was called “Light Sources” (LS), has not only changed its name to Sustainable Smart Lighting, but the topics have broadened in scope. It receives contributions from more disciplines, such as control and signal processing, sensing, IoT networking, Healthy buildings, AI, optics, and physics, but also for instance from percepti-on and human technology interaction. In November, ILI brings the debate to Eindhoven.

We invite you to save the dates: November 12 to 14, 2024, the LS24 conference during the GLOW week.
Follow news on LS24 at SSLEindhoven.com and via linkedin.com/company/sustainable-smart-lighting.

Early bird registration is valid till October 10th. Contact: ili@tue.nl

IEEE · IEEE FUTURE DIRECTIONS · IEEE SMART LIGHTING · IEEE Smart Cities · IAS IEEE INDUSTRY APPLICATIONS SOCIETY Linking Research to Practice · ILI INTELLIGENT LIGHTING INSTITUTE TU/e

Days to Re-entrainment Following the Spring and Autumn Changes in Local Clock Time: Beyond Simple Heuristics

Mark S. Rea[1,2], Rohan Nagare[1], John D. Bullough[1], and Mariana G. Figueiro[1], Light and Health Research Center

Circadian disruption, a breakdown in the regularity of activity patterns across the 24-h day, can lead to a variety of maladies. Some individuals and organizations object to the twice-yearly, seasonal changes in local time because it contributes to circadian disruption. The number of days required to re-entrain the circadian system to the new local time following transitions to or from daylight saving time is not completely understood, but several simple rules of thumb (i.e., heuristics) have been offered to minimize the days to re-entrainment and, thus, circadian disruption (e.g., go for a morning walk). Recently, the authors developed a computational model for predicting circadian phase from calibrated light-dark exposure patterns, based largely on the pioneering work of Kronauer and colleagues. This model was used here to predict the days to re-entrainment of the circadian systems of "larks" and "owls" to a new local time if they were exposed to one of three specific light interventions. Simulations showed that the timing of a light intervention must account for chronotypes (e.g., timing of minimum core body temperature) and direction of shift (i.e., phase advance or delay) to achieve re-entrainment to the time change more quickly. Simple heuristics are not necessarily adequate for minimizing the days to re-entrainment.

[1] Light and Health Research Center, Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, NY, United States

[2] Mark S. Rea, mark.rea@mountsinai.org

Introduction

Models are developed to help us understand natural phenomena. Whether simple heuristics or complex algorithms, the value of any model depends upon its ability to accurately predict natural phenomena, both in terms of direction and magnitude. The present study employs a recently published computational model, the circadian stimulus (CS)-oscillator model (Rea et al., 2022), which is aimed at predicting light-induced phase changes, to accelerate re-entrainment following the shift from standard time to daylight saving time, and vice versa. Some of those predictions are counter to common heuristics (Tumin, 2023; Suni, 2024) for reducing circadian disruption. Since the seminal publication of Circadian Clocks (Aschoff, 1965), much has been learned about the human master clock in our brain and how its timing is affected by light exposure on the retina. Ideally, the master clock will synchronize or entrain to the local, daily cycle of light and dark. Through entrainment, the master clock orchestrates the ideal timing for executing our physiological and behavioral functions over the entire 24-h daily cycle. Indeed, it is the ability of the master clock to anticipate what needs to happen, and when, that makes the circadian system so remarkable. Without a consistent, synchronizing 24-h cycle of light and dark, however, the master clock loses its ability to accurately anticipate and then control the best timing of physiology and behavior. As has been shown in innumerable studies, health and reproductive success (Miller and Takahashi, 2014; Swamy et al., 2018) are compromised by disruption of a regular circadian cycle resulting from disruption of a regular 24-h cycle of light and dark exposure on the retina.

The mountain of accumulated knowledge about the master clock in response to light can ideally be boiled down into simple heuristics for promoting circadian entrainment (e.g., UL Standards & Engagement (2019)) and thus, better health. By consistently exposing our retina to bright days and dark nights, the master clock can consistently influence what biologically needs to happen at what time(s) and thereby can orchestrate the entire circadian system for better chances of survival and reproduction. But we clearly do not always behave in accordance with that simple rubric. Rather, as a highly intelligent and highly social species, we find many ways to break the synchrony between the natural 24-h light-dark exposure pattern and the light-dark exposure profiles that we actually experience, thereby negatively impacting the timing of the master clock. For example, modern humans commonly travel rapidly across time zones, placing the timing of the master clock at odds with the new local times of sunrise and sunset (Meir, 2002). We also work and play into the night, limiting our exposure to bright light while we sleep during the day and extending exposure to dim light well into the night (Qin et al., 2003). Even without rapid, trans-meridian travel or shift work, nearly all of us living within the built environment (Cox-Ganser and Henneberger, 2021) experience insufficient light exposures during the day and prolonged light exposures after sunset (Reiter et al., 2007; Bonmati-Carrion et al., 2014; Smolensky et al., 2015).

Many people around the globe experience the sudden change in local clock time twice a year, forcing us to re-entrain our biological clock to the new local time. Therefore, our complicated modern lifestyles limit the predictive power of any simple heuristic. That being the case, we need to develop more-complex predictive models that consider the complicated sociological and technological environment in which we live. To do so, we need to integrate three conceptual domains into a more complete and thereby more accurate predictive model of circadian entrainment.

Retinal Response to Light

First, we must define light as it affects the master clock. Light is a biophysical construct that reflects the spectral and absolute sensitivities of the human retina to optical radiation. The photopic luminous efficiency function [V(λ)], or the "eye spectral sensitivity curve," was developed by the International Commission on Illumination (CIE) in the 1920s (Commission Internationale de l'Éclairage, 1926) to support international commerce for the emerging electric lighting industry such that a lumen (visually effective radiant flux) was the same in one country as it was in another. V(λ) was created from empirical psychophysical experiments without the benefit of a clear understanding of how the human retina converts optical radiation into neural signals to the brain. Today we know that V(λ) represents the spectral sensitivity of two cone photoreceptors (L-cone and M-cone) in the retina as they feed one multi-neuron channel connecting the retina to the conscious brain. We also now know that the neural channel characterized by the V(λ) spectral sensitivity function does not function at low light levels, like starlight. The luminous efficiency of the so-called scotopic channel [V'(λ)] was established in the by the CIE in the 1950s (Jansen and Halbertsma, 1951) and is characterized by the rod photoreceptor action spectrum. A scotopic function was needed because the spectral and absolute sensitivities of rods are very different than those for the two-cone, photopic channel [V(λ)]. Indeed, we now describe the human eye as having a "duplex retina" (Barlow, 1972), one channel for daytime, photopic light levels, and one channel for nighttime, scotopic light levels. As the neuroscience has progressed since the 1920s and 1950s, we now know that there are five photoreceptors in the retina and, even more importantly, that they all participate in many neural channels that leave the eye to reach different parts of the brain. Light for each of these channels will be different because the photoreceptors and neurons that convert optical radiation into neural signals leaving the eye differ from light that stimulates the photopic or scotopic channels (Rea, 2012).

One of the multi-neuron channels leaving the retina, the retinohypothalamic tract (RHT) of the optic nerve formed by the axons of the intrinsically photosensitive retinal ganglion cells (ipRGCs), reaches the suprachiasmatic nuclei (SCN), the master biological clock in the brain. This light-sensitive channel drives the timing of the biological clock, where, hopefully, it sends neural signals to support a robust synchrony between the exogenous light-dark cycle and the endogenous diurnal-nocturnal cycles of physiology and behavior. Not surprisingly perhaps, the combinations of photoreceptors and neurons that form this neural channel are complex. A quantitative model of both the spectral sensitivity and the operating characteristics of the RHT neural channel has been developed (Rea et al., 2021a) that, importantly, is consistent with human retinal neural anatomy and physiology (Rea et al., 2021b).

