THE MAGAZINE OF THE ILLUMINATING ENGINEERING SOCIETY

LD+A

LIGHTING DESIGN and APPLICATION

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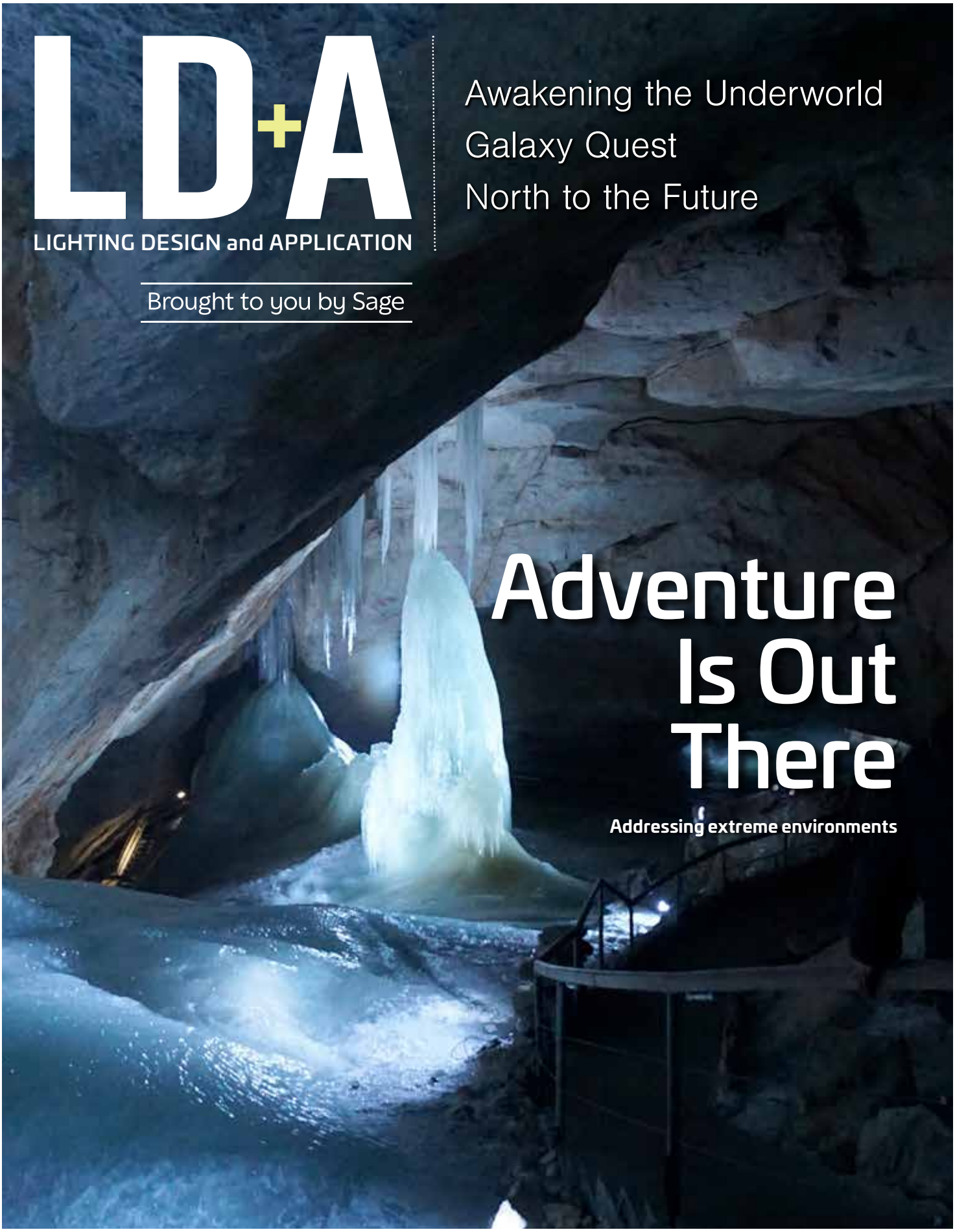
Awakening the Underworld

Galaxy Quest

North to the Future



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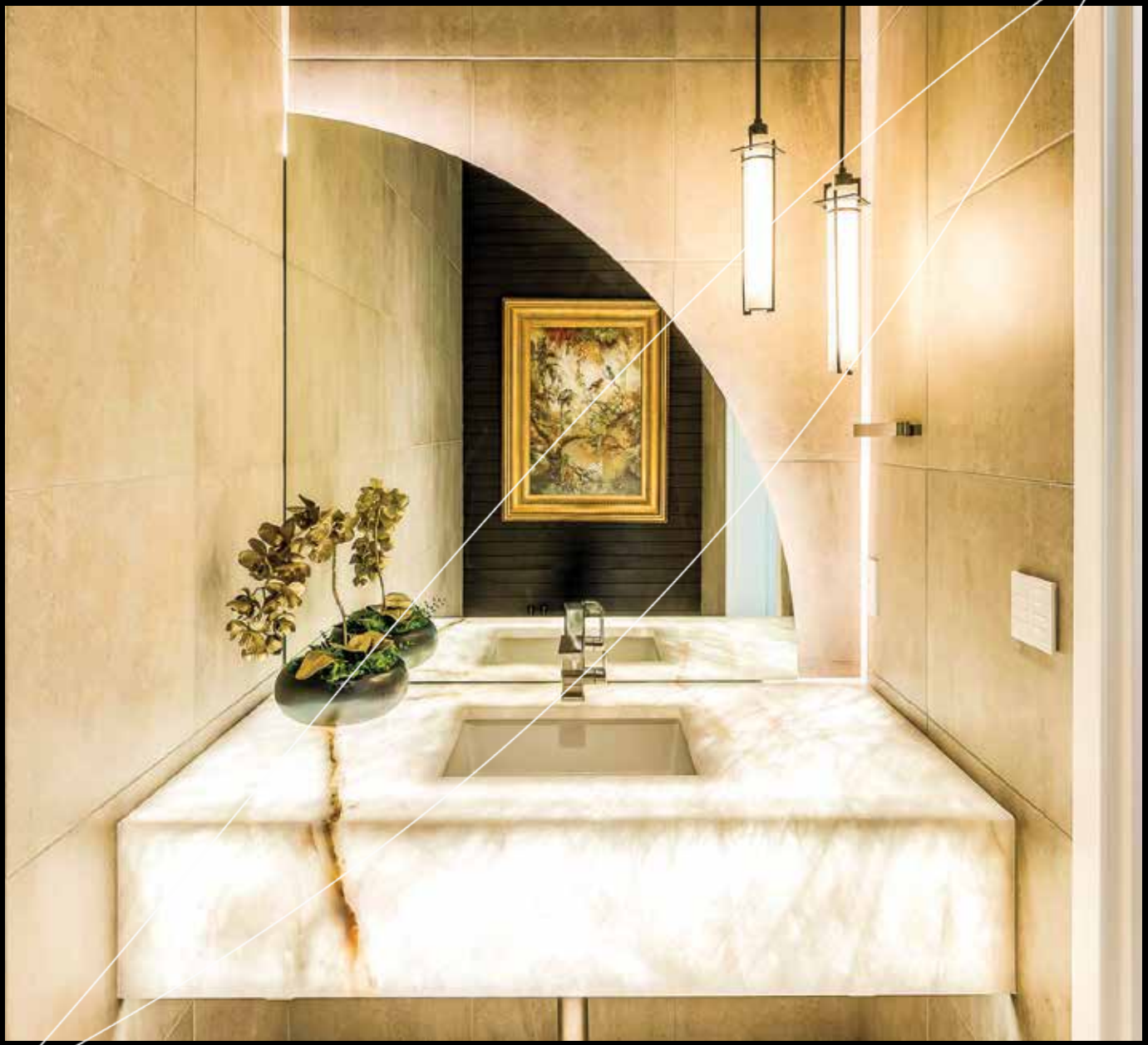

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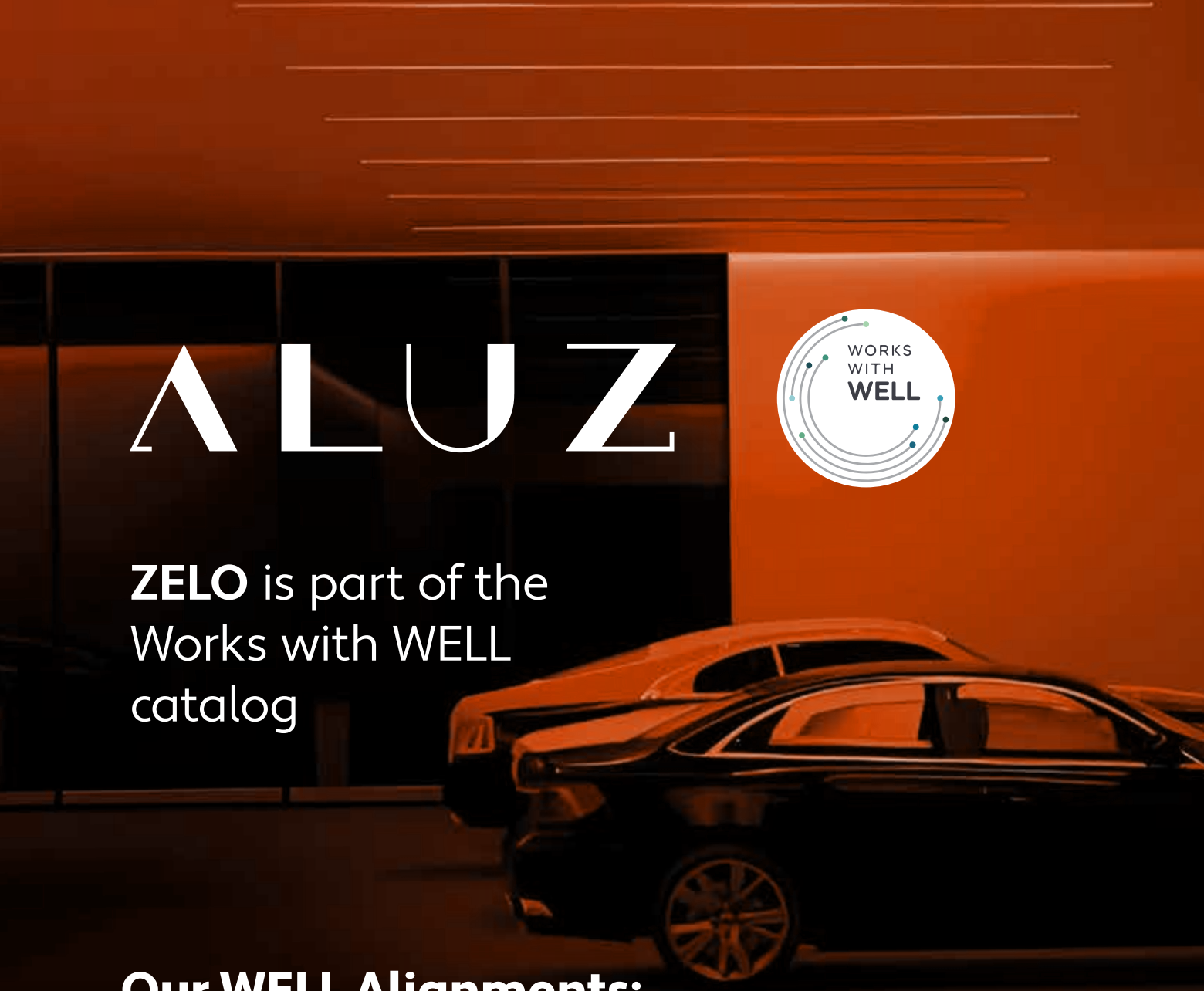

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FIRST UP

PLUS

Photo: Ken Duncan

FEATURES

On The Cover
Illumination showcases the natural wonders within show caves. Photo: Cave Lighting

EDITOR'S NOTE

Going to Extremes

With Billy Joel recently drawing the curtain on his historic 10-year residency at Madison Square Garden, it's the perfect time for *LD+A* to sing a different tune. In this issue, we're stepping well outside the more familiar areas of lighting applications to present a look at addressing the illumination needs of more intense environments. While the Piano Man may not know why he goes to extremes, lighting designers have been focused on scaling heights and exploring the depths to provide illumination to a wealth of extreme destinations across the globe—and beyond.

> "Illumination is crucial in many areas located well beyond our immediate communities

In this issue's first feature article, "Awakening the Underworld," Alexander Chrapko and Vladimir Vashkevich detail the challenges in lighting show caves including the Giant Ice Cave on the Dachstein glacier and Haut-Martelange slate mine in Luxembourg. Diving deeper, "Rolling in the Deep" reveals how remotely operated vehicle illumination is essential to unlocking the secrets of the ocean floor, such as at the Pacific Remote Islands Marine National Monument. For those whose heads are well above the clouds, "Galaxy Quest" provides Toni Clark's perspectives on the lighting required for NASA spacecrafts' next-generation systems.

This Big Blue Marble on which we reside offers a variety of land-based hurdles for modern-day designers. Continuing our exploration of extremes with our feet firmly on the ground, Jeremy Maxie addresses Alaska's freezing temperatures, seismic activity and significant seasonal differences in available daylight, which are just a few unique obstacles faced when designing projects in The Last Frontier. Shifting southwest to Australia, Mark Tailby recounts the construction and illumination of a mountaintop symbol designed to benefit the local Indigenous community.

While you may not be navigating these extreme conditions on your current projects, they are a testament to the technical acumen, dedication and creativity of lighting designers. Illumination is crucial in many areas located well beyond our immediate communities to help provide valuable knowledge about, and experience in, unfamiliar environments. While it's important to chronicle the industry's widespread commercial, infrastructure and hospitality successes, highlighting these extreme applications provides insights into the unique skills needed and uncommon careers available to those interested in shedding light on new worlds. Excelsior!

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LD+A
LIGHTING DESIGN and APPLICATION
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INSIGHTS

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Photo: Comcast Spectator

Brightening-up Broad Street

An exterior retrofit for a 20,000-seat entertainment complex in Pennsylvania

Philadelphia sports fans can rest assured that the likes of Gritty and Franklin the Dog can easily find their way home to the Wells Fargo Center, a venue for the NHL's Flyers and the NBA's 76ers, with its nearly 1,000 ft of new LED lighting. A popular spot for concerts, political conventions and WWE events, the newly upgraded Wells Fargo Center features a dynamic exterior illumination system by designers from The Lighting Practice. Now, three 35-ft high LED panels, designed by ANC, cover an area of 10,500 sq ft to play a one-minute video loop and combine with customizable strut lighting by Acclaim around the corners and roofline of the arena to display the teams' orange and blue colors. The system is equipped to not only withstand the four seasons of Philly's weather but also provide various lighting scenes triggered by real-time actions on the ice and court during games.