Briefly, the spectral sensitivity of the RHT neural channel (**Figure 1**A) is characterized by what is termed circadian-effective light (CL_A). All five photoreceptors in the retina (L-cone, M-cone, S-cone, rod, and ipRGC) contribute to CL_A and their relative participation in spectral sensitivity changes with the amount of optical radiation incident on the retina. The operating characteristics of the RHT channel are modeled in terms of circadian stimulus (CS), which quantifies the magnitude of the neural signal generated by the retina from threshold to saturation (**Figure 1**B), typically following a sigmoid-like function (DeLean et al., 1978; Evans et al., 1993). Dark for this neural channel can be defined as CL_A levels below CS threshold, and bright as CL_A levels above CS saturation. For the RHT neural channel, CL_A from full moonlight is below CS threshold but well above rod threshold, and CL_A from daylight, even on a cloudy day, is above CS saturation but well below cone saturation. CL_A levels within the indoor built environment are almost always between CS threshold and CS saturation as illustrated in **Figure 1**B.

Calibrated Ambulatory Light Data

Second, we need to be able to capture representative profiles of calibrated light and dark exposures to the human retina as they might affect the timing of the master clock. Ambulatory light measurement devices must be used so that the timing, duration, and amount of the circadian-effective light exposures are recorded over the course of the 24-h days. These light measurement devices must be calibrated in terms of the RHT channel spectral and absolute sensitivities, CL_A and CS, respectively. Ideally these devices should measure optical radiation near the person's eyes, but this is often not practical or acceptable to the person, compromising the spatial accuracy of these measurement devices to various degrees (Figueiro et al., 2013). The first such calibrated circadian-effective light measurement device, the Daysimeter, was developed in 2005 (Bierman et al., 2005). The sensor was worn near the eyes and included three optical sensors (RGB). Through post-processing, the spectral sensitivity and the operating characteristics of the RHT neural channel were used to estimate the magnitudes of the circadian-effective light exposures every 3 min throughout the recording period, typically over seven consecutive days.

Several iterations of the Daysimeter have since been developed (Bierman et al., 2005; Miller et al., 2010; Rea et al., 2010; Figueiro et al., 2013). The accuracy of the calibration has improved as a better understanding of the spectral sensitivity (i.e., CL_A 2.0) (Rea et al., 2021a) and operat-

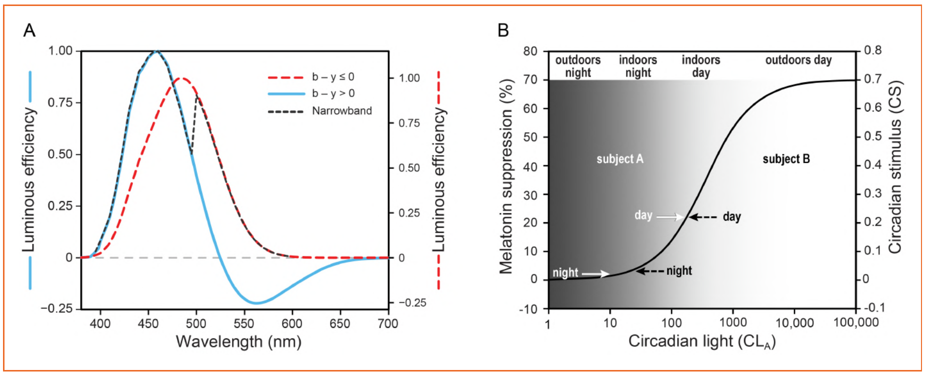


Figure 1: Spectral sensitivity of the RHT channel to monochromatic sources and to polychromatic "warm" (b (blue) – y (yellow) ≤ 0) and "cool" (b – y > 0) lights (**A**). Operating characteristic of the RHT channel from threshold to saturation (**B**); the value gradient illustrates CLA levels that would commonly be found in different locations and times of day. Also shown in panel B are the average CS levels measured during the day and during the night (before bedtime) for the two exemplar subjects in the present study (see "Exemplar subject profile selections").

ing characteristics (i.e., CS) of the channel has increased. However, again underscoring the complexity of human behavior, the spatial accuracy of the Daysimeter has been compromised to some degree because, as noted previously, subjects have been reluctant to wear the device near the eyes as it was originally designed (**Figure** 2A). Subjects were more compliant when the Daysimeter was worn as a pendant (**Figure** 2B) without, unlike wrist-worn devices, compromising accuracy compared to measurements at the eyes (Figueiro et al., 2013). Notwithstanding, continuous calibrated ambulatory light measurements across several days are essential for characterizing the 24-h light-dark exposure pattern that synchronizes, or disrupts, the biological clock with respect to a person's local position on Earth. Without that information, it is impossible to characterize circadian entrainment or how a light intervention might affect entrainment. We have used the Daysimeter in **Figure** 2B successfully in several field studies (Figueiro et al., 2014; Rea et al., 2016).

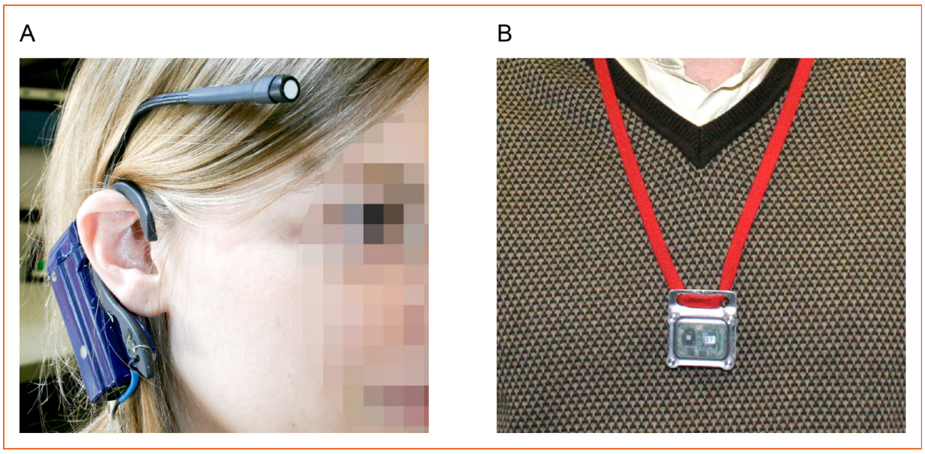


Figure 2: Examples of the Daysimeter worn near the eyes (**A**) and worn as a pendant (**B**). Images with permission of the Lighting Research Center.

Response of the Biological Clock to Retinal Input

Third, once the RHT neural channel signal to the SCN has been quantified, it is then necessary to model how the biological clock processes that signal for downstream communication of circadian phase to the many various systems that govern our physiology and behavior. Kronauer (1990) and colleagues (Kronauer et al., 1999) developed a van der Pol oscillator model of the SCN whereby its phase changed in response to photic input from the retina, measured in terms of photopic (two cone) illuminance. Several investigations have utilized this model, or variations on it, to predict light-induced phase changes quantified in terms of the predicted changes in clock time for the minimum core body temperature (CBT_{min}), a common marker of circadian phase (Refinetti, 2020). Many of these studies have been in a laboratory setting (St Hilaire et al., 2007; Mott et al., 2011) while others have used personal light measurement devices in the field (Woelders et al., 2017; Huang et al., 2021). All of these studies show a predictive accuracy of photopic (two cone) light-induced circadian phase changes no better than approximately 1 h.

The recently developed CS-oscillator model (Rea et al., 2022) retains the basic structure of the Kronauer et al. (1999) model, but the photic input is defined in terms of CS (Rea et al., 2021a; b). Four independent studies measuring circadian phase changes (Sharkey et al., 2011; Appleman et al., 2013; Figueiro et al., 2014; Rea et al., 2016), before and after a light intervention, were used to compare the predictive accuracies of the Kronauer et al. (1999) and CS-oscillator models. In these four studies light measurement devices (Daysimeter) calibrated in terms of photopic illuminance (lux) or CL_A were used to continuously measure personal light exposures over 24 h for one week. The predicted phase changes in dim light melatonin onset, another measure of circadian phase, ranged from mean absolute error (MAE) between 0.91 h and 1.43 h using the Kronauer et al. (1999) model, with an average MAE of 1.07 h (1 h, 4 min). With the CS-oscillator model the range of MAE values was narrowed to between 0.59 h and 0.63 h with an average MAE of 0.61 h (37 min). To reach this level of accuracy from the CS-oscillator model, the initial circadian phase of an individual must be accurately estimated to properly assess the impact of a light intervention on altering circadian phase. It is also worth noting that the entire 24-h exposure pattern is needed for this level of accuracy, undermining the simple heuristic often repeated that only light exposures during the morning and the evening need to be considered to predict phase changes.

Goal of the Present Study

The present study utilizes information in all three aforementioned domains to predict how circadian phase is affected by personal light profiles experienced by two working adults, a typical "morning" (lark) type and a typical "evening" (owl) type (Lack et al., 2009), before and after the twice-yearly seasonal changes in local time at two geographically distant US cities (Boston and Detroit), but within the same (Eastern) time zone. We begin with exemplar, seven-day, 24-h, light-dark (and activity-rest) patterns obtained from calibrated Daysimeters that were worn as pendants (i.e., as in **Figure** 2B) by the two individuals. The Daysimeter records raw photic light levels from three channels, R, G, and B, and movement from three orthogonal accelerometer channels, x, y and z. Through post-processing, calibrated light levels can be quantified in terms of photopic illuminance in lux, or circadian-effective light, at CL_A 1.0 (Rea et al., 2010) or CL_A 2.0 (Rea et al., 2021a; b) levels. The CL_A 2.0 levels represent a refined version of the 1.0 version of the model used to characterize light for the circadian system, based on recent nocturnal melatonin suppression data collected to test predictions from the 1.0 version (Nagare et al., 2019b; Nagare et al., 2019c; d). From the processed CL_A levels, CS levels can then be determined (Rea et al., 2021a; b). From the processed accelerometer data, an activity index (AI) is determined (Miller et al., 2010). AI is the root mean square (RMS) deviation in acceleration in the three (x, y and z) accelerometer channels for each logging interval.

From the CS-calibrated, seven-day light-dark pattern, the CS-oscillator model was engaged to predict CBT_{min} with respect to local time before-and-after the transition times to standard time (ST) during the autumn (November) and to daylight saving time (DST) during the spring (March). From the two, lark and owl, before-and-after determinations of CBT_{min}, the days to re-entrainment (DTR) were then determined. DTR is defined as the number of days it takes for the internal biological clock of an individual to temporally re-align itself to local clock time following the autumn or the spring transition. The exemplary light-dark patterns were then virtually modified in several ways to illustrate how the CS-oscillator model could be used to predict DTR following those virtual light interventions. A goal of the present study was to determine how various, practical light interventions could be used by larks and owls to minimize DTR following the two seasonal changes in local clock time. Recognizing the infinite variations in behavior patterns, light exposure patterns, individual chronotypes, and geographical location, our general goal was to develop a more refined and accurate set of heuristics so that individuals could more rapidly adjust to the transition to and from DST.

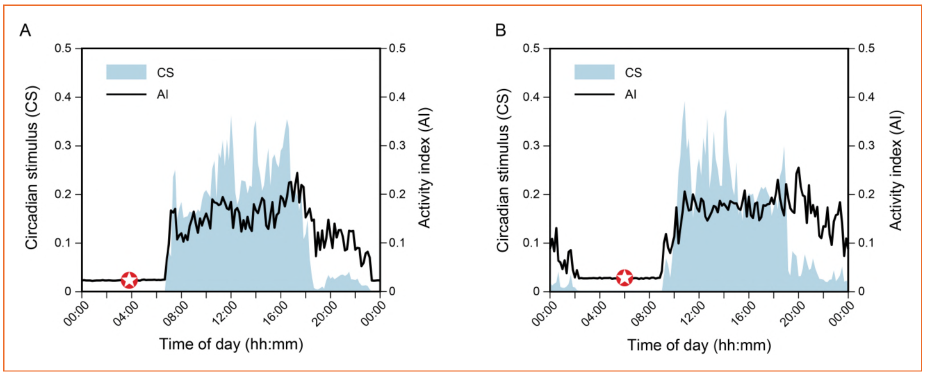


Figure 3: Temporal light-dark exposure (CS, shaded) and activity (AI, solid line) profiles, each averaged over seven days, for subject A, the lark (**A**), and subject B, the owl (**B**). The star represents the time of CBT_{min} based upon the light-dark exposure profile.

Methods

Exemplar Subject Profile Selections

Figures 3A and 3b show 7-day average daily levels of CS and AI (arbitrary units) for two employed subjects (denoted "A" and "B") who participated in one of our Light and Health Institute online educational programs in September 2022. Subjects were permanent daytime workers and wore the Daysimeter as a pendant for a week at their home/work location prior to beginning the program. A variety of tabulated metrics derived from the Daysimeter data are shown in **Table 1**. Of particular note, CBT_{min} (see "Days to Re-entrainment" for determining CBT_{min}), was calculated from the CS-oscillator model (Rea et al., 2022). Based upon that determination, subject A was classified as a "lark" (**Figure 3**A) and subject B was classified as an "owl" (**Figure 3**B) (Gale and Martyn, 1998; Roenneberg et al., 2003). The terms lark and owl are used here to characterize their relative CBT_{min} times, both of which lie near the center of the range for "morning types" and for "evening types," respectively (Lack et al., 2009). In the context of exemplar subject selection for the present study, however, we wanted to not only select subjects who were different in terms of their predicted CBT_{min}, but we also wanted to select ones who were "typical" of individuals working and residing indoors most of the day, given that most Americans spend 90% of their time indoors (U.S. Environmental Protection Agency, 1989). It is noteworthy that their phasor magnitudes, indicating the strength of the synchronization between the 24-h light-dark and 24-h activity-rest rhythms (Rea et al., 2008), were very similar, indicating that both subjects were equally entrained to their personal light-dark exposure patterns and their activity-sleep schedules. Consistent with the similar phasor magnitudes,

Parameter	Subject A	Subject B
Wake time (typical)	07:00	09:00
Bedtime (typical)	23:20	02:15
Hours of inactivity (sleep)	7 h, 40 min	6 h, 45 min
Baseline (initial) CBT_{min}	03:51	06:04
Difference between CBT_{min} and wake time	3 h, 9 min	2 h, 56 min
Phasor magnitude	0.35	0.30
Phasor angle (h)	1.37	2.32
Mean waking activity index (AI)	0.10	0.12
Mean circadian stimulus (CS); wake to bed	0.16	0.15
Mean CS (wake time to 19:00)	0.22	0.22
Mean CS (19:00 to bedtime)	0.02	0.03

Table 1: Metrics derived from Daysimeter data for subjects A and B.

the difference between the CBT_{min} and wake time was about 3 h for both subjects, a value not unlike that found in other studies for entrained individuals (Carrier et al., 1999). Naturally, however, the phasor angles, which indicate the relative offset between the light-dark cycle and the activity-rest cycle (Rea et al., 2008), of the two subjects were quite different, consistent with their CBT_{min} values and their lark and owl categorizations.