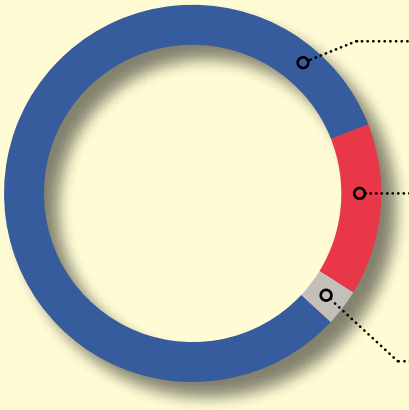
NY Approved for Home Energy Rebates

The U.S. Department of Energy (DOE) approved New York's application for the Inflation Reduction Act's Home Energy Rebates, making the Empire State the first in the nation to receive funding (an initial $158 million) to help families save money on energy-efficient electric appliances. The aim of the program is to make the installation of electrical panels, insulation and heat pumps a more-affordable endeavor for Americans through savings in annual energy costs and the creation an estimated 50,000 jobs in construction, manufacturing and similar sectors.

New York State Governor Kathy Hochul said, "New York is setting the pace in the transition to modern, affordable and efficient homes. With this funding, we continue the transition to an affordable clean energy future that benefits all New Yorkers. We thank President Biden, Secretary Granholm and the New York Congressional Delegation for their support and are proud to partner with the DOE to lead on this historic opportunity."

Eleven other states including Arizona, California, Colorado, Georgia, Hawaii, Indiana, Minnesota, New Hampshire, New Mexico, Oregon and Washington have already applied for funding approval.

After "My Retail Anchor" (*LD+A*, April 2024) received an extra-warm welcome across social media platforms, *LD+A* editors were curious how many people in lighting are also second generation to the industry just like Bill Pierro, Jr., the article's author. Results from our LinkedIn poll show:



84% of respondents are first-generation members of the lighting industry

13% of respondents are second-generation members of the lighting industry

3% of respondents are third-generation members (or more) of the lighting industry.

THEY SAID IT

"One of the major users of light for NASA is camera systems. We have to think a lot about the proper marriage of lighting environments for people and cameras"

Toni Clark, "Galaxy Quest," p.38

MERGERS & MORE:

- **Buro Happold** is set to serve as the lighting and acoustical designer as well as engineer and sustainability consultant for the upcoming Los Angeles International Airport's extension project, Midfield Satellite Concourse South.
- LED lighting manufacturer **Fluence** has partnered with California cannabis cultivator **Clade9**.
- **Leviton's** Oregon facility for engineering and manufacturing energy-efficient commercial lighting controls has achieved carbon neutrality.

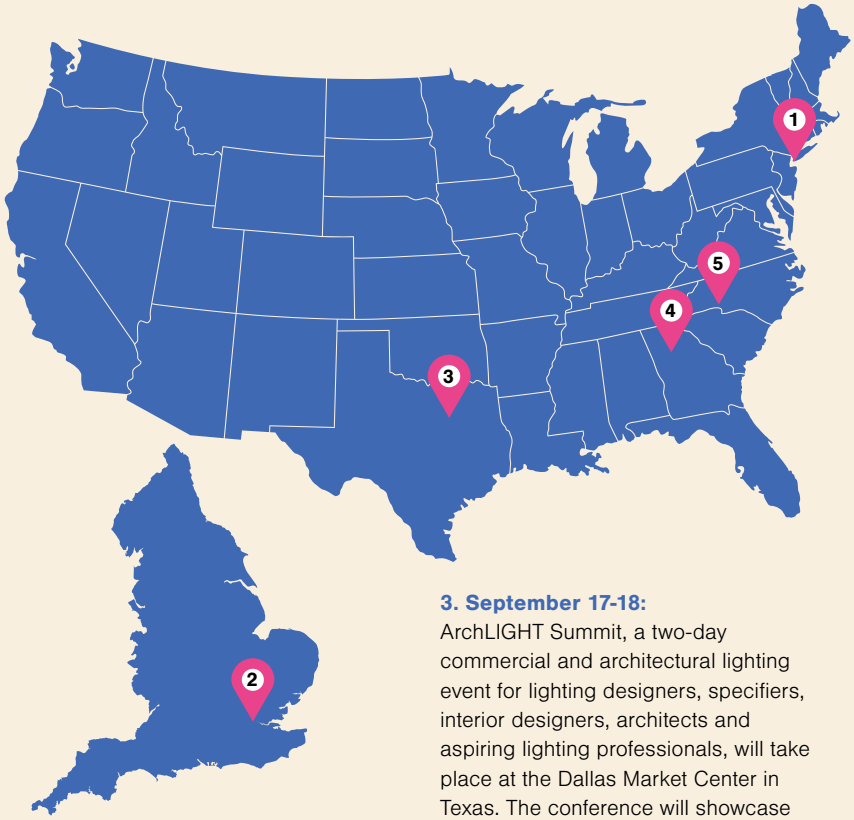
Photo: Solatube International

Sixty Solatube SolaMaster 330 DS-O Tubular Daylighting Devices channel sunlight deep into the new Ganahl Lumber flagship store in California.

Solar Powering Social Housing

Worcestershire, UK-based Solar Select, a PAS-2030-certified family business providing green energy and renewable solutions, has played a critical role in powering social housing projects in England under the Social Housing Decarbonization Fund. The initiative provides funding for social homes in buildings currently below Energy Performance Certificate rating C to be upgraded with the adoption of decarbonized heating systems, resulting in more energy-efficient homes and overall reduced carbon emissions. In addition to new internal, external and loft insulation; air source heat pumps; windows; and doors, solutions from Solar Select, including solar PV, inverters and Mechanical Extract Ventilation, will help with the production of maximum energy and minimum losses in dozens of homes by 2030.

EVENTS



1. August 15-17:
The IES annual conference—IES24: The Lighting Conference—is the preeminent conference for all things lighting, from research to design to technology and more. Attendees experience pre-conference workshops, educational sessions, presentations and numerous networking opportunities. The event will take place at the New York Marriott Marquis Times Square.
www.ies.org

2. September 12
The Industry Committee for Emergency Lighting (ICEL) will host the second ICEL Emergency Lighting Conference at the Cavendish Conference Hall in London. Attendees will have the opportunity to listen to emergency-lighting experts speak on legislative changes and strategies to drive change into the future as well as network with industry professionals, manufacturers and influential stakeholders. Attendance is complimentary, but space is limited.
www.thelia.org.uk

3. September 17-18:
ArchLIGHT Summit, a two-day commercial and architectural lighting event for lighting designers, specifiers, interior designers, architects and aspiring lighting professionals, will take place at the Dallas Market Center in Texas. The conference will showcase products from leading brands and includes accredited educational sessions as well as hands-on experiences.
www.archlightsummit.com

4. September 22-25:
The Street and Area Lighting Conference appeals to a broad spectrum of attendees with a primary focus of improving outdoor lighting. The conference will take place at the Atlanta Marriott Marquis in Georgia and provide outdoor lighting training classes, seminars, networking sessions and an exhibit hall.
www.ies.org

5. October 27-November 1:
The 2024 Aviation Lighting Committee Fall Conference provides opportunities for attendees to network with more than 300 of the aviation lighting industry's best electricians, engineers and manufacturers through panels, presentations and discussions. The event will take place in Charlotte, NC.
www.ies.org

ASK AN EP

CHRISTIANA BEVILACQUA

This student pursuing a Bachelor of Architecture and Master of Sciences in Architectural Science with a concentration in lighting from **Rensselear Polytechnic Institute** possesses a passion for sustainability and technological advancements

Why light?

Architecture relies on light as an indispensable element. The designs expressed through architecture would be nothing without this catalyst that provides life and energy to its surrounding environment. Light serves as a transformative tool to accentuate a building's distinct character, as well as highlight its textures, materials, scale and structures. The transition between daytime and nighttime lighting also provides distinctive strategies and techniques that can enhance the user's approach, experience and appreciation of an intricately manipulated work of architecture. Lighting is so important and crucial to the evolution of the architectural field.

What is your favorite project on which you have worked?

When I worked as a building technology intern at Simpson Gumpertz and Heger, I had the opportunity to participate in the restoration project of the Carpenter Center for the Visual Arts in Cambridge, MA. Le Corbusier's composition includes a centralized ramp through the building, which is used to carry natural light to each interior space. This ramp allows for the atmosphere to seamlessly blend between the interior space and the outside world. This is my favorite project that I have ever worked on, thus far in my career, because of the unique strategy and composition.

What is the best part of your lighting education?

The highlight of my lighting design education occurred on a recent class outing in New York City. On our tread through traffic-filled streets and busy parks, we analyzed what types of lighting applications may be effective given the existing design of each area. Our analysis journey began in the daylight and as the day progressed, we watched as the implementation of the streets' lighting fixtures transformed the outdoor environment. We investigated the modern, energy-efficient technologies of the upgraded LED streetlights around Times Square to the acorn lanterns lining the paths of Central Park. Partaking in this examination of lighting technologies and outdoor fixtures provided me with a perspective on how lighting applications can elicit emotions from viewers. Witnessing these works and applications in person afforded me a deeper understanding of the architectural field.

> "We investigated the modern, energy-efficient LED streetlights around Times Square to the acorn lanterns lining the paths of Central Park

Most important thing for the future of the lighting industry?

I constantly see that light is not merely a technical element but a dynamic tool that can evoke function and emotion. This observation is shaped by my passion for architecture and the study of how it can be enhanced through light. This passion will enable me to make a meaningful contribution to the classroom, the advancement of design and function in architecture and, more broadly, society. I believe that this perspective combined with my passion for sustainability and interest in the technological advancements of lighting tools is very important for future developments in the lighting industry.

The Emerging Professional column explores issues affecting younger lighting professionals and those new to the industry.

Photos: Adam Goldberg Photography

❶ Sixteen cylindrical luminaires, up to 9 ft tall, in vivid hues are hoisted from a ceiling mounting structure. Each luminaire is held with four support cables, some exceeding 60 ft.

❷ Installation was completed at the floor level before it was raised into place; the entire chandelier can be lowered and fixtures can be individually removed for maintenance.

❸ Operating on an astronomic timeclock, after-hours illumination allows the workplace to have a striking nighttime presence.

HOW THEY DID IT

The Chandelier at Windward Parkway

A collaborative effort by **Windward Lighting Studio**, luminaire manufacturer Lumetta, hoist manufacturer Dynapac Rotating Co., contractors CA South and E.C. Electric Inc. and structural engineers from Penta Engineering Group built the multi-story chandelier inside the 100-ft tall atrium of the Windward Parkway office building in Alpharetta, GA.

PROGRESSIONS

Mark Lien

Future Forecast Retrospective: 26 years of reporting on the future of lighting

The cultural revolution of the 1960s challenged public trust in our institutions. We found that four Presidents, beginning with Eisenhower, lied to us. Journalists reported this deceit and helped to reverse a national tendency to over-trust authority. At that time, journalism was among the most respected professions. (Broadcast journalist Walter Cronkite was often cited as "the most trusted man in America.") Since that time, the pendulum has swung to an opposite extreme of distrusting not just authority but expertise. Social media has precipitated this, and the lack of respect for expertise has further divided and damaged our national discourse.

As pendulums swing to two extremes, we are now at an extreme state of distrust. When I write and present, I think of myself as a reporter. Reporters need to understand their topic well enough to clearly communicate it. They seldom are the subject matter experts but have the skill of simplifying difficult concepts. I went to a CIE Conference in 2003 where the speakers were primarily subject matter experts. Most were awful presenters, but the content was exceptional, as they foresaw the LED revolution. They needed a translator, a reporter that understood enough to communicate it to our industry. Industry professionals, now culturally inclined toward distrust, need confidence that those reporting are trustworthy.

For decades, I have written, taught and presented on lighting content in the hopes of making it more understandable for lighting professionals. I have presented on everything from photometry to international trade barriers but my favorite topic to present is the future of the lighting industry. In the past year, several people have requested that I review my past work for accuracy and write about it. There are value judgements filtering the content I present, as I would not want to promote something unfairly harmful to our industry or anyone in it.

When I make predictions or projections, it is based on the content I deliver. I waded through my presentations delivered from 2009 until a decade ago and will share some of the highlights. I started presenting on a national stage in 1998 but copies of my earlier work are trapped forever on some old hard drives or just lost to the ravages of time. Anything more recent than 2014 has not ripened to the point where it bears fruit as an example of whether or not it was worth reporting.

> My overall impression is that, to our detriment, our field progresses slowly

Dubai Presentation 2009

- Reported that (from *World Energy Outlook* 2008) "Current global trends in energy supply and consumption are patently unsustainable—environmentally, economically, socially" and "Preventing catastrophic and irreversible damage to the global climate ultimately requires a major decarbonization of the world energy sources."
  In retrospect: This seems prescient, as our energy metrics are finally shifting to carbon and emphasizing decarbonization. Elon Musk has predicted that "the world will face supply crunches in electricity and transformers next year [2025]." *The Washington Post* last March wrote that "America is running out of power." We are experiencing unprecedented climate-related catastrophes now.

Dubai Presentation 2012

- Reported on an article from *Nature* magazine: "Technology: A jump on wireless power."
  In retrospect: When presenting at Lighting Middle East in Dubai earlier this year, there were two vendors with booths at the trade show that were supplying products that enable wireless power for lighting products.
- Detailed technology allowing users to control lighting and other things with our brain activity through devices and implants.
  In retrospect: Some devices

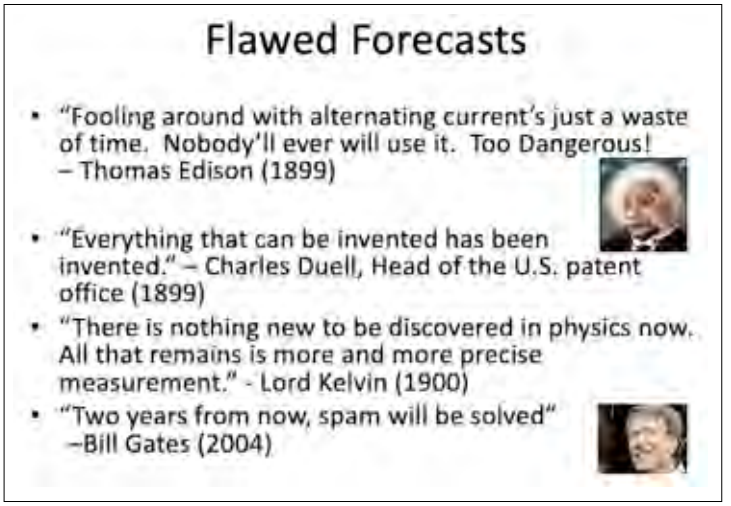
are in their third generation now including headsets that can play *World of Warcraft* and other software just by thinking about it. Neurolink has attained FDA approval and proceeded with the first brain implant to enable paralyzed people to control devices and allowing them to perform tasks previously impossible.

Texas Presentation 2012

- Discussed new eyewear with a yellow tint designed to filter blue light.
  In retrospect: Currently available as an option with most prescription eyewear.

Lighting Solutions Center/ Hubbell Lighting 2012

- Reported on a new system that incorporates LED lighting and radio frequency communications to help consumers find products in large stores. RFID tags on products are marked on a map in an app to lead users toward the items for which they are searching.
  In retrospect: There were test stores with this and a technology that was based upon this research, but it has been slow to catch on. (It may be another example of how some tasks are easier to perform without an app [e.g., flipping a light switch]).
- Reported on flexible OLED prototypes.
  In retrospect: OLEDs are still viable and in use in the automotive industry but never could compete with LEDs for price and performance, making it a niche product.
- Provided details on lighting nanotechnology and the trend of it making lighting smaller.
  In retrospect: For the past five years, the IES Progress Report has, as one of the main reasons for inclusion, accepted the smallest versions of luminaires and, along with sources, they continue to shrink. There are economic and environmental benefits as well as enabling the lighting to provide function with less



One example of a "Flawed Forecasts" slide that I have used in previous presentations.

or no distraction in spaces where lighting is not the focal point.

- Extensively detailed graphene being used as a light source, as a component of light sources and to make flexible transparent electronics.
  In retrospect: Graphene is currently being used in various lighting technologies.

Lightfair 2013

- Reported on Li-Fi as a wireless networking system.
  In retrospect: The U.S. has been slow to utilize this technology, but Europe was in second-generation luminaire families by 2018.
- Discussed that marijuana growers were using 1% of U.S electricity and presented an article from *High Times* magazine on converting to LEDs.
  In retrospect: LEDs are now a primary light source for cannabis growers.
- Reported on the growth of the ultraviolet LED market.
  In retrospect: The growth of the niche UV market accelerated during COVID for disinfection, and UV LEDs are now in viable product offerings.

IES Street & Area Lighting Conference 2013

- Reported on the "circular economy," citing the first report, *Towards the Circular Economy*, that highlighted the rationale for transitioning.
  In retrospect: In October 2021, The UK-based Society for Light & Lighting issued TM-66 – *Creating a Circular Economy in the Lighting Industry.*

Lightfair 2014 /NCQLP Keynote

- Detailed the convergence of other technologies with the lighting community.
  In retrospect: In 2024, almost all lighting innovation is due to fusion with other technologies converging with lighting such as sensors, solar and artificial intelligence, among others.
- Reported on "Photon-hoggish humanity set for orgy of illumination," with the article stating that with cheaper light sources, humans use more light.
  In retrospect: Jeff Tsao from Sandia National Laboratories stated, "Over the past three centuries...the world has spent about .72% of the worlds per capita gross domestic product on artificial lighting," concluding that "... there may be little reason to expect a different future response from our species."

My overall impression is that, to our detriment, our field progresses slowly. Other industries have capitalized on this to lead in areas when we moved sluggishly. Sustainability and smart lighting protocols are two areas where lighting could have led. We did successfully lead by reducing our energy use, but that was driven by short-term ROI after the U.S. Department of Energy and IES promoted and standardized LEDs.

The previous bullet points are based on presentations of which I have copies. Because most of this is reporting on the evolution of our industry, there are no degrees of correctness as long it is reported responsibly. Some things I spoke about still have not materialized as viable in the marketplace, such as bioluminescence and nanoscale sources. Other innovations failed due being replaced by LEDs (e.g., pulse start metal halide). Some arrived too late to be refined enough to be competitive, such as electrodeless and microwave lamps.

It is in the context of the beginning of this article that I hope you trust that I have delivered a glimpse into the future of our lighting industry. Some reporting cited things that would occur without noting when. It is much easier to predict what is going to happen than when it may happen. Some things emerged quicker than others, a statement to their perceived value. If there is interest, I may do another retrospective on my articles over time and detail how their then-futuristic content fared.

Mark Lien, LC, LEED AP, is industry relations consultant for the IES.

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Michael Poplawski

Dialogue Between Lighting and HVAC Systems: Improving building system integration

Lighting systems have long been capable of sensing when someone enters or exits a room and using that knowledge to turn lights On or Off. More recently, connected lighting systems with sensors integrated into every luminaire have become broadly available, facilitating highly granular occupancy detection.

Similarly, HVAC systems have long been able to use an understanding of building occupancy to adjust temperature setpoints and reduce energy use without significant impacts to occupant comfort. Energy codes (e.g., ANSI/ASHRAE/IES Standard 9.1-2022 *Energy Standard for Buildings Except Low-Rise Residential Buildings*, IECC [International Energy Conservation Code] and Title 24) now require "occupied standby HVAC control," whereby systems adjust both temperature and ventilation setpoints in zones that are determined to be unoccupied during normal occupancy hours.

Here we have two building systems, each employing sensors to detect people—or the absence of people—to aid in energy reduction. Naturally, these systems should be capable of engaging in dialogue, right? Although today's lighting and HVAC systems are capable of such dialogue via BACnet communication networks or application programming interfaces, their interoperability—i.e., the sharing of actionable information—is limited by a number of practical issues.

Resolving these issues is an important focus for energy efficiency organizations, standards bodies and the U.S. Department of Energy (DOE), where we are working with stakeholders to light the path toward broader building-system interoperability, deeper energy savings and reduced emissions from buildings. These efforts are motivated by the opportunity to reduce up-front material and labor costs and the many advantages lighting systems offer as sensing platforms.

Lighting control zones are typically smaller than HVAC zones, making their zone-level sensors more than capable of detecting occupancy in typical HVAC zones. Lighting systems with sensors integrated into every luminaire can serve even the smallest HVAC zone sizes. In principle, such systems can even be configured to support reduced HVAC zone sizes that might result from retrofits targeting the greater energy savings that temperature setpoint-widening control schemes can deliver with smaller zones.

"The single biggest problem in communication is the illusion that it has taken place." George Bernard Shaw was talking about human communication when he made this oft-repeated observation, but it applies to the issues that often stymie lighting/HVAC integration in real-world projects. Although some of the first versions of connected lighting systems with BACnet interfaces had issues that resulted from not implementing the latest version of the BACnet standard, many of today's incarnations can reliably make lighting sensor or zone occupancy data available via a BACnet interface. However, the availability of this data is a necessary, but not sufficient, criteria for effective integration with the HVAC system. While the exposed occupancy data is associated with a lighting zone or luminaire, the HVAC contractor or system integrator needs to know which sensors are measuring occupancy in an HVAC zone. In an ideal world, the location of a lighting sensor relative to HVAC zones would be well-documented in the final project construction drawings and verified by a single engineer-of-record. However, this is often not the case. Separate engineering firms may have designed the lighting and HVAC systems, and their final designs may have been correlated with different versions of the architectural design. Furthermore, once the project goes into construction, and the engineer drawings are transferred to separate electrical and mechanical contractors,

> "For the third and final phase of the L-Prize competition, DOE is asking entrants specifically to address lighting/HVAC system interoperability

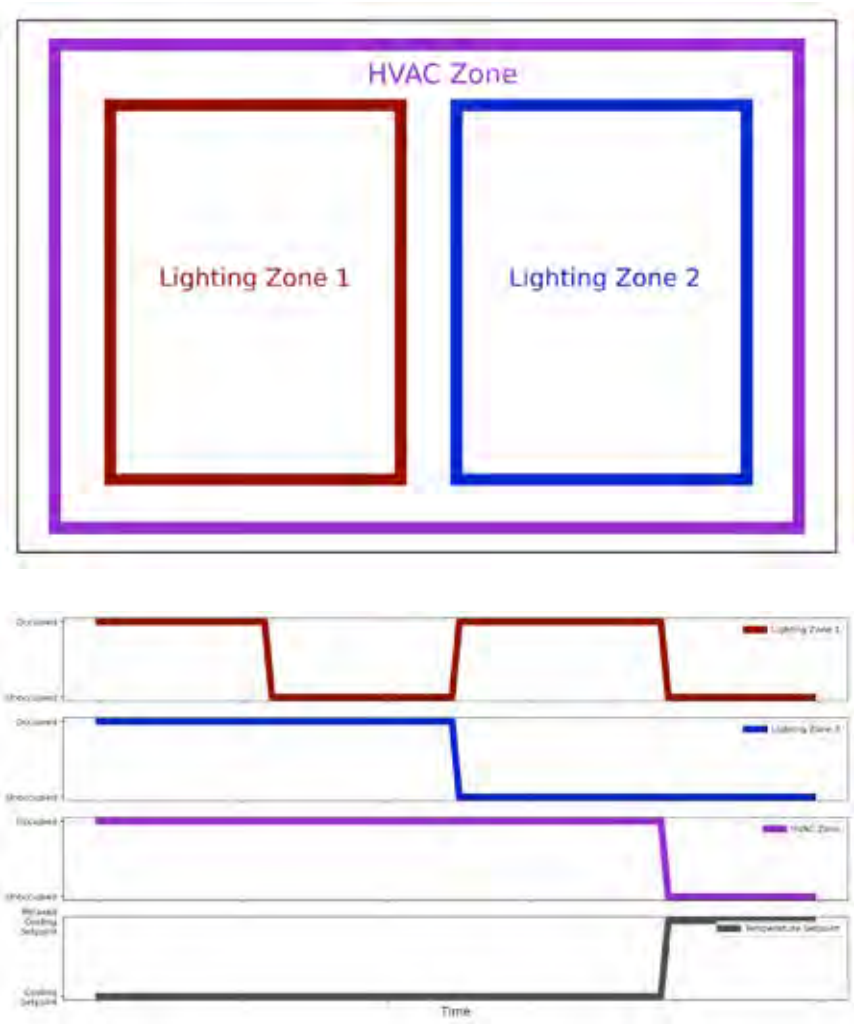
one or both of the designs may have been altered to resolve issues and/or installation conflicts or as the result of value engineering.

In cases where the HVAC contractor or system integrator is able to accurately identify the occupancy data points in the lighting system that correspond to a given HVAC zone, they may find that in many (if not most) cases, there are multiple corresponding points. This scenario begs answers to many questions. Should all the available data be used to determine HVAC zone occupancy, only some of the data or just one of the data points? If only one data point, which one? If more than one, which ones, and how should the many data points be algorithmically processed to determine a single HVAC zone occupancy value?

Ideally, these details were decided and documented in design, but in practice, this is not often the case, and decisions are made during integration without an understanding of how they impact the HVAC control strategy and the associated energy savings expectations. In addition, strategies to use all available data may be compromised by cost considerations, as the current labor-intensive practice of "mapping" data points from a BACnet object (e.g., the lighting system) into the BACnet network is typically priced on a per data point basis, making the integration of all available data cost-intensive.

Multiple DOE efforts are targeting these barriers to success. Chief among them is support for the development and adoption of emerging semantic interoperability standards (e.g., ASHRAE Standard 223). These standards enable the creation of semantic models of building systems that allow the systematic digital documentation of, for example, the zone that is being observed by a specific occupancy sensor, the relationship between that zone and building rooms as well as the BACnet object identifier that is associated with the data that the sensor is sending to the BACnet network.

The creation and integration of standardized semantic models of lighting and HVAC systems enable the creation of software tools that transform the human-centric lighting sensor-to-HVAC zone mapping



Representative example of the use of occupancy data from multiple lighting zones to determine HVAC-zone occupancy and trigger a temperature setpoint-widening control scheme.

process into one that is semi or fully automated. Another effort involves developing a digital design workflow that simulates occupancy and reveals the impact of, for example, using data from one, all or a subset of the available lighting sensors in a given HVAC zone to determine HVAC-zone occupancy.

A third DOE effort is driving lighting innovators to develop new functionality in pursuit of the latest L-Prize. For the third and final phase of the competition, the Manufacturing and Installation Phase, DOE is asking entrants specifically to address lighting/HVAC system interoperability. In particular, the competition will award 10 bonus points to entries that can share lighting energy use and zone occupancy data over a BACnet interface; five bonus points for systems that can calculate and share customized HVAC zone occupancy data from available lighting zone occupancy data; and 15 bonus points for entries that successfully demonstrate this capability in a real-world installation. Finally, DOE's Integrated Lighting Campaign has added a recognition category for lighting and HVAC integration in 2024 to give a shout-out to innovators that are making interoperability breakthroughs.

The adoption of semantic interoperability standards will require the development and deployment of new digital tools and workflows. Changing existing practice is always hard, and new approaches need to deliver value to soften the initial resistance to change. If the adoption of semantic interoperability standards and related new tools and workflows can reduce the barriers to effective integration of lighting and HVAC systems to deliver code-required energy savings, then perhaps that success can ease the path for other use cases, including the automated configuration of advanced control schemes, automated commissioning and automated fault detection and diagnostics. The creation of standardized semantic models of lighting and other building systems provides a lifetime benefit to new and existing systems, enabling a paradigm we see in other technology ecosystems where improved performance and new features are only a software install away, as opposed to requiring the time and cost of deploying new hardware. This paradigm shift can greatly accelerate the ability of buildings to realize their energy efficiency potential and thereby support the nation's decarbonization goals.

Michael Poplawski, Member IES, IEEE and ASHRAE, is a chief engineer and team lead at the Pacific Northwest National Laboratory. His research efforts develop digital tools, workflows and semantic models that facilitate building system integration and the use of software applications that support system configuration, operational energy management and maintenance, electric grid interaction and other data-driven use cases.

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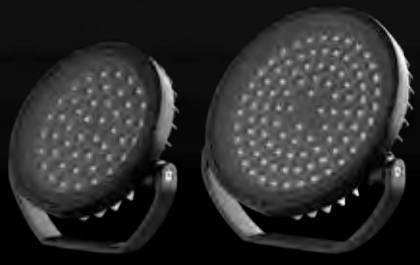

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SIGHTLINES

Sarah Richter and Sara Schonour

It's Alive! WILD's Mentorship Program comes to life

Last June, Women in Lighting + Design's (WILD's) vision of a more balanced, equitable and diverse industry came one step closer to reality. Unlike a traditional, paired mentor-mentee arrangement, WILD's Mentorship Pilot connected women at all stages in their lighting careers to learn from each other. Five structured cohorts set goals, encouraged growth and skills-building and established lasting connections.