Although phasor magnitudes and angles depend upon the synchrony between the 24-h light-dark and activity-rest patterns, irrespective of absolute levels of CS and AI, it is important to note that the average daily CS and AI levels are both quite similar for the two subjects. Further, the CS and AI levels for these two subjects are like those for subjects from other similar studies (e.g., Figueiro et al. (2012)). Moreover, their average CS levels are typical of subjects who spend most of their active hours in indoor spaces (Figueiro et al., 2019; Figueiro et al., 2020). What is more, it is noteworthy that their daytime CS levels, presumably associated with commercial workspaces, are higher than those associated with their evening light levels, presumably associated with residences (Rea et al., 2020).

Again, this difference between daytime and evening CS levels is typical of subjects from other studies. The grey-value gradient in **Figure 1**B illustrates CS levels that would likely be experienced outdoors at night, indoors at night, indoors during the day, and outdoors during the day. The average CS levels during daytime and during evening from **Figure 3**A and **Figure 3**B are, as would be expected, consistent with the nominal categories illustrated in **Figure 1**B.

Days to Re-entrainment (DTR)

As previously noted, the CS-oscillator model permits estimations of CBT_{min} clock time from a subject's daily (24-h) personal light-dark exposure profiles (measured in terms of CS), like those shown in **Figure 3**A and **Figure 3**B. CBT_{min} is both an input to the CS-oscillator model and an output from the model. To begin the process of estimating CBT_{min}, an initial estimated value of CBT_{min} is entered into the model along with the personal light-dark exposure pattern representing several (in this study, seven) 24-h days of time-series light exposure data for an individual. The CS-oscillator model calculates the individual's new CBT_{min} clock time based on the light exposure profile, to a precision of 0.01 h. To identify an individual's baseline CBT_{min} time, assuming a continuous seven-day weekly light exposure profile that repeats indefinitely, the CS-oscillator model is run iteratively using the calculated CBT_{min} time from the previous run as its input, until the resulting CBT_{min} time does not change within 0.01 h.

For the re-entrainment analyses, the initial CBT_{min} value was the asymptotic CBT_{min} for the baseline period, then shifted by 1 h to represent the immediate clock-time shift associated with the transition to or from DST. Several iterations of the model calculations were then conducted with the same seven-day light-dark exposure pattern. After each iteration, a new CBT_{min} value was output from the model, representing the CBT_{min} time resulting from the previous estimated CBT_{min} value and the light-dark exposure pattern. The resulting CBT_{min} is then entered into the model again and, using the same light-dark exposure pattern, the next CBT_{min} is output. Eventually, the estimated CBT_{min} would reach an asymptotic value.

As an example of this process, the solid line in **Figure 4** shows how CBT_{min} would change during a series of model iterations when clock time had been advanced 1 h (Δ=60 min) as would occur in the spring following the transition from ST to DST. To estimate the DTR following a time change in the spring and in the autumn, a criterion shift in CBT_{min} of 50 min (Δ=50 min) was selected for all model iterations in the present study. This criterion was selected for three reasons; first, because as shown in **Figure 4**, a shift approaching 60 min can take as much as three times longer to achieve than a shift of 50 min. Second, the CS-oscillator model's precision level of 0.01 h, while mathematically accurate, is not necessarily accurate in real-world conditions where other factors such as diet (Potter et al., 2016) or exercise (Youngstedt et al., 2019) can effect small changes in circadian phase. Third, as asymptotic model predictions can be unreliable (Sandberg et al., 2021), and a 50-min criterion shift is close to the inflection point of the re-entrainment curve in **Figure 4** where it changes from very steep to nearly flat, using this criterion provides a more reliable estimate of the relative time needed to re-entrain following DST-related transitions. In the example shown in **Figure 4**, the DTR is equal to nine days. The baseline, or initial, CBT_{min} for both subjects,

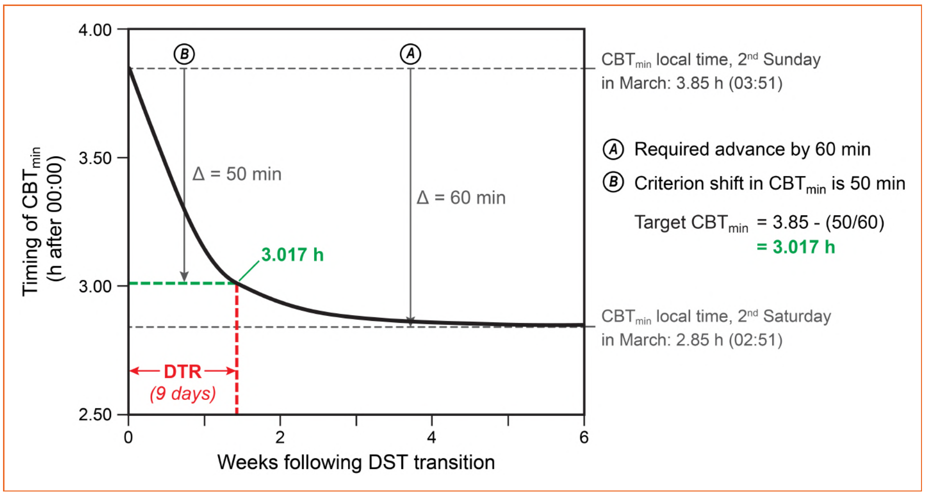


Figure 4: Illustration of the predicted change in CBT_{min} (Rea et al., 2022), represented by the heavy black line, for subject A following the transition to DST.

based strictly upon their personal light-dark exposure pattern, is shown in **Table 1**.

In estimating DTR, we explicitly assumed that the activity-rest pattern would be governed by the local clock time for the two working subjects without regard to a change in local time from ST to DST, and vice versa (e.g., people must get to work at the same clock time before and after a seasonal change in local time). Further, because these two subjects were (presumably) exposed only to indoor lighting the relationship between the activity-rest pattern and the light-dark pattern would always remain the same. Thus, in terms of local clock time, the relationship between their sleep time, including bedtime, mid-sleep, and wake time, and their personal light-dark exposure pattern would remain unchanged.

To determine the effects of the instantaneous change in local clock time from ST to DST and from DST to ST, we reassigned the previous CBT_{min} value (e.g., 04:00) to the new CBT_{min} after the transition, which would be 1 h later (e.g., 05:00) in the spring and 1 h earlier (e.g., 03:00) in the autumn with respect to the local clock time prior to the clock time change. This places the baseline estimated CBT_{min} from the CS-oscillator model at odds with the new, shifted CBT_{min}. Again, keeping the relationship between light-dark pattern and the activity-rest pattern fixed before and after the shift in local clock time, we were then able to determine how many iterative cycles, or days, it would take for CBT_{min} to reach the 50-min criterion shift to the new local clock time. In other words, we were able to determine how long it would take to return to the same temporal difference between CBT_{min} and local clock wake time as before the change in local time; this difference was approximately 3 h for both subjects (**Table 1**).

For our analyses we further assumed that the two subjects either resided/worked in Boston, near the eastern border of the Eastern Time Zone, or in Detroit, at a similar latitude but near the western border of the Eastern Time Zone, where sunrise is 50 min later.

Results

DTR Without Light Intervention

The baseline CBT_{mins} prior to the change in local time and the CBT_{mins} after the change in local time and the resulting predicted DTRs for Boston and for Detroit were determined for both subjects. Since these two subjects only experienced indoor lighting, the 50-min difference in sunrise had, as expected, little or no effect on DTR for both the lark and the owl. Given their personal light-dark exposure patterns were different, however, it would take the owl longer than the lark to re-entrain to the time changes, both in the spring and in the autumn (**Table 2**).