"Cross-pollinated mentoring has been desperately needed in the lighting industry," explained Addie Smith, principal, Studio Adelia. "I'm delighted WILD has stepped up to create a platform for such an ambitious program. My favorite part about participating was getting the opportunity to learn from the differing perspectives across generations, regions and roles in the industry. My hope is that this program helps retain women in lighting by offering support, understanding, community and perspective as we navigate competing challenges and priorities in work and life."

The Mentorship Program is the newest of WILD's four national programs, joining the Diversity, Equity, Inclusion and Respect Committee; Lamplighter Coalition; and Parent Resource Group. These four initiatives span the organization's 22 chapters and focus on key industry issues. Mentorship enriches participants' professional experience, with the goals of encouraging industry retention of valuable talent and diversifying the highest levels of leadership in lighting companies.

Having a mentor is widely known to be a cross-cutting, differentiating factor in job satisfaction, career and salary advancement, confidence and empowerment. Yet, surprisingly, only 37% of female professionals have one. The WILD Mentorship Program hopes to exceed that statistic for women and their allies in the lighting industry.

As Mentorship Committee co-chairs, we are excited to announce the 2024 fall debut of the "official" WILD Mentorship Program. "Mentorship and membership are the two main focuses of my presidency," said WILD President Alessa Aguayo. "To me, WILD and mentorship go hand-in-hand—professional and personal development as well as providing a sense of community."

> "Cross-pollinating designers, sales agents, manufacturers, educators and others naturally advances a deeper level of understanding of how the lighting industry works

The program's full rollout is designed to attract a diverse, evolving community of participants with varied lighting backgrounds. The cohorts are structured to foster safe, inclusive and non-competitive environments where women learn, share and grow. With some coaching and guidance from Mentorship Committee members, participants empower and celebrate each other. This culture of mutual support and accountability provides an inclusive and open environment to engage in dialogue and inspire action.

Back in November 2023, a call for volunteers for the pilot program went out via the WILD newsletter, and more than 75 participants quickly applied. The WILD Mentorship Committee then grouped cohorts in a variety of styles: women of various ages, backgrounds, locations across the U.S., experience levels and areas of professional development interests. Each cohort was equipped with a Mentoring Committee liaison and a resource tool kit to help provide structure for the three-month test program with the flexibility to explore what worked. Groups were largely self-managed, with members working together to determine topics of focused conversation, discuss

ideas and challenges and brainstorm possible solutions and courses of action.

Prior to the pilot, the Mentorship Committee used a goal-oriented strategy to evaluate various mentorship styles. WILD chose a multidisciplinary, multi-geographical, peer-to-peer approach to share experience across generations and benefit as many members as possible.

Those new to the industry or to a particular professional role benefit from the perspectives of seasoned veterans. Likewise, more senior participants gain managerial and technological insights from a different generation of colleagues. Cross-pollinating designers, sales agents, manufacturers, educators and others naturally advances a deeper level of understanding of how the lighting industry works. Lighting professionals often work in multiple roles and market sectors across their careers, and sharing those experiences grows an understanding of how each of the players can operate best in the overall industry. In the future, the Program Committee hopes to expand the types of mentoring offered to include more traditional one-to-one pairings and potentially roundtables on timely industry issues.

When the pilot concluded, the cohorts were generous with their feedback. The committee reviewed pros and cons on the structure, format, duration and other key aspects of the program. Overall, the feedback was positive, with many participants noting the benefits of the peer-to-peer/cohort mentoring style.

"I joined the Mentorship Program because I am in a transition period in my career," explained Xiaoying (Sarah) Wang, associate principal, Oculus Light Studio. "I am taking on more management and marketing responsibilities, facing new challenges and eagerly seeking advice. Everyone in the group generously shared resources and knowledge to help each other achieve our goals. They connected me with other female leaders across the industry. These extended contacts also provided valuable insights that will definitely help me going forward. The small group size made our conversations meaningful and intimate, allowing us to freely share opinions, questions and concerns. I am truly grateful."

Diversity in professional roles and level of experience in the field permitted multiple perspectives and experiences, with the goal that participants will go forward making more-rounded, better-informed decisions.

"It was really awesome to combine people from different parts of the industry and bring unique skill sets together in our discussions," said Stacey Kennedy, senior director, Focal Point. "Our cohort had a great variety of job types, levels of experience and geographic locations. The diverse perspectives were invaluable in looking at the challenges we face—in our day jobs or as women. We found that many of us were dealing with the same kinds of issues in different forms. We got so much out of the program that our group has decided to continue meeting every other week, even though the pilot is officially over."

With the feedback collection complete, the timeline for the full six-month program's next steps include:

- August 2024: Application cycle opens
- September 2024: Applicants are matched into peer-to-peer cohorts
- October 2024: Cohort kickoff
- March 2025: Program completion
- April 2025: Collect feedback from participants.

Applications are open now at *https://womeninlightinganddesign.org/mentorship/.* The only requirement for participation is WILD membership.

Additionally, The WILD Mentorship Committee is always looking for dedicated teammates to join its ranks. Please send a note to wildmentorshipprogram@gmail.com to sign up or learn more about the program.

Sarah Richter, Member IES, Associate IALD and Associate AIA, is principal of Sarah Richter Design and WILD Mentorship Program co-chair.

Sara Schonour, LC, Member IES, IALD, is the owner of Luxsi, a lighting/strategy/ideas-consulting practice, and WILD Mentorship Program co-chair.

DIVERSITY

Cheryl English

The Ubiquity of Diversity, Equity, Inclusion and Respect

Perspectives about diversity have certainly evolved over the decades. When people ask me about my thoughts on diversity, I often need to pause and reflect on various stages of history. The interesting thing is that definitions of diversity have morphed over time based on society's mores.

My background has influenced my perspectives about diversity. I grew up in the Rocky Mountains at a time when there was not a lot of exposure to ethnic or religious diversity. I was in the field of engineering in the late 1970s when the gender ratio was less than 5% women. Fortunately, I was a member of a sorority, which contributed to significant life lessons about diversity. It expanded my perspective to include individuals with a wide range of demographics and values, and I am proud to say that my sorority sisters remain an important part of my life today and continue to challenge my thinking.

Following college, I entered the construction industry, where the gender ratio for technical professionals was not much different. I was the only woman in various business and trade association meetings for many years. I honestly did not focus on the fact that I was in a minority; I sought out individuals I respected and learned professional protocol from them.

During the 1990s and 2000s, I found myself in many awkward circumstances that seem unimaginable in today's business environment. From being the focus of off-color comments at meetings and challenged on construction sites based on gender, to announcements at industry conferences asking the women to leave so "the gentlemen" could proceed with the business activities, I made a commitment to reshape the perspective and credibility of women in the construction industry and the IES. It took 79 years, but Rita Harrold broke the glass ceiling, becoming the first female president of the IES in 1985. Since then, there have been six women to serve as the Society's president.

I am proud to say that with support from my colleagues and family, I have achieved many important recognitions while working to break gender bias.

> It took 79 years, but Rita Harrold broke the glass ceiling, becoming the first female president of the IES in 1985

I became the first female vice president of Lithonia Lighting in 2000, followed by other important honors in the IES and industry trade associations.

So how do we promote change? I classify actions to raise awareness for the importance of diversity into three categories.

1. **Silence.** This is the easiest course of action—just focus on being your best self, hoping that is enough to be recognized and promote change. Unfortunately, this action allows narrow mindsets to continue unchallenged and impedes progress for change. It also takes away from being your authentic self, causing more frustration, doubt and stress. My call to action is do not be silent—it stalls change and breaks down your self-worth.
2. **Be vocal.** Unfortunately, if not managed with diplomacy, this action can often be perceived as anger and cause the offenders to become more defensive and closed-minded. Sometimes this may be an appropriate action based on specific situations, but keep in mind that unintended consequences can create a perspective that vocal minorities are "troublemakers" or "not team players." I generally suggest using this technique with

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caution. But when managed appropriately, this technique can help expedite change. In the words of the late politician John Lewis, "Get in good trouble, necessary trouble."

3. **Be a diplomate for change.** I encourage this approach in most situations; it requires you to be inquisitive, respectful and professional. When confronted with an offensive situation, I step back and question what would cause this to happen. Every individual has a unique history and experiences. When I ask questions, I gain a better understanding about diversity. Until we understand the cause of individual actions, we cannot promote change.

What did diversity mean to me 10 years ago? Much progress had been made for certain demographics, such as women. But understand that progress is a journey, not a point in time. A decade ago, diversity was recognized but perhaps not fully embraced. It was often feared based on the need to change the status quo. At that time, the focus on diversity related to ethnicity, religious beliefs or sexual orientation was very lacking.

What does diversity mean to me today? I am proud of the efforts by the IES to bring more attention to a broader focus of minority groups. The IES Diversity, Equity, Inclusion and Respect Committee has made outstanding progress in education and awareness—not just focused on individuals but the need to address disadvantaged communities and the built environment. More businesses are committed to diversity priorities as it relates to their employees and customers, but they are also supporting social good within their communities. In the words of the late businessman and proponent of sustainability Ray Anderson "...there is no more strategic issue for a company, or any organization, than its ultimate purpose. For those who think business exists to make a profit, I suggest they think again. Business makes a profit to exist. Surely it must exist for some higher, nobler purpose than that." And as the spouse of a Vietnam veteran, it means so much to me to witness a shift in respect for our military personnel and veterans, promoting more support for them and their families.

What is my perspective on diversity 10 years from now? While much has been accomplished, we are honestly still in an infancy stage for change. It is my hope that each of our IES Members focus on respect and understanding as a foundation to expand the impact of change. I look forward to a day when we do not have to focus on diversity because respect and understanding are universal, without question. I know this sounds cliché, but when we allow noble priorities to drive our decisions and actions, singling out special interests is irrelevant.

I challenge you to be a diplomat for continuous change. Go forward with curiosity and put yourself in new situations to expand your understandings. Approach all situations, personal and professional, with diplomacy and respect.

Cheryl English, Fellow IES, is a retired lighting manufacturing executive with experience in public policy, marketing, engineering and testing labs. She is a past president of IES and a Louis B. Marks awardee.

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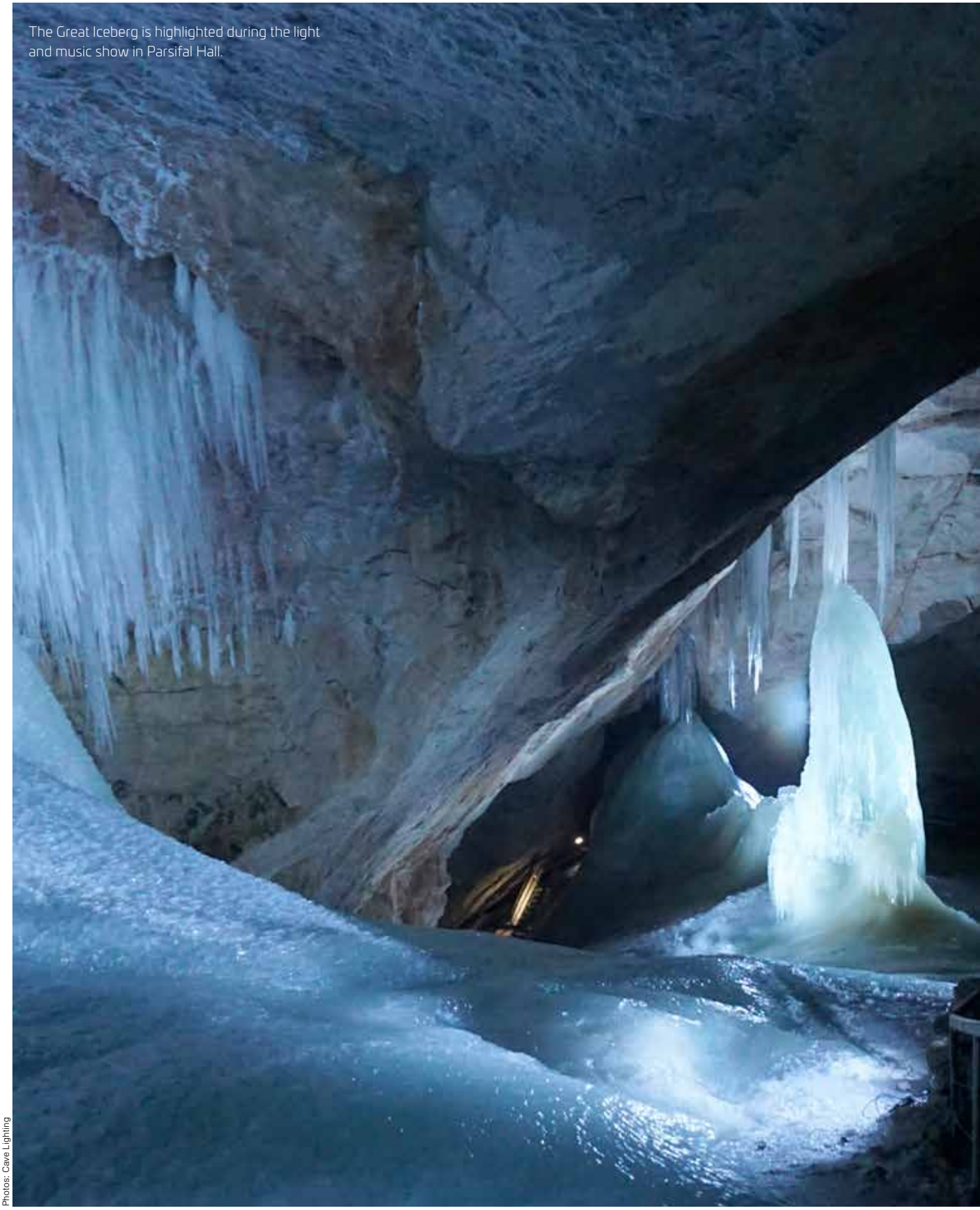
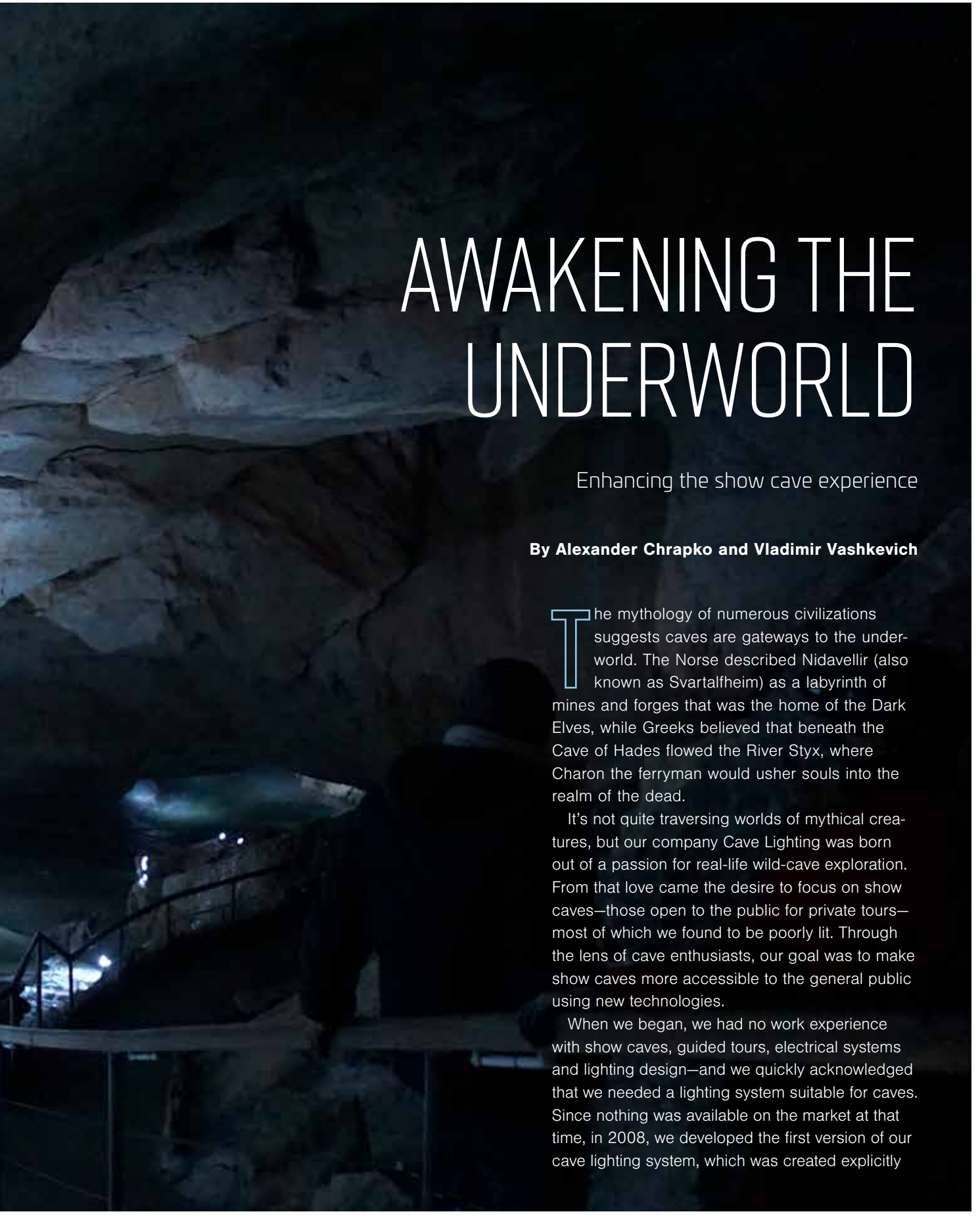


The Great Iceberg is highlighted during the light and music show in Parsifal Hall.

Photos: Cave Lighting



AWAKENING THE UNDERWORLD

Enhancing the show cave experience

By Alexander Chrapko and Vladimir Vashkevich

The mythology of numerous civilizations suggests caves are gateways to the underworld. The Norse described Nidavellir (also known as Svartalfheim) as a labyrinth of mines and forges that was the home of the Dark Elves, while Greeks believed that beneath the Cave of Hades flowed the River Styx, where Charon the ferryman would usher souls into the realm of the dead.

It's not quite traversing worlds of mythical creatures, but our company Cave Lighting was born out of a passion for real-life wild-cave exploration. From that love came the desire to focus on show caves—those open to the public for private tours—most of which we found to be poorly lit. Through the lens of cave enthusiasts, our goal was to make show caves more accessible to the general public using new technologies.

When we began, we had no work experience with show caves, guided tours, electrical systems and lighting design—and we quickly acknowledged that we needed a lighting system suitable for caves. Since nothing was available on the market at that time, in 2008, we developed the first version of our cave lighting system, which was created explicitly

Vladimir Vashkevich programs CN and CP controllers in Dripstones Hall in Giant Ice Cave.

for use in the harsh environments in show caves and show mines. During that process, we realized that the way cavers see things is very different from electricians, planners, architects, lighting designers and scenographers. The biggest challenge was that the electrical companies had little expertise with the underworld. While their systems provided illumination, it was often dreadful—offering poor aesthetics and destroying cave environments.

From 2005 to 2008, most show caves were illuminated with only warm white light (3000K). Since this color temperature cannot reproduce accurate colors of underground objects, we relied exclusively on cool white light (6000K). This color temperature proved to be suitable for highlighting the natural colors and white speleothems (mineral deposits formed from groundwater within underground caverns). Later, we experimented with different color temperatures, using variants ranging from cool white to amber and different beam angles from 10 deg to 120 deg.

The technical solutions required for illuminating caves are relatively straightforward. In contrast, the lighting design and scenography of each cave visit are unique and differ from project to project. While we develop and produce our own lighting for use in show caves, it is relatively easy to find good luminaires on the market with an IP65 rating for outdoor use or IP68 for underwater use. However, these luminaires are developed and intended for a wide range of applications and not for an environment with 95% to 100% humidity. It is best to favor robust housing that can survive in a harsh environment for a relatively long time. The first systems we built have been in use for 16 years, and the luminaires are still in good shape, with a few minor exceptions.

Cave lighting combines lighting control with industrial automation and relies on a combination of centralized and decentralized systems. The lighting control system is also developed in-house and includes lighting controllers, multimedia controllers and wireless controllers. Standard solutions from various manufacturers are used for automation, such as smart power supplies, UPS, batteries and surge-protection devices from Phoenix Contact GmbH & Co. KG and PLC and Power over Ethernet switches, as well as other automation components from WAGO GmbH & Co KG.

The control of the lighting system depends on the concept of the system (i.e., the management) and, to some extent, the lighting design. In many projects, a fiber-optic network is set up and PLC

automation of the electrical system is integrated, which is then combined with the lighting control system. The lighting control system contains static and dynamic elements, and different protocols are used, such as PWM, DMX 512 or analog switching.

Cave illumination is not a one-person or single-company endeavor. The job relies on cooperation and synergy with specialists from different fields including electrical planners, lighting designers, architects and scenographers. Ultimately, lighting in caves only really works if the safety of show cave visitors is assured. Therefore, lighting is divided into two parts: safety (or trail) lighting and accent lighting. Safety lighting is responsible for illuminating the guide path and contains redundant elements to ensure reliable lighting. Depending on the country and requirements, the path lighting can be between 1 lux and 5 lux, which effectively illuminates the area for visitors.

Once safety has been ensured, various accent lighting options can be implemented. Lighting design in show caves or other underground tourist attractions are applied in very different ways. For example, designers may develop a holistic concept with a story and use the lighting to tell that story. Others may wish to present the cave as a natural wonder and ensure that its beauty is accessible. In any case, in underground projects, it is very important to avoid over-illumination and using intense colors, which often overwhelm visitors. A balance and equilibrium of lighting are essential; we work predominantly with white light and prefer not to exceed a maximum illuminance of 200 lux on cave surfaces.

Top: Dripstones Hall features a DMX 512-controlled light and music show.

Bottom: One of two PLC-controlled automated robot bears help transform Giant Ice Cave into an "underworld Disneyland."

There isn't a one-size-fits-all solution for cave lighting—each location offers unique challenges that often require creative solutions. Let's take a

First Hall in Martelange utilizes integrated Rosco spots and Sony projectors.

look at two of our projects: the Dachstein Giant Ice Cave in Obertraun, Austria, and the Haut-Martelange Slate Museum in Luxembourg.

One of our most extreme projects is the restaging of the Giant Ice Cave on the Dachstein glacier, located at the borders of Salzburg, Upper Austria and Styria. This site is one of the few high-alpine show caves in the world. The entrance sits at an altitude of 1,421 meters (~4,660 ft) above sea level. The length of the show cave section is approximately 800 meters (~2,625 ft), with a height difference of approximately 70 meters (~230 ft) between the entrance and the exit. Giant Ice Cave is divided into two parts: a lower section with ambient temperatures of up to 3 deg Celsius and an upper section with ice formations and maximum ambient temperatures of +/- 0 deg Celsius.

The company Pronatour GmbH from Vienna, Austria, was primarily responsible for the project and developed a concept that would use amusement effects to transform this show cave into a type of "underworld Disneyland." Taking the lead on the lighting design and electrical planning, we saw things differently; after numerous discussions and tests on site, Pronatour agreed on a combination of natural and authentic lighting with several multimedia islands that included light and music shows, colored lighting and dynamic content.

The third zone of the cave features a PLC-controlled automation network and is divided into nine guide zones. The first four zones are ice-free and predominantly illuminated with white lighting between 6000K and 4500K. The special features of this part of the show cave include two fully automated robot bears that are centrally controlled via PLC.

Zones five to nine include the actual ice cave, which possesses thick layers of ice, ice figures and special shapes including various forms like icicles and ice surfaces, with the largest formation being the iceberg. A combination of cool white and RGBW lighting was used for the staging in these areas. In various areas of the ice cave, five light and music shows were constructed in collaboration with scenographer Jan Ptacin, thematically supporting the tour and the story being told. For example, in Dripstones Hall (zone 2), the show supported the explanation of the speleogenesis of the cave. In Parsival Hall (zone 6), the show includes music from German composer Richard Wagner's "Parsifal."

For the pathway lighting, we used 5000K CL-LMT luminaires (30 lumens, 1 watt). For the accent lighting, we employed 4500K to 6200K CL-LSQ2 luminaires (250 lumens, 3.5 watts) and 4500K to 6200K CL-LQP2 luminaires (1,200 lumens, 12 watts). RGBW light and music shows were equipped with DMX-controlled CL-EQP luminaires, which were originally designed for the entertainment sector.

The environment is what made this project particularly unique. We began installation in February 2018 when the temperatures were -25 deg Celsius

The exit passage at Martelange mine includes GVA PIXELDOME luminaires.

outside and -12 deg Celsius in the cave entrance. We had to work both on and in the ice, not only designing the lighting (i.e., finding locations for the lamps and creating lighting scenes) but also drilling holes, laying cables and electrical connections and programming them.

Another challenge was the exposed location of the cave and the very poor protection of the electrical network. We quickly realized that the show cave was not electrically protected against overvoltage. As a result, a special lightning protection system with approximately 50 customized lightning protection devices (SPD) was developed and installed.

Dealing with frozen features is only one type of challenging cave illumination environment. The Haut-Martelange slate mine at the Slate Museum complex in Luxembourg offered entirely different obstacles to overcome. The museum and slate quarry are located on an 8-hectare open-air site with 26 renovated craft workshops. The mine possesses a complex topology and is approximately 600 meters (~1,969 ft) long and extends over five different levels. The difference in height between the entrance and the deepest level of visitation is nearly 80 meters (~263 ft). At the very bottom of the area set up for visitors, you can experience two large "lakes," which are actually flooded shafts, some of which reach a depth of 100 meters (~328 ft). At the start of the project, the entire mine was underwater, and it took two years to pump the water out. In 2021, the construction project began, but it was hampered by flooding and landslides. By November 2022, the mine began operation and the museum officially opened.

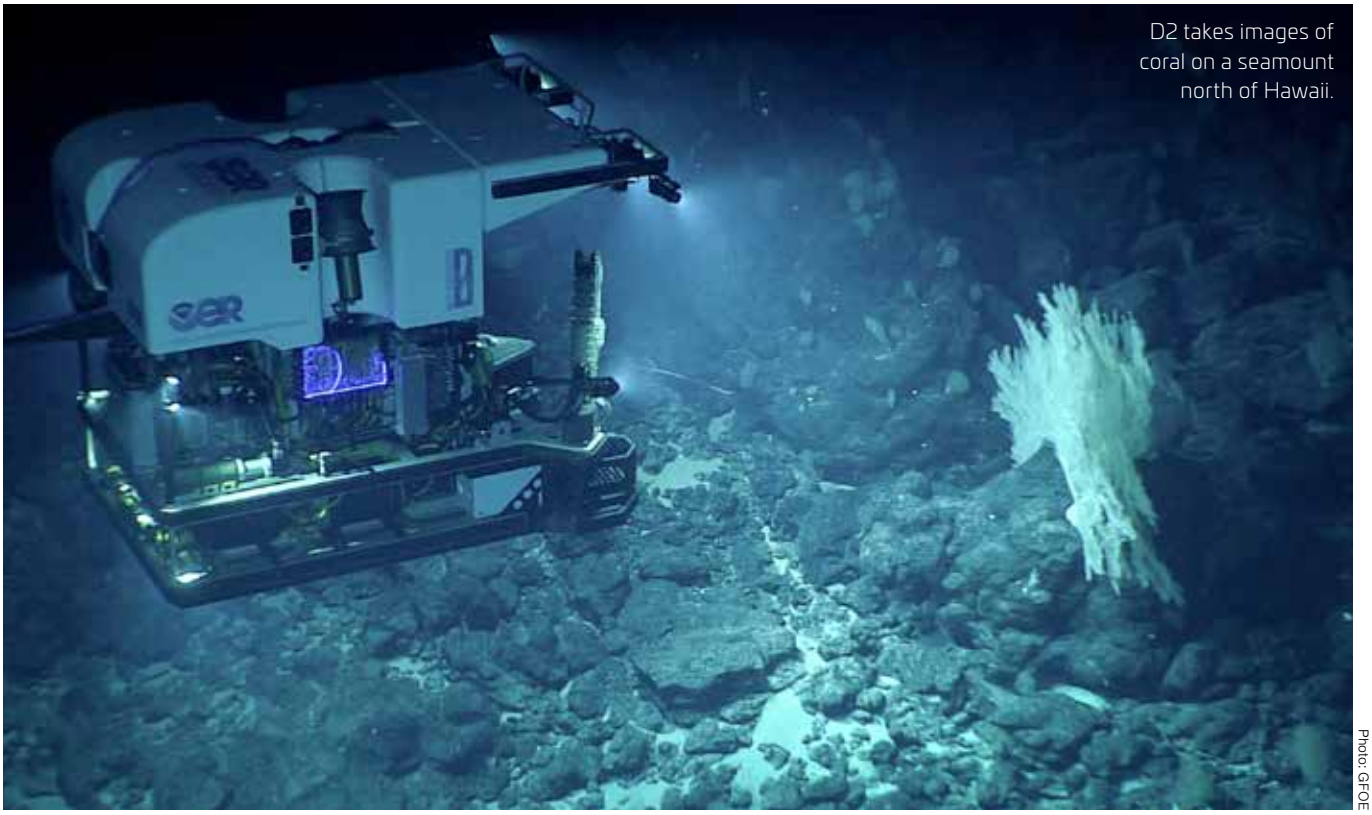
The lighting system installed in the mine was extensive and included a PLC-controlled automation network with six sub-distributors and power supply for devices with 230 VAC, 48 VDC, 36 VDC and 24 VDC. For the trail lighting, PWM-controlled, 6000K CL-LMT luminaires were employed along with DMX-controlled, 2700K PIXELDOME lights (from GVA Lighting) for path lighting. Accent lighting was realized with PWM- and DMX-controlled CL-LSQ and CL-LQP series fixtures with color temperatures between 3000K and 6200K. Some of the mine's multimedia light shows were created using CL-EQP luminaires, which are color-calibrated and controlled via DMX. Five Sony projectors, packed in special housings, were installed along with 12 IP65-rated, 5500K, ROSCO Image Spots.