As noted in the "Goal of the Present Study", our primary goal in this study was to explore the impact of different practical light interventions that might be taken by larks and or owls following the change from ST to DST, and vice versa, to determine if and how DTR could be reduced, thereby minimizing the duration of circadian disruption due to the sudden change in local clock time. Three presumably practical calibrated light interventions were selected for modeling with the CS-oscillator model. Each light intervention was added to the light-dark profiles in **Figure 3**A and **Figure 3**B, quantified in terms of the amount (CS) and duration (hours) and by the local time it was applied. It should be emphasized that these interventions are intended to be carried out after the transition to DST or ST and would be expected to cease once re-entrainment was established. An unchanged indoor behavioral profile before and after the transition will ensure continual entrainment of the stabilized circadian phase to the original, unchanged, light exposure profile.

			DTR	
Intervention	Season	Goal	Lark	Owl
None	Autumn	Delay	10	14
	Spring	Advance	10	15

Table 2: Days to re-entrainment (DTR) for the lark and the owl following the transitions between DST and ST, with no change in light-dark exposure profiles relative to clock time.

			DTR	
Intervention	Season	Goal	Lark	Owl
Evening self-luminous display (30 min)	Autumn	Delay	7	14
	Spring	Advance	*	14
Trip to FL	Autumn	Delay	7	21
	Spring	Advance	8	4
Morning walk (45 min)	Autumn	Delay	*	*
	Spring	Advance	6	6

* Re-entrainment not achieved.

Table 3: Days to re-entrainment (DTR) for the lark and the owl for different post-transition interventions.

DTR With Light Intervention

Self-luminous Display

A recent meta-analysis investigating changes in screen time following the COVID-19 pandemic revealed that leisure (non-work/non-academic) screen time has increased by 0.7 h per day in adults (Trott et al., 2022). Several studies have characterized light exposures at the eye from self-luminous displays. For instance, Gringras et al. (2015) reported that smartphones (iPhone 5S, Apple Inc., Cupertino, CA, US) can deliver a light level of 51 lx at the eye when operated from a typical reading distance of about 22.5 cm. For typical self-luminous spectra, this would translate into a CS value of 0.12. With regard to self-luminous displays, Wood et al. (2013) and Nagare et al. (2019a) have reported that iPads (iPad Air 2 and iPad 2, respectively, Apple Inc., Cupertino, CA, US) deliver around 70 lx at the eye for an average viewing distance of 30.5 cm, or a CS of 0.13. For this virtual intervention, it was assumed that both the lark and the owl viewed a self-luminous display (CS = 0.13) for 30 min beginning at 19:00, around dinner time. For the two profiles under investigation in this paper, this clock time corresponds to the end of higher interior light level exposures (e.g., those from the workplace during the day) and the beginning of lower interior light level exposures (e.g., those from typical of a residence indoors) (Rea, 2000).

Trip to Florida

It is not uncommon for people in Boston and in Detroit, having approximately the same north latitude (42°N), to vacation in Miami, which is in the same time zone but much further south (28°N) during the colder months. In March during the change in local clock time, the day lengths in all three cities are approximately 12 h. In November, during this change, the day lengths are slightly shorter (10 h) in the northern cities than in Miami (11 h). One would expect the time spent outdoors in Miami would be longer than it would be in Boston and Detroit because of warmer weather, particularly when a person is on vacation. For this virtual intervention, it was assumed that the lark and the owl residing in Boston and the lark and the owl residing in Detroit both flew to Miami the Saturday evening of the clock change in spring and autumn. They then spent the next week outdoors in bright daylight. For this virtual intervention it was assumed that the lark and the owl kept the same activity-rest cycle they had exhibited in their respective cities. Because the owl would get up well past sunrise, however, the duration of their daylight exposure would naturally be less (9 h) than it would be for the lark (11 h). To simulate the light levels they would experience while outdoors in daylight, the recorded CL_A light exposure profiles (for the daylight hours) in **Figure 3**A and **Figure 3**B were all multiplied by a factor of 10, a representative multiplier for outdoor versus indoor light exposures for many individuals (Rea, 2000).

Morning Walk

Recent statistics suggest that about 49 million people in the U.S. reported engaging in running and jogging activities in 2021 (Statista, 2024). An even greater number of people (115 million) reported engaging in walking for fitness activities during the same year. In fact, the physical activity guidelines from the American Heart Association recommend at least 150 min of moderate intensity aerobic activity per week (> 30 min per weekday) to improve health and well-being (American Heart Association, 2024). It has been well-documented that even on cloudy days, daylight can deliver very high light levels at the eye (CS ≥ 0.5). For this virtual intervention, it was assumed that the lark and the owl went for an outdoor (CS = 0.5) morning walk for 45 min, 30 min after waking.

The results of the three intervention simulations are shown in **Table 3**. In some cases in **Table 3**, an asterisk (*) indicates when the intervention shifted the individual in the wrong direction for the DST-related transition in clock time (e.g., when an intervention caused a phase advance but the DST-related transition called for a phase delay). The DTRs in both Boston and Detroit were the same for these virtual light interventions. (A separate virtual light intervention comparing Boston and Detroit is discussed later to illustrate how a later sunrise in Detroit would affect predicted changes in circadian phase.) Of particular interest, the DTR values in **Table 3** show that the same intervention can produce very different outcomes depending upon the season when the local time change occurred. As a prime example, a 45-min morning walk in the spring accelerates re-entrainment because it provides bright light exposure to advance circadian phase, but that same walk in the autumn prevents re-entrainment because it is counter to one wanting to delay circadian phase.

It is also interesting to consider light at night by the evening self-luminous display exposure. This has no effect on the owl because the timing of the light exposure is well before their CBT_{min} and outside both the delay and advance phase response to light (see **Table 2**). However, the same evening light exposure has a profound effect on the lark because, again, the timing of the light exposure is during the delay phase response to light and closer to their CBT_{min}.

As already noted, these virtual light interventions had little or no differential effect between Boston and Detroit for the morning walk or for the evening self-luminous display. The reason is that these two light interventions simulated here did not differentially influence DTR because they were not differentially exposed to daylight. The self-luminous display exposure in both Boston and Detroit was never accompanied by daylight because it was viewed indoors and the morning walkers in both Detroit and Boston were outside after sunrise. Suppose the morning walks were taken by the lark immediately after waking during the springtime, rather than 30 min after waking (which resulted in a DTR of 6 days according to **Table 3**). In this case, the earlier exposure to daylight during the walk in Boston would have advantaged the lark in Boston (reducing DTR from 6 to 5 days). However, because the sun would not have risen in Detroit at the same clock time, the earlier walk would disadvantage the lark (increasing DTR from 6 to 9 days). For the owl, there is less difference because the sun has already risen by the time the owl wakes up, regardless of location within the time zone.

Discussion

There has been a great deal of discussion among politicians, bureaucrats, and the public about the wisdom of preserving or eliminating DST. Some people voice a preference for ST all year long while others prefer to have DST throughout the year. Others, perhaps the majority, like the fact that there are two yearly changes in local clock time so that, with respect to local clock time, they can commute to work in daylight during the winter and can enjoy daylight on the patio or in the backyard during the summer (Coogan et al., 2022).