The installation and programming of the project was a real challenge, as rope techniques were required and high bulkheads climbed to install, connect and pre-program the luminaires. Specialists often had to work 20 to 30 meters (~66 to 98 ft) above the ground with hammer drills and Toughbooks in hand. Another obstacle was the underwater installation of the lighting. Initially, the plan was to dive and install the lighting underwater. However, we determined that the water could be pumped out of the shafts and the installation completed using an inflatable boat.

Currently, we are on our 111th project and, looking back, we see a path that has sometimes been rocky (no pun intended), but it has brought both success and customer satisfaction. Sixteen years ago, there existed only simple systems where light was switched on and off. Today, we can plan and create very complex systems with numerous elements that support intelligent guidance and are conceptually diverse. While we have, thus far, implemented many video projections in projects, full video mapping underground is a project we look forward to undertaking, possibly this year in France. Just like the lighting designers in the above-ground world, cave illuminators continue to push the envelope to enhance the sense of wonder to all those who descend beneath Earth's surface. ◎

THE AUTHORS | Alexander Chrapko is one of the founders of Cave Lighting CL GmbH & Co KG. He has organized and managed cave lighting projects in more than 20 countries.

Vladimir Vashkevich is a product and project manager and a technical manager in the pre-planning and detailing of electronic installations, maintenance of technical documentation and after-sales services at Cave Lighting CL GmbH & Co KG.



D2 takes images of coral on a seamount north of Hawaii.

Photo: GFOE

ROLLING IN THE DEEP

Lighting a path for ocean exploration

By Craig Causer

From the Pacific Remote Islands Marine National Monument to Alaska to the Azores, engineers and videographers from the Global Foundation for Ocean Exploration (GFOE) and researchers from the National Oceanic and Atmospheric Administration (NOAA) set out on the ship *Okeanos Explorer* to document the wonders of the deep blue sea. Crucial to these exploratory missions are remotely operated vehicles (ROVs), such as the GFOE-designed Deep Discoverer (also known as D2), which provide access to harsh environments that are significantly below the ocean's surface (**Table 1**).

Using the D2's sensors, researchers can gather information such as salinity, water temperature and dissolved oxygen, and the ROV's manipulator arms provide its operators with the ability to collect biological and geological samples. What might be most impressive is what the vehicle "sees"; its primary camera can zoom in on a 3-in long organism from 10 ft away. D2 also records high-definition video, which is sent via satellite connection to scientists located on shore. This real-time video provides guidance to the pilots when collecting samples, and it is also broadcast to the Internet, allowing the general public to witness various expeditions. But all of this is not possible without light. Since there is rarely any significant light beyond 200 meters (~660 ft), it's accurate to say that at D2's exploratory depths, the "big ol' blue" has faded to black.

"When we're designing a vehicle for the program on which we work, we're designing it to go to 6,000 meters [~19,700 ft]," explained David Lovalvo, founder, president and CEO at GFOE, which designs, builds and operates ROVs to support the U.S. government's ocean operation programs. "The actual visibility at that depth is quite good, but there is no light, so we have to completely illuminate the area in which we are working. Everything with respect to how we light and film is

developed by us. That means that all of the light is very carefully chosen and placed in relation to the cameras. As we're moving along the bottom, we have a light pool that gives us the ability to get really good video and still images."

Lovalvo noted that GFOE relies on technology from companies that specialize in underwater lighting rather than building its own systems. For many years, incandescent lighting was used underwater and then, in the 1980s and 1990s, hydrargyrum medium-arc iodide (HMI) light provided a significant upgrade by burning close to sunlight at 5600K while improving the ability for imaging. HMI did not last long due to its high price tag and the evolution of LEDs.

"When LEDs started to make their way to the market, it changed everything," Lovalvo said. "It was so unbelievable, the difference in cost between an LED light and HMI light. And the HMI light head was very large. For every HMI light, you had to have a special ballast, which needed to be inside pressure housing. So, the light and the ballasts all had to be in special titanium pressure housings to withstand the pressure at 6,000 meters. Additionally, they all had to be tested at 10,000 to 11,000 psi to certify them to go on a vehicle. We still have all of the original HMI lighting and ballast systems that were used on the ROV. However, the introduction of the LED came so quickly behind the development of the HMI system that it made no sense to continue supporting the much more expensive and complex HMI system. Ultimately, the physical size and much-reduced power requirement of the LED lighting was the way to go."

When GFOE developed the 9,000-pound D2 for NOAA, one of the main objectives was determining the packaging and light on the vehicle so that it could capture optimal images and video. Flood lights were determined to be the best option, and GFOE worked with DC Power and Light Company to select products comprising materials that would thrive at the ocean's depths, including titanium (due to its strength, light weight and being less corrosive in salt water) and sapphire (which was used in lenses to withstand the significant increase in pressure when the vehicle is submerged). DSPL manufactures several types of underwater lights, but the ones most readily used on D2 are the LED Sealite LSL-2000, the HD Multicam and the Micro Sealaser.

Withstanding the extreme conditions is only half the battle; D2 still must successfully complete its mission—the retrieval of samples and high-quality imaging, both of which require effective illuminance of the vicinity in which the ROV travels. In very clear water, ROVs can easily light from 20 to 30 ft ahead of the vehicle, Lovalvo explained, but it takes a lot of light to do so. Currently, D2 emits 126,000 lumens of light to allow for the quality of images that are captured. When developing the lighting system, GFOE created a solid model of the front of the vehicle and began testing lights in different locations. By programming the characteristics of each light into a CAD model and moving lights around, the team developed a design that produced an effective light pool.

For underwater use, it is critical to keep the lights away from the camera lens. If the lighting is too close to the lens, all of the particles suspended in water will appear in the picture. On the front of the vehicle, GFOE placed a camera in the

Table 1. An overview of the GFOE-designed ROV D2.

Size	Length: 3 meters (10 ft) x Width: 2 meters (6.5 ft) x Height: 2.6 meters (8.5 ft)
Weight	9,150 pounds
Equipment	Cameras capable of capturing high-definition videos, 20 LED lights, multiple sensors and two manipulator arms to collect samples
Depth	Maximum of 6,000 meters (19,685 ft)
Speed	1 knot under its own power; 3 knots if towed

Photo: Art Howard, GFOE

An engineer checks D2's systems. Note that the swingarms are partially deployed on the sides of the ROV.

center while many of the lights were installed on swingarms that fold, move around and spread apart approximately 1 meter on the sides of the D2, providing optimum lighting capability.

D2 operators also have the ability to control dimming; they can spread the light and control banks of lights to decide how much light to place on a subject, which helps produce optimal images that scientists use to identify species of fish, coral or geological features. The lighting is not just there to produce pretty pictures, it's essential in capturing the science.

Temperature is an issue as well. One thing that incandescents, HMIs and LEDs have in common is a sensitivity to operation in an environment that is not surrounded by water, which makes testing problematic. Lighting is designed in housings that withstand intense pressure, but they also capture heat. So, if the lights are not surrounded by water, they burn out quickly if run too long in air. "The HMIs were the worst—if you left them on less than a minute, you would be looking at trouble," Lovalvo stated. "The LEDs were a little more friendly. Still, because they're packaged in a housing, there is no easy way to disperse that heat. But when you surround it with water, the light is happy."

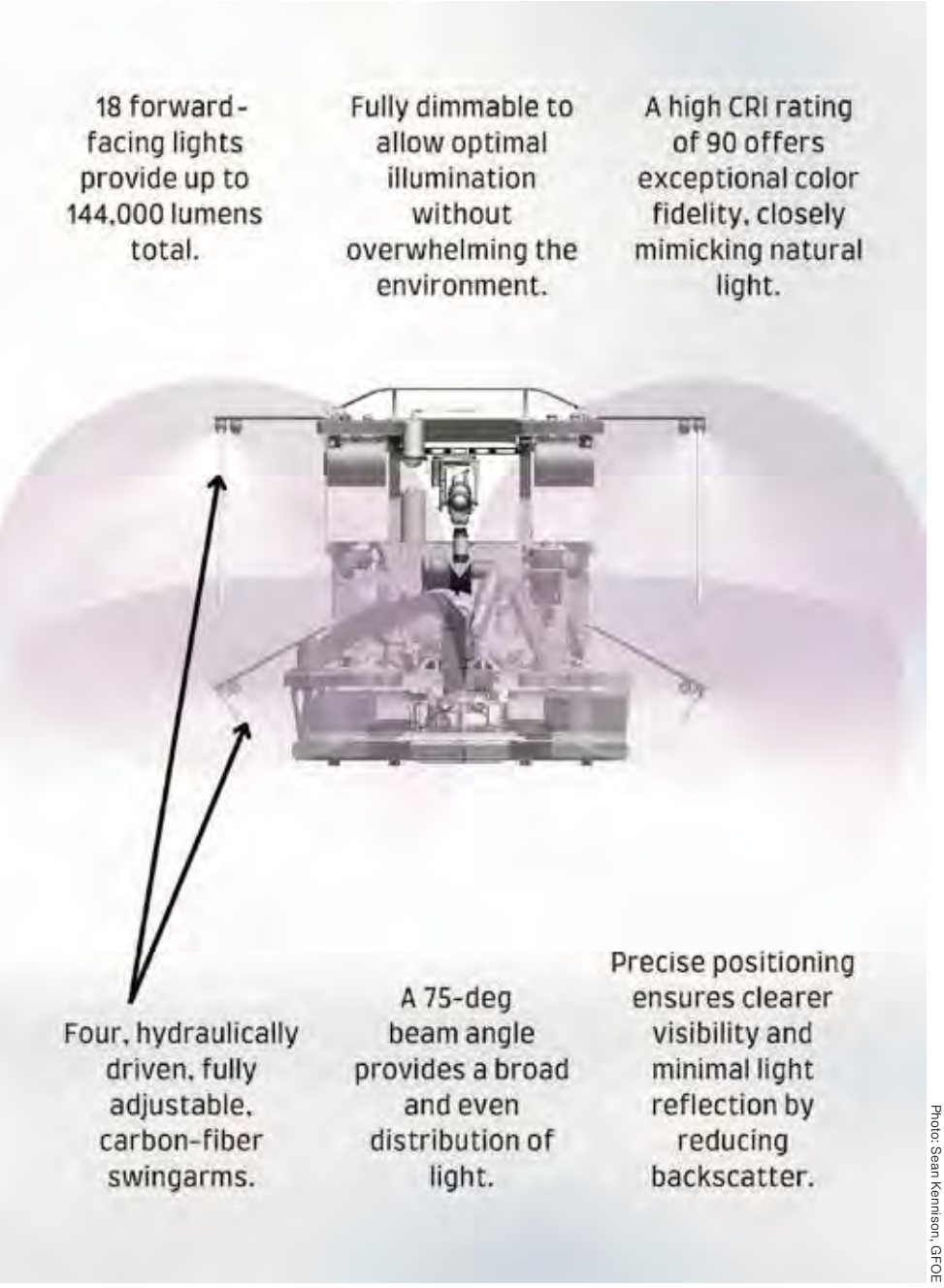


Photo: Sean Kennison, GFOE

A description of ROV D2's lighting capabilities.

All of the control, power and communication for ROVs are supplied through a tether that connects the vehicle to the surface vessel. When providing the power from the surface, it has to travel down a cord—the more power being sent, the larger the diameter of the cord that an ROV must drag behind it. LED efficiency helps mitigate the size of the tether, making it the current lighting of choice.

With GFOE and NOAA typically working 6- to 8-hour days underwater, the question often arises: Is the illuminance from ROVs causing any negative reactions from marine life? Although Lovalvo said that he has never seen a reaction by marine life that seems to be a negative response to D2's light, he cautioned that he is not a scientist, and doesn't "know definitively that we're not causing stress in an animal."

Since people often express concern about how light affects marine life, GFOE is working on developing a camera system where viable images could be produced from a dark environment. In partnership with digital imaging solutions and camera company Canon, GFOE is exploring a "see-in-the-dark" video camera dubbed the ME-20, which will

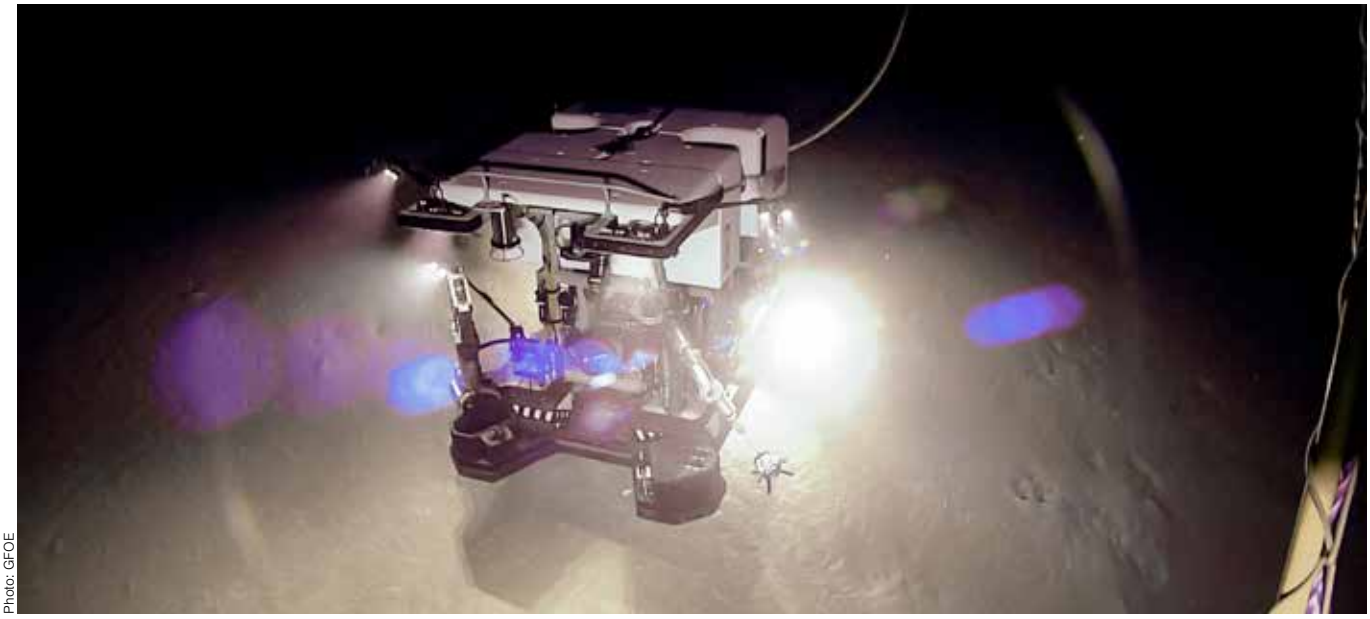


Photo: GFOE

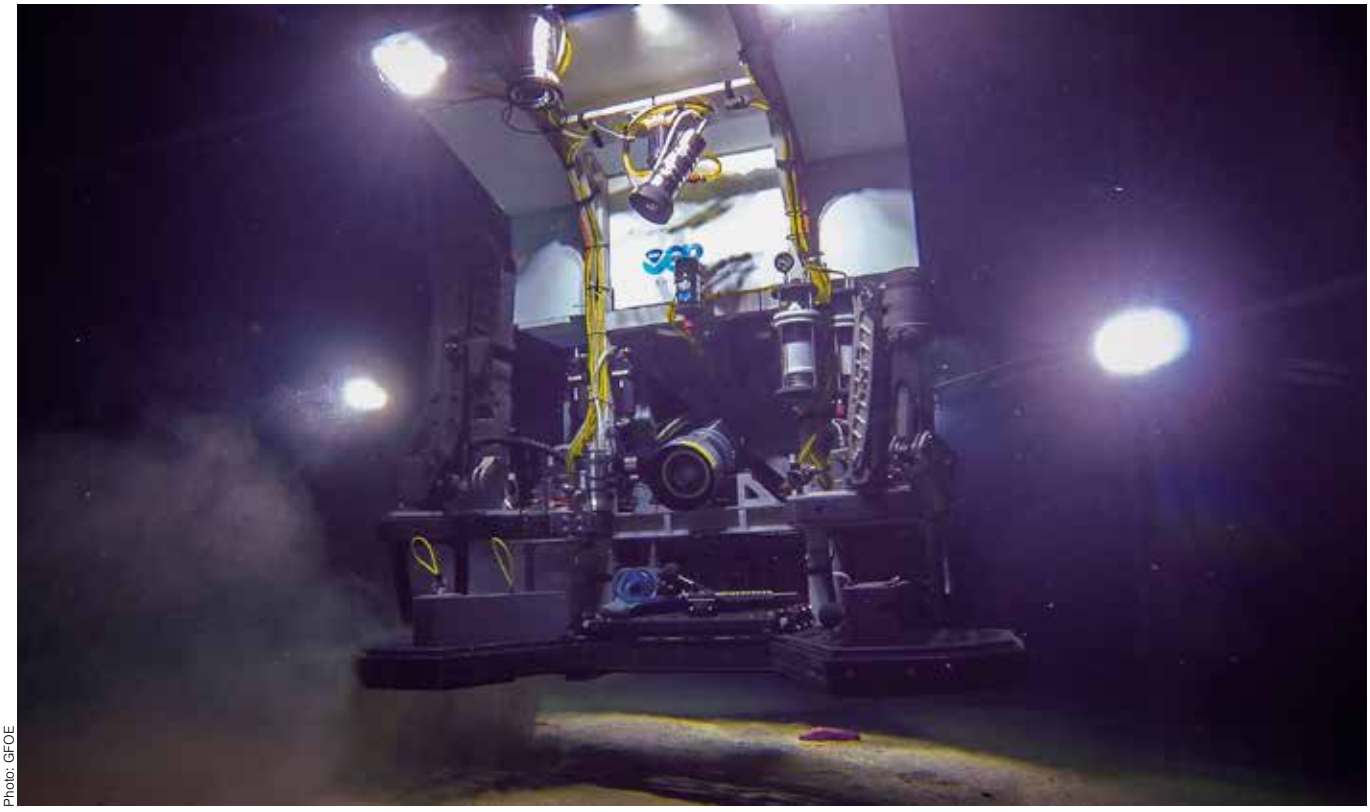


Photo: GFOE

be tested and compared to lighting to see how, if at all, marine life behavior is affected.

"If you want to make a giant leap to make things better in terms of imaging and value to scientists, it's in the camera technology and not the lighting," Lovalvo said. "The lighting is really spectacular at this point in time, but the two main challenges are packaging better cameras and data storage. We've been shooting in HD since 2008. HD is not state-of-the-art, so the next step is 4K, but that's twice as much data as HD. You have to be able to store it, because the government wants you to collect data from the time you put that vehicle in the water until the time you take it out. That's a tremendous amount of data, even shooting in HD." ◎

Top: D2 lights up the seafloor during a dive.

Bottom: Swingarms move the light source away from D2's cameras to reduce backscatter.

GALAXY QUEST

Illuminating NASA's next-generation spacecraft systems

By Craig Causer

An engineer working on NASA's Mars 2020 mission uses a solar intensity probe to measure and compare the amount of artificial sunlight that reaches different portions of the rover. To simulate the Sun's rays for the test, powerful xenon lamps several floors below the chamber were illuminated, with their light directed onto a mirror at the top of the chamber and reflected down on the spacecraft.

Photo: NASA/JPL-Caltech

Despite science fiction tales of galaxies far, far away, the actual edge of space, known as the Von Karman Line, is only 62 miles above sea level. Hollywood's depictions of space exploration have historically been presented with excitement and exuberance—"Space: the final frontier" and "To infinity...and beyond!" are just two phrases seared into the public's collective brains. (And for those who lean more pessimistic: "In space, no one can hear you scream.") Without effective lighting systems, in space, no one can see you either.

As NASA's Artemis campaign continues to explore the Moon for scientific discovery, technology advancement and to learn how to live and work on another world, it is also preparing for future human missions to Mars. To gauge where NASA stands with illuminating its next-generation spacecraft, *LD+A* spoke with Toni Clark, Human Health and Performance contract fellow for Spacecraft Lighting Systems (Leidos, Inc.), Johnson Space Center Lighting Lab technical lead, and Extra-Vehicular-Activity Human Surface Mobility Program lighting system manager, at NASA Johnson Space Center in Houston, TX.

Can you start by defining "next-generation spacecraft systems?"

Toni Clark: Anything that we are inventing that is planned for space can be considered next-generation. Everything that goes into space is custom—there's no standardization. It would be nice to have the latest technologies on these spacecrafts but it's not like *Star Trek* and *Star Wars*. You

take what you've designed for terrestrial applications and then you have to ruggedize it to manage and operate in a spacecraft environment, which obviously is not on Earth. You could even classify high-altitude balloons as spacecraft because you're at a different pressure, thermal environment and radiation, and all that impacts the successful operation of the electronics that you may want to use. Contrary to popular belief, you don't usually design the vehicles to look pretty; you design them to survive.

Is the lighting geared toward complementing the overall design of each spacecraft or is the functionality more important than the form?

Clark: Advice is provided to NASA on lighting systems solutions that starts with the standard industry trade recommendations. That includes IES, ASTM, NEMA, the National Highway Safety Administration and many others. You start off with a baseline. Where the application does not fit the design space, as far as these standards, we have to deviate based on the hazards of the operational environment. A lot of times, we start off with a baseline, from a human systems perspective, and then we have to go with human-in-the-loop testing to figure out if we're allowed to do it differently. When it comes to adjusting how we do things, priority is given to operational safety, performance, crew and system health as well as mission objectives.

From a lighting perspective, you're probably thinking about how people use light, but one of the major users of light for NASA is camera systems. We have to think a lot about the proper marriage of lighting environments for people and cameras. Sometimes our solutions are bounded by physical architecture for the lighting support systems, including power, radiation, thermal and mass. For example, the IES may recommend 350 lux for a particular application, but we may be power constrained and not able to pull off the uniformity ratio recommended for that task because of lamp placement. Then you have to have a tradeoff—are there hazards or productivity issues? Glare, circadian lighting, color fidelity and surface reflectance are all important, and you have to try and find a happy medium.

What are some of the most significant challenges?

Clark: The biggest challenge in lighting is the technology—the actual fabrication of the lamps. Companies are now beginning to have their "Aha—light can look like anything" moment. In the hardware world, where a lamp is a lamp, it's a big leap to try and craft a lamp specification for a light source on a spacecraft that doesn't look like a light. For instance, can you get away with indirect lighting or having luminous candles where the walls glow? Getting that type of information communicated in a requirement space without being overly prescriptive is challenging. You're hoping that the person on the other side is a creative individual who sees that and can work with it. In the architecture and lighting worlds, there are many lighting engineers; in the NASA world, there are not. Many times, creativity equals dollar signs. You can have a creative person who comes with an artistic lighting plan and then is told it's too expensive.

The hardware side is a significant challenge, especially heat. LEDs can burn out rather quickly, so you really have to have a good heat sink design. For spacecraft, they deal with lower gravity, and lower-gravity tasks have challenges with the

Photo: NASA/Johnson Space Center

An interior view of the ISS' Destiny U.S. Laboratory at night under ambient light with the main lights turned off.

utilization of conduction to move heat. You need passive conduction or active cooling—and active cooling doesn't always mean fans. If you're in a confined space, the last thing you want is another noisemaker. It would be awesome to have a whole IoT system that could do everything. But smart things tend to get eaten up by radiation. All electronics are susceptible to radiation, and memory chips are the most vulnerable. This creates challenges in implementing sophisticated lighting automation systems that might rely on memory or firmware to facilitate automatic actuation.

Materials present another challenge. In a confined space, you have a higher oxygen content, so all of the materials that you're normally used to dealing with—like plastics, which are highly flammable—have to go through a certification process. You could even have issues with soldering, as certain types of solder processes will grow crystals in space on your circuit board, which can short out a system.

Power is also a limited resource. You have power for your primary systems and your emergency systems and then you have to prioritize what is on emergency systems. In a building, if you have an emergency—the lights go out or there's a fire—you're on reduced power that illuminates the escape routes. On a spacecraft, you don't always get a chance to escape. Sometimes you have to stay and keep things going until a repair can be made. You have to think about contingencies.

Lighting has been improved at NASA with automation, alternate light source designs, enhanced energy efficiency and reduced heat emissions, but you have all of these additional electronics issues that affect lamp survival. Getting that thermal, radiation and power trifecta is often a killer on a lot of lamp designs.

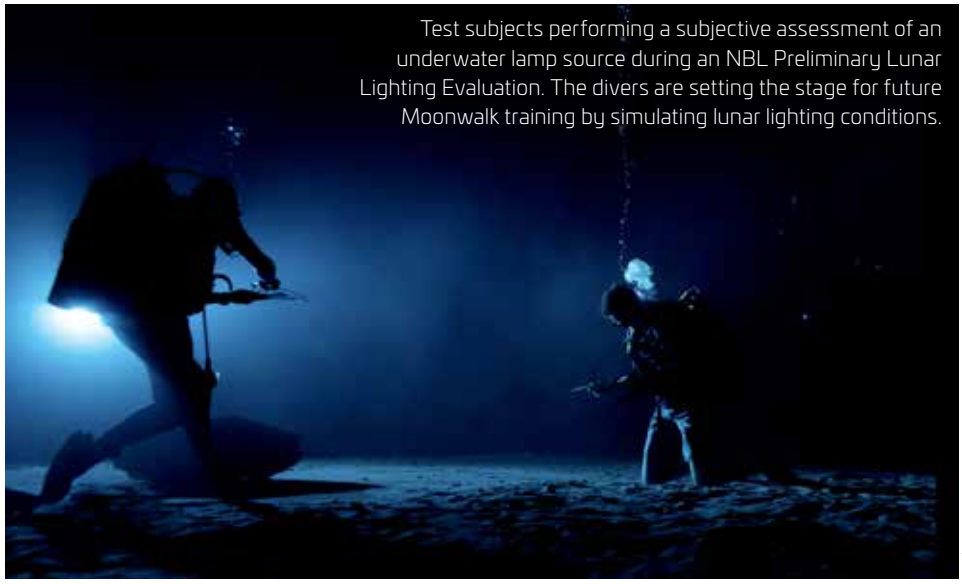
How are lighting requirements different between low Earth orbit missions to those on the Moon and Mars?

Clark: Low Earth orbit, like on the International Space Station (ISS), benefit from an approximately 90-minute orbit that provides both daylit and nighttime conditions. The spacecraft is close to Earth, and Earth creates a giant diffuse reflector. ISS has both direct high-intensity collimated light from the Sun

and intense diffuse light from Earth. From an exterior operations perspective, you have a lot of options. If you didn't plan your exterior operation correctly, you can just wait for the Sun to come back into a good position—the 90-minute wait is not that bad.

The big impact on lighting design focuses on exterior operations. Let's talk about leaving low Earth orbit. For example, on the lunar surface, we don't have a giant Earth hanging over our head anymore; all we have is the Sun. Exterior tasks, especially at the lunar south pole, which is where NASA's Artemis mission is going, is challenging. The day/night cycle is one month. So, on a one-Earth-day excursion, the Sun is not going to move around much. Whatever is poorly lit, is poorly lit for a long time. This cycle may have some adjustments depending on the rotation/axis of the Moon with respect to the Sun. At the poles, the Sun is coming in at a low inclination angle, which results in the Sun being in your eyes or creating extremely long shadows.

On the Moon, the sky is black and not diffuse; there's no atmosphere or scattered light. Shadows have hard edges and are super-dark—they can be so dark that they look like lakes. It's like "all-or-nothing" conditions. The visual contrast problem is extreme; you have human eye adaptations and limitations, where you can't just go from light to dark. If you're trying to look into a shadow, it's not a perfect scenario because your eye is still exposed to other objects in the field of view that are not in shadows. Trying to get enough energy into an area to see it is a design challenge.



Test subjects performing a subjective assessment of an underwater lamp source during an NBL Preliminary Lunar Lighting Evaluation. The divers are setting the stage for future Moonwalk training by simulating lunar lighting conditions.