Many chronobiologists do not like the seasonal changes in local time because most people live by local clock time, not biological time. This can create a sudden change in the light-dark exposure cycle relative to clock time which governs the activity-rest cycle. Chronobiologists know that this sudden disparity between clock time and biological time creates circadian disruption which has been linked to poor sleep (Harrison, 2013), accidents (Sullivan and Flannagan, 2002; Lahti et al., 2010), and even mortality (Poteser and Moshammer, 2020). As a result, many chronobiologists have argued for discontinuation of the seasonal changes in local time, often favoring ST over DST.

The analyses performed for this study suggest that DTR following a change in local time can be accelerated or prolonged indefinitely depending upon the light-dark exposure cycle. The heuristic that light can both delay and advance circadian phase is certainly not new, but what is new is the potential of the CS-oscillator model to quantitatively guide individuals experiencing a change in local time so that they can minimize DTR and thus minimize the duration of circadian disruption, based on the chronotype and lifestyle. It is important to consider, at a minimum, an individual's chronotype (i.e., owl vs. lark) because the analyses here demonstrate that different chronotypes will respond differently to interventions like those discussed in this paper. Because of this, some advice given to the general population (e.g., "get daylight exposure in the morning" (Suni, 2024)) may not always be applicable or beneficial for re-entrainment after ST/DST transitions.

Directionally, everyone knows that the biological clock must, with respect to the new local clock time, advance in the spring and delay in the autumn. Everyone also knows that re-entrainment of the biological clock to the new clock time is not instantaneous. The exact number of days to re-entrain has not been clear; some have reported the time to re-entrain is seven days (Monk and Folkard, 1976), but others say it can be accomplished in two days (Lahti et al., 2010). The present study suggests that "doing nothing different" after the local clock time change requires 10 to 15 days for re-entrainment. Two things should be made clear about this exercise. First, the modeled quantitative predictions are just that, predictions. They are offered here based upon the latest science, but any and all predictions are and should be subject to empirical hypothesis testing. These predictions are only as good as the accuracy of information within the three domains described in the "Introduction" (the retinal response to light, ambulatory light data and the response of the biological clock). Without that information it would be difficult to predict the magnitude or even the direction that a change in the light-dark cycle might drive the biological clock.

Second, although we selected two real examples of daily light profiles and life-style activity patterns for analysis, the generalizability of the predictions for all people is limited. The two subjects that we selected were ones who had limited exposure to daylight. This seemed reasonable since the large majority of human activity is carried out indoors (Cox-Ganser and Henneberger, 2021). These data were also collected following the worldwide COVID-19 pandemic and may reflect a greater likelihood than before to stay indoors at home (Gold, 2023). We modified these two actual light-dark profiles to determine how additional, virtual, "practical" light interventions might affect predictions of the direction of circadian shift and the time to re-entrainment. We held lifestyle activity patterns constant assuming that people's work and social activities are governed mainly by the local time, not biological time. There are literally an infinite number of daily light profiles and daily lifestyle activity patterns that are possible to model, including special ones like those experienced by farmers (bright light all day), computer analysts (dim light all day), flight attendants (non-24-h light exposures), and firefighters (shift workers). The two profiles we used in this paper could not possibly be indicative of the entire Western population, but they are typical of "morning" (lark) and "evening" (owl) types (Lack et al., 2009). Still, there is a great deal more "custom" work that needs to be undertaken to predict helpful, individualized light interventions, including better understanding the slower circadian adaptation of older adults (Costa, 2003) and those with large circadian rhythm amplitudes (Reinberg et al., 1978). We hope, however, that the CS-oscillator model can be a useful tool for enhancing our understanding of these and related factors.

	A		B		C	
Season (goal)	**Self-luminous display**		**Trip to Florida**		**Morning walk**	
	Lark	Owl	Lark	Owl	Lark	Owl
Autumn (delay)	Good	Neutral	Good	Bad	Very bad	Very bad
Spring (advance)	Very bad	Neutral	Good	Very good	Good	Very good
	(Timing: 30-min viewing, beginning at 19:00)				(Timing: 45-min, beginning 30 min after waking)	

Figure 5: Qualitative impacts of the three interventions (with timing note, where applicable) for larks and owls immediately after the autumn and spring DST/ST transitions: self-luminous display (**A**), trip to Florida (**B**), morning walk (**C**).

Notwithstanding, and assuming that our two cases are not outliers, the guidance in **Figure 5** is offered as "extended heuristics" to suggest light interventions that might help with the spring and autumn changes in local clock time. The green and red hues represent the direction of phase change induced by the light intervention with respect to the goal, either advance or delay. The hue saturation represents the magnitude of the direction induced by the light intervention. As previously mentioned, these three extended heuristic interventions are meant to be temporary, only occurring after the transition to DST or to ST until re-entrainment is achieved. Further, based on the underlying light exposure profiles we evaluated, the predictions described here apply to individuals who are primarily exposed to indoor lighting, a large fraction of the population.

Conclusion

The CS-oscillator model (Rea et al., 2022) used in the present study provides "extended heuristics" that probably can help people cope better with the twice-seasonal changes in local time associated with DST. Whereas these twice-seasonal changes in local time affect nearly everyone, their negative impact on the circadian system is probably small with respect to those induced by irregular light exposures experienced by individuals who engage in shift work or frequent air travel across multiple time zones. The CS-oscillator model is potentially important for developing strategies to minimize circadian disruption in these particularly vulnerable populations, but the model's predictions need to be verified empirically and extended to more extreme chronotypes and to shift workers before formal implementation. ■

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Abbreviations

AI: Activity index
CBT_{min}: Core body temperature minimum
CIE: Commission Internationale de l'Éclairage
CL_A: Circadian light
CS: Circadian stimulus
DST: Daylight saving time
DTR: Days to re-entrainment
ipRGC: Intrinsically photosensitive retinal ganglion cell
MAE: Mean absolute error
RHT: Retinohypothalamic tract
RMS: Root mean square
SCN: Suprachiasmatic nuclei
ST: Standard time

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

MSR: conceptualization, formal analysis, investigation, methodology, project administration, supervision, validation, visualization, writing (original draft, review, and editing). RN: conceptualization, data curation, formal analysis, investigation, methodology, resources, software, validation, visualization, writing (original draft, review, and editing). JDB: Formal analysis, investigation, validation, visualization, writing (original draft, review, and editing). MGF: conceptualization, funding acquisition, methodology, project administration, supervision, validation, writing (review and editing). All authors are accountable for the content of the work.

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Data Availability Statement

The data analyzed for the study will be made available by the corresponding author on reasonable request.

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LED Lighting in Horticultural Applications – A 2024 Update

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LEDs have become the "go to" fixture type for most horticultural lighting applications. Growers are replacing high-pressure sodium (HPS) with LEDs, often delivering a higher intensity than before. In addition, new supplemental lighting installations are usually with LEDs.

There are several reasons for the widespread adoption of LEDs, most notably the technological advances and increased grower appreciation for how lighting can improve crop quality, decrease production time, or both. LEDs are much more complex than conventional fixtures because they vary widely in light output (intensity and spectrum), efficacy (electrical efficiency), beam angle, cost, ease of installation, etc.

Before delving into some performance characteristics of LEDs, we need to ensure that fixtures have been designed to tolerate growing conditions (for example, high humidity) and meet benchmark standards specific to horticulture. To help accomplish this, growers are advised to consider LED products that are on the Horticultural Lighting Qualified Product list by the DesignLight Consortium (DLC). Visit designlights.org for more information.

Three of the major ways to characterize an LED fixture are light output, light spectrum and efficacy. All three are based on photons within the photosynthetically active waveband (PAR; 400–700 nm). There are compelling reasons to also consider far-red light, which extends PAR (ePAR) to 750 nm or 800 nm.