Photo NASA/Lauren Maples

THE DEEP END OF THE POOL

The 202-ft long, 102-ft wide and 40-ft deep indoor pool at NASA's Johnson Space Center's Neutral Buoyancy Lab (NBL) is one of the world's largest. The lab is used for mission planning, astronaut training, hardware verification and various aspects of ensuring mission success during spacewalks. In preparation for NASA's Artemis mission to the Moon's South Pole, where the Sun resides only a few degrees above the horizon—causing extremely long and dark shadows—lunar lighting conditions were simulated at the NBL.

"A few years ago, the NBL approached us about what they could do to improve their pool," explained Toni Clark, Human Health and Performance contract fellow for Spacecraft Lighting Systems (Leidos, Inc.), Johnson Space Center Lighting Lab technical lead, and Extra-Vehicular-Activity Human Surface Mobility Program lighting system manager, at NASA Johnson Space Center in Houston, TX. "NASA has a phrase, 'Test like you fly.' For lunar-based applications, we advised them that they needed to darken the walls of their pool because the lunar landscape is a dark sky. We wanted to make sure that when they are performing tests underwater, the contrast ratio that the test subjects are seeing are more relevant to what they would see on the Moon. NBL also invested in a narrow-beam lighting system to improve its test environment by creating a high-contrast scenario."

NBL requested information from the lighting industry on solutions for the pool's high-pressure impact environment but most of the companies that manufactured underwater lighting were not interested in tackling the challenge. According to Clark, NASA's Lighting Lab emulates 130,000 lux at 5-deg beam dispersion on its test articles—including people. "The goal was to try to get nearly collimated but really high intensity and get that contrast threshold up real high," she added. As a result, the NBL employed a powerful underwater cinematic lamp—the SeaPar Underwater 1,200-W HMI—originally designed for the James Cameron-helmed film *The Abyss*. At 5600K and able to operate at depths up to 120 ft, the lamp, which received a 1991 Technical Achievement Award from The Academy of Motion Picture Arts and Sciences, perfectly fit NBLs needs.

There are plenty of unique hurdles to overcome when designing a lighting environment in the NBL including the depth; refraction index, transmission and absorption of water; and the blue tint of an underwater environment. "Because of that refraction index, you have air to water, so when you're underwater, it's like a mirror," Clark said. "If you don't keep your light source way down below the water ceiling, the light is going to hit the surface and bounce back depending on the inclination angle with respect to the surface. You need to map out where you are aiming your lights and manage the overhead lights in the pool area."

Photo: NASA/Kate Rubins

Going farther than the Moon—let's talk about Mars.

Clark: I haven't been involved in Mars-specific lighting design evaluations, however, given that Mars has an atmosphere and a day/night cycle that approximately matches Earth's, my assumption is that standard exterior design processes and techniques would work on Mars, but the planet would still present many of the same challenges as does the Moon—addressing weight, radiation, thermal and power.

What research and/or innovations has NASA made thus far to address the lighting needs for future lunar and Mars missions?

Clark: One caveat is that developing something new is very difficult. However, the same lighting innovations that make life better on Earth have the potential to make lighting better for NASA's purposes. One technology is the Internet of Things (IoT)—how you use communications to improve, wireless or otherwise, the automation of lighting systems, sophisticated communication, actuation of lights turning on and off and smart adaptive systems. Potentially, you may see IoT on a kit that you might be able to certify to allow your lighting system to be more versatile.

NASA previously designed solid-state lighting assemblies to replace general luminaire assemblies for the improvement of visual acuity and provide a crew health countermeasure for circadian rhythms, sleep, alertness and performance.

I like a lot of the innovations I've seen on optical light guides, especially when it could possibly meet the requirements of our materials engineers. It would allow you to have a lamp architecture that fits within the constraints of the physical architecture where the light might go. Let's say that one of your problems is heat management. An optical light guide would allow you to put the light engine in one place and have the light exit somewhere else, where, from a mechanical design perspective, you couldn't have done it otherwise. I also like some of the new technology around clear, transparent optical encapsulants. While its use could make a lamp heavier, it could be potentially used for heat management by filling it into the cavity of the lamp to make it more resilient to vibration or dust.

When I look at the automotive world, I like what I'm seeing with solid-state light sources. For instance, several years ago, Audi came out with a vehicle that uses laser matrix head beams, and that was pretty slick. There's some potential for that type of technology. Some of the companies out there are making holographic diffusers, which is great from a beam-shaping perspective. All of the applications of spectral lighting—there's now so many types out there including ultraviolet, violet, near-infrared, 800 nm—that you can come up with a very custom spectrum. These all have potential use cases for interior and exterior lighting systems.

Are there any spacecraft that are either new or soon to be unveiled that will integrate some of these technologies? Or are these breakthroughs way down the road?

Clark: NASA has requirements on the books for some of its newer spacecraft for automated lighting systems. They are not in the air yet—so we'll have to see. This all goes back to the balance of certification; if something is too difficult to certify, you start having to simplify. If it's not in the requirement space and there's no business model to have that type of crazy-cool

Photo: NASA/Marie Reed

The Orion spacecraft for NASA's crewed Artemis II (right), Artemis III (left), and Artemis IV (center) missions stationed next to each other at NASA's Kennedy Space Center in Florida.

lighting system, you're not going to see it because the cost of manufacturing for spacecraft applications is so high. Somebody has to have a deep wallet.

What areas of innovation do you see breaking through in the next decade? Are there any areas that have thus far fallen short of expectations?

Clark: The application of white-light-emitting lasers and LED technologies that pre-collimate the light before it exits the chip will be game-changers for both Earth- and NASA-based applications. This enables a range of creative optical manipulation techniques and other smart adaptive lighting design techniques. With pre-collimated, you can start doing a lot with optical management materials; you don't have to waste space with lenses and reflectors to get the light collimated. It will allow for the lights to be tightly matrixed. The white lasers that I know of have a pretty limited spectrum and color fidelity range, so a lot of work has to happen to make those lasers more applicable to lighting.

I would also like to mention that we've been the beneficiary of some great work by lighting professionals and organizations. A few years ago, the IES updated its color fidelities scoring method with IES TM-30 [*IES Method for Evaluating Light Source Color Rendition*]. With IES TM-30, the standard is robust in providing really good information about calculations. From an evaluation perspective, it allows you to do the science in evaluating slight changes in color- or spectrum-mixing and how it impacts how material look. Another is the IES and CIE push to standardize circadian health countermeasures. In everything we do at NASA, we have a requirement—there is going to be some standard of evaluation for it. Having research out there that has new information that is relevant to the technologies that are being manufactured today really helps with keeping our spacecraft requirements up to date.

Where have some of the technologies fallen short? IoT and automation. I want to have an automated circadian health countermeasure that does all of the thinking for the crew. In some cases, most crew members would like that, but in other cases, people like to march to their own tune. You can't force people to be healthy if they don't want to be. Then, other times, you just can't have the automation system you want—for spacecraft it's most likely because you couldn't certify something or you ran out of budget. ◎

Kisimgiugtuq School in Kivalina, in Northwest Arctic Borough, Alaska.

Photo: Kevin Smith

NORTH TO THE FUTURE

Tackling design challenges in The Last Frontier

By Jeremy Maxie

Lighting design in Alaska involves many of the same elements that designers all over the world consider. Metrics, constructability, aesthetics, owner/client approval, cost and similar issues are all commonly addressed on projects in the 49th U.S. state. We also have a number of factors that may be present in some areas and not others, such as freezing temperatures, seismic activity, large seasonal differences in available daylight, an enormous land mass with climates ranging from rainforest to tundra, a limited road system requiring material to be transported by airplanes and cargo barges to large portions of the state as well as thousands of miles of coastline with salt spray and wind-blown moisture. Projects in Alaska must be evaluated for all of these factors and the lighting design modified as needed to provide the most effective solutions.

The saying may be, "Everything is bigger in Texas," but Alaska is over twice the size of the Lone Star State and can fit Texas, California, Montana and most of the New England states inside of its borders. Alaska has areas that rarely experience below-freezing temperatures, while other parts of the state can hit -46 deg Celsius/-50 deg Fahrenheit or colder in the winter. When specifying exterior luminaires, this presents a wide range of challenges as some areas operate fine with -20 deg Celsius/-4 deg Fahrenheit ratings—and can even use 10 deg Celsius/14 deg Fahrenheit ratings—others require a minimum temperature of -30 deg Celsius/-22 deg Fahrenheit, and the north and west of the state neccessitate -40 deg Celsius/Fahrenheit ratings. In some locations, the temperature will often dip below -40 deg Celsius/Fahrenheit, and so

the only solution is to specify this temperature and hope for the best when it gets colder. When you combine these extreme temperatures with weather conditions, it becomes very important to specify the right ratings for equipment.

When emergency egress lighting is needed on the exterior of a structure, temperature ratings require thoughtful design. It is often difficult to find -40-deg rated emergency drivers, so when working in areas requiring this rating, we must use a few different solutions. One is to employ remote heads from an interior exit sign/EM lighting unit, though the temperature rating of the heads needs to be confirmed—I have had cases where the mechanical components were not robust enough for the cold. Another solution is to use an inverter indoors for selected exterior emergency luminaires. This can be a large central inverter, a smaller inverter powering a number of luminaires at select locations or micro-inverters connected to one or two luminaires. Where remote mounting is an option, an emergency driver can be installed inside of the building and connected to the exterior luminaire. Even standard drivers can be problematic, as I recently ran into an issue where a manufacturer could not physically fit the -40-deg rated driver inside of the body of 2-in. slot luminaires, so we had to find an alternate solution.

Warm color temperatures may be preferred in some areas as a beacon through snow or fog. This is not a common request, but it is something that has come up in the past and needs to be considered and discussed. In particular, site lighting for arrival into villages and towns from coastal areas and open trails should be visible in as many conditions as possible. Blowing snow and ice fog are very common, and a warmer color temperature that stands out in whiteout conditions serve a similar purpose to a lighthouse on a dark coastline. (Note: Snow and fog have also challenged wireless controls. Exterior wireless controls have recently seen more widespread adoption but, historically, have been difficult to specify due to the temperature rating of the equipment and their inability to function in these elements.)

Additional ongoing discussion and research into the most appropriate color temperature for both interior and exterior lighting in northern latitudes must continue. There have been comments in the past that warmer color temperatures are better due to low solar angle and the resulting spectral power distribution but, to date, the design direction on this is still undetermined. Most lighting design in Alaska uses 3500K or 4000K, similar to many other areas.

Our state has also very broad differences in daylight depending on the season. The northernmost communities such as Utqiagvik (formerly Barrow) experience approximately 70 winter days where the Sun does not rise above the horizon and, conversely, the same amount of time in the summer where the Sun stays above the horizon. In Anchorage, where almost half of the state's population resides, there are almost 19 hours of darkness on the winter solstice and 19 hours of daylight on the summer solstice. While this typically does not change how much light is placed into a space, it does require more usage in the winter, which is also the time that utility bills are highest due to heating requirements. The Alaska Village Electric Cooperative provides power to 59 communities across the state, and, in some cases, electric rates exceed $1 per kilowatt-hour, which requires efficient design, even in the lack of code-required design. There are cases where the dearth of daylight results in much higher required light levels per local standards than IES tables. In Utqiagvik, the standard for offices and classrooms was an average of 100 footcandles, and other design standards for municipal or educational organizations have seen similar light level requirements. These seasonal variations in available daylight are felt in both winter and summer for their more pronounced impacts on circadian rhythm, sleep patterns, energy levels and similar physical responses than areas with less drastic differences.

Photo: Pat Collins

Examples of exterior equipment (left) and a conduit (right).

Photo: Keegan Rauf

An incandescent/fluorescent hybrid: an early energy efficiency upgrade?

While we're on the subject of energy codes, there are a few significant codes/standards to be considered. At the statewide level, the Alaska Administrative Code requires ASHRAE 90.1 compliance for buildings owned by the State of Alaska, while the Department of Education and Early Development requires ASHRAE 90.1 compliance in school projects. In Anchorage, the International Energy Conservation Code has been adopted for a number of years with the most recent update applying its use to existing buildings, as it had only been required for new construction in the past.

As the most seismically active state in the U.S., Alaska experiences thousands of earthquakes each year. While most are too small to be felt, the state has also experienced the most powerful earthquake ever recorded in North America (9.2 magnitude in 1964), and in 2018 experienced a 7.1-magnitude earthquake just outside of Anchorage. The building codes here are written with this type of seismic risk in mind: In addition to the positive attachment required by the National Electric Code (NEC), luminaires require independent seismic wires connecting them to structures so that they are supported separately from the ceiling should it fall. In addition, pendant-mounted luminaires must be cross-supported to keep them from swinging into walls or other luminaires and objects. Another consideration for seismic design is the inclusion of an equipment grounding conductor in all conduits containing line voltage conductors. The NEC allows a conduit to be used as the ground path, but the Municipality of Anchorage does not. Outside of Anchorage, it is common practice to include an equipment grounding conductor in all conduits containing line voltage conductors. During an earthquake, a conduit coming apart at the fittings can create a life-safety hazard if one is depending only on the conduit for a safe path to ground.

The ground movement resulting from seismic activity, as well as freeze/thaw cycles and the melting of permafrost, can often create strain on underground conduit systems, particularly where it comes into light poles, boxes or buildings that may have experienced a different amount of movement than that of the conduit. The design of these systems require the use of flexible sections of conduit, elongated conduit slots in piling, rigid sweeps when coming above the surface and similar measures to prevent broken conduit and conductors in site lighting circuits.

Along with living in The Last Frontier comes a vast array of special applications to consider depending on a project's location. Alaska has over 6,000 miles of coastline, which is more than the 48 contiguous states combined. These coastal areas require additional considerations such as corrosion/salt-spray resistance. Combined with low temperatures, these circumstances require extensive research to find the right combination of ratings in the luminaires that get specified.

In-grade, uplight and low-mount luminaires can be problematic due to snow and ice buildup that blocks the light and hinders the use of snow plows, shovels, snow blowers and similar equipment, as well as the long-term exposure to moisture that often gets past the seals on these luminaires. In the proper setting, such as a sidewalk that includes a snowmelt system, these solutions are viable, but it is often difficult to find the right application.

One particularly prominent design area in Alaska involves landing strips and runways. Since most of the state is inaccessible by roads, Alaska possesses many locations to land an airplane. There are hundreds of airports and landing strips that are maintained for air traffic, and that doesn't include the countless bodies of water that are used for float planes, glacier landings during flightseeing tours and similar nonconventional uses