Light output refers to the number of photons (in micromoles, or µmol) emitted by a fixture per second and has a unit of $\mu mol \cdot s^{-1}$. Technically speaking, light output is the photon flux of the PAR (or ePAR) waveband, which can only be measured in a testing laboratory. The light spectrum refers to relative percentages of blue, green, red and far-red light, and although the peak wavelengths are also important, they are usually not reported.

Test setup in the Controlled Environment Lighting Lab in the Department of Horticulture at Michigan State University. Photo credits: Erik Runkle.

Finally, fixture efficacy refers to the photon flux of a fixture divided by the energy consumed to emit that quantity of light. Its unit

MANUFACTURER AND MODEL	PHOTON FLUX (µmol·s⁻¹)		LIGHT PERCENTAGE (400-800 nm)				PAR EFFICACY (J·s–¹)
	PAR (400-700 nm)	FAR RED (700-800 nm)	BLUE (400-500 nm)	GREEN (500-600 nm)	RED (600-700 nm)	FAR RED (700-800 nm)	
Acuity Pro VPS 3 FRS	915	14	16	31	51	2	2.57
Arize Element L1000 H-YHNXB3	1868	5	8	0	92	0	3.11
BIOS Endeavour 1750	1751	24	18	34	47	1	2.62
Fluence VYPR 3p VR-3P-B6F	1695	199	12	22	56	11	2.56
Fluence VYPR 3X VR-3X-BW3	873	18	22	41	36	2	2.39
Gavita CT 1930e LED	1902	26	22	31	46	1	2.4
MechaTronix Coolstack Max 5RBHW	3979	32	7	3	89	1	3.18
P.L. Light HortiLED Top 2.0 RWMB	1085	5	7	9	84	0	3.18
Philips GPL TLL 800 DRW_MB	797	3	14	6	81	0	3.19
Philips GPL TLC 2100 DRWFR_1	1911	189	5	8	78	9	2.96
Sollum Tech. SF-ONE SF-05DA	2175	152	9	12	72	7	2.78
TSRgrow TG-800HVR-WL5-8L	2040	35	20	32	46	2	2.5
Valoya RX600 SolrayX	1721	30	19	37	42	2	2.62
TotalGrow High Int. Top-Light 620	1707	27	19	32	48	2	2.75
Vision Tech Efinity OUMUA-HE600	1625	33	20	38	40	2	2.7

Table 1: The variation in light output and fixture efficacy of 15 LED fixtures on the DLC Horticultural Lighting Qualified Products List. LEDs listed are primarily for supplemental greenhouse lighting and were arbitrarily selected for illustration purposes only. *Data courtesy of Erik Runkle.*

is micromoles per joule, or µmol · J^{-1}. Fixture efficacy is usually reported for the PAR waveband (photosynthetic photon efficacy, or PPE).

"While the performance metrics of LEDs are important, there are other aspects that merit consideration when selecting a lighting fixture."

ERIK RUNKLE, MICHIGAN STATE UNIVERSITY

Table 1 illustrates the variation in light output (photon flux), light spectrum (percentage of photons in each of four wavebands), and efficiency (efficacy) of 15 LED fixtures on the DLC Horticultural Lighting Qualified Products List. In early 2020, there were fewer than 100 qualified LED products for horticulture. In early 2024, there were around 1,500. By design, DLC-qualified products are at least 35% more efficient than HPS. For example, 440-W HPS lamps with a magnetic ballast have an efficacy of 0.94 µmol · J^{-1} and 1040-W double-ended HPS lamps with an electronic ballast have an efficacy of 1.70 µmol · J^{-1} based on data from Utah State University.

The vast majority of horticultural LED products consist of individual blue, white and/or red LEDs. Fixtures with the highest efficacies usually emit mostly red light, since red LEDs are the most efficient. The green light percentage is related to the percentage of white LEDs, and the light emitted will appear whiter as the percentage of green light increases. A low green light percentage (e.g., <15%) translates into light that will appear more pink or purple.

There is a large variation in photon flux among LED products, which means the fixture number, installation height and spacing and light uniformity can vary dramatically.

In addition, some LED fixtures (including three in **Table 1**) emit a meaningful amount of far red light, which can directly and indirectly increase plant growth. However, these photons are not counted in the PAR photon flux measurements or efficacy metrics.

While the performance metrics of LEDs are important, there are other aspects that merit consideration when selecting a lighting fixture. This includes, but is not limited to, product/brand reliability, customer service, installation cost, electric rates, availability of energy rebates, fixture form factor and ease of installation. ■

This article was published under the original title "LED lighting: A 2024 update" in the February 2024 issue of GPN magazine: GPN.

LED professional Symposium 2024 LpS Digital Summit & LpS Awards

Luger Research e.U. / LED Professional

The LpS Digital Summit takes place annually at the beginning of December. In conjunction with this event, the LpS Digital Awards are also presented. In this article, we aim to provide you with more detailed information about the LpS Summit and the Awards, as well as explain how you can actively participate in the event.

The LpS Digital Summit and LpS Digital Awards will take place on December 5, 2024. The event will be held online, and will include a half day of presentations, panel discussions, and the awards ceremony. A detailed schedule will be released closer to the event. Stay tuned for more updates and make sure to mark your calendar.

LpS DIGITAL SUMMIT 2024

Sponsorships

If you are interested in sponsoring the LpS Digital Summit or the LpS Digital Awards and branding them with your organization, please contact us. We will put together a promotion package that will fit all of your requirements.

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Announcing the LpS Digital Summit and LpS Digital Awards – December 5, 2024

The LpS Digital Summit is set to take place on 5th December 2024, marking a significant event in the world of lighting technology. This year, the Summit will once again serve as a platform for industry leaders, innovators, and enthusiasts to converge, share insights, and explore the future of lighting solutions. On the same day, we are proud to host the prestigious LpS Digital Awards, celebrating outstanding achievements and innovations in the field. This dual event offers a unique opportunity for participants to engage with cutting-edge developments and honor the pioneers of our industry.

Siegfried Luger, Event Organizer

"Join us for an inspiring afternoon on the subject of lighting."

SIEGFRIED LUGER, CEO OF LUGER RESEARCH E.U. AND PUBLISHER OF LED PROFESSIONAL

Join Us at the LpS Digital Summit – Register Now

Luger Research e.U., publisher of LED Professional, is the organizer of the annual LpS Digital Summit, which evolved from the annual symposium in Bregenz, Austria. This year's event will take place online on December 5, 2024. Themed "Trends in Lighting - Focus on Relevance", the summit focuses on current trends across various lighting sectors. A panel of renowned experts from organizations, industry, and research will discuss the latest developments. Following the expert discussions, the annual LpS Digital Awards will be presented, recognizing excellence in products, systems, and sustainability. Submissions for the awards are open until the end of November. The registration platform for the event is also open, and participation is free of charge.

Program Outline

- Keynotes
- Panel Discussion with Lighting Experts and Participants about "Trends in Lighting - Focus on Relevance"
- Awards Ceremony

Don't miss the chance to participate in the LpS Digital Summit 2024. Whether you are a seasoned professional or a newcomer to the industry, the Summit offers valuable insights and networking opportunities. Engage with leading experts, discover the latest trends, and contribute to discussions shaping the future of lighting technology. Register now to secure your spot and be a part of this dynamic event.

Register for the Summit

Registration Link

Submit Your Innovation for the LpS Digital Awards

The following awards will be bestowed:

- Achievement Award for exceptional contributions by an individual.
- Scientific Paper Award for the best scientific paper published in 2024 in the LED professional Review.
- Product Awards for outstanding innovations.
- Sustainability Awards for products of special significance in sustainability and eco-design.

This year, for the second time, the AI Prize will be also awarded, evaluated by a trained AI lighting model in the areas of Market & Innovation, Technology, and Sustainability.

LpS DIGITAL AWARDS 2024

The LpS Digital Awards are now open for entries. We are seeking the most innovative and impactful contributions to the lighting industry. If your project, product, or research has the potential to revolutionize the field, we encourage you to submit it for consideration. Award winners will be announced during the LpS Digital Summit. Submit your entry by the end of November and take your place among the industry's elite.

Submit Your Innovation

Submission Link

Contact Us

For more information about the LpS Digital Summit, speaker submissions, participant registration, or award entries, please contact us at

Contact Us

info@lugerresearch.com

We are here to assist you with any questions you may have.

Bringing together the brightest minds and most innovative companies in the lighting industry for the LpS Digital Summit and Awards is our goal and what makes us excited. Whether you are attending as a speaker, participant, or award entrant, your involvement is what makes this event truly special. Join us in December to celebrate innovation, share knowledge, and drive the future of lighting technology. ■

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

Good Light Group, Society for Light Treatment and Biological Rhythms, the Daylight Academy, and Luger Research | 7th Edition

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 post-doctoral 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 upon 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?

Dr. Harmsen talks about a recently completed study where he tested whether natural daylight during office hours is more beneficial for metabolic health outcomes of type 2 diabetes patients, compared to constant articial lighting.

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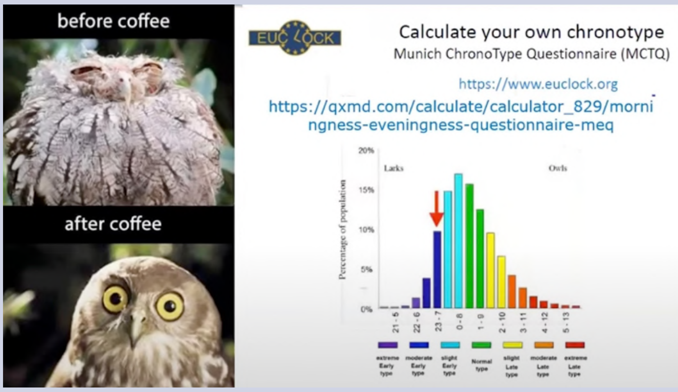

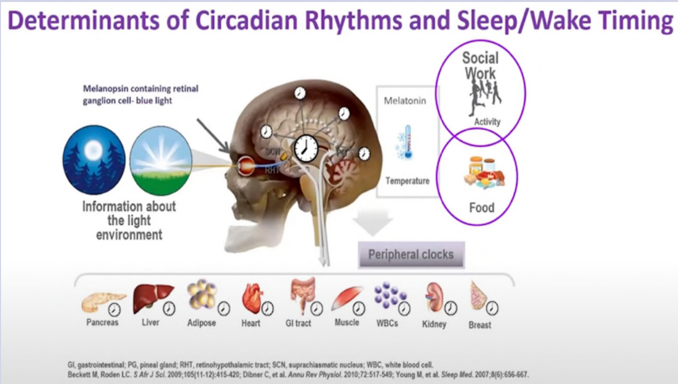

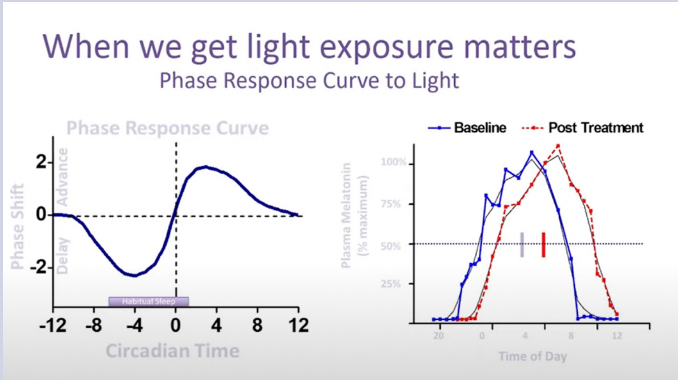

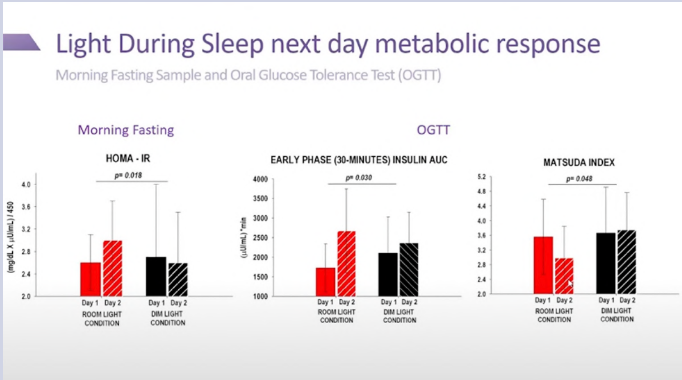

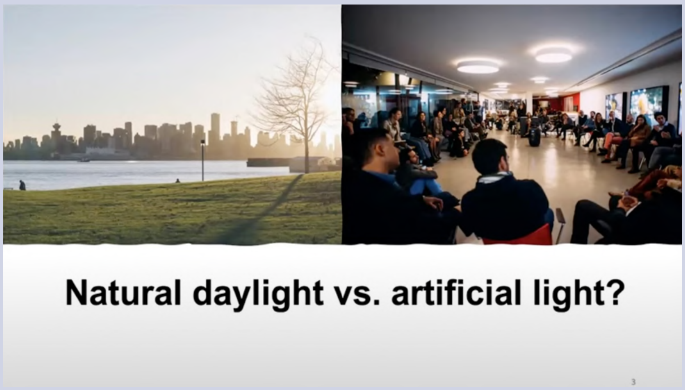

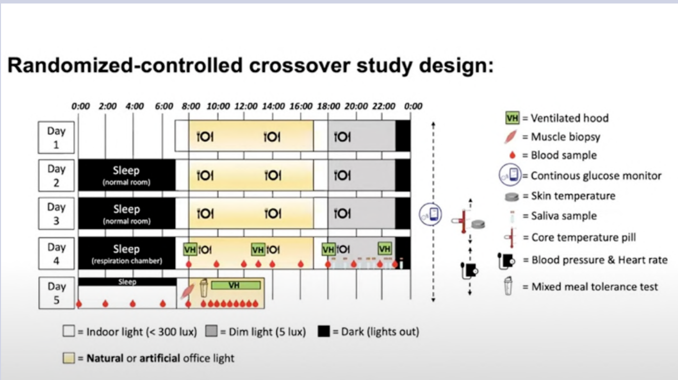

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PREVIEW*
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Lighting the Way Forward

Innovations in DALI, Health, and AI-Driven Control
The upcoming issue of LpR #106 promises to be packed with cutting-edge insights into the future of lighting technology. We feature an exclusive interview with Mark McClear, Casambi's CEO, reflecting on his first 100 days at the helm and discussing the latest innovations, particularly in relation to DALI. In another interview, Arnulf Rupp from the DALI Alliance breaks down the fundamentals of DALI technology while exploring the newest trends and developments, including DALI+. A White Paper from the Good Light Group delves into recent research on the connection between light and health, highlighting the economic benefits of good lighting. We also explore the fascinating possibility of controlling lighting and effects via an app using music metadata, where algorithms can be swapped out with AI models to detect moods in conversations and adjust lighting accordingly. In addition, we cover the critical selection criteria for UVC light, particularly LEDs, and what parameters to consider for various applications. Alongside these, expect global industry news, expert commentary, and a thought-provoking editorial to round out an issue you won't want to miss.

* *Subject to change without notice.*

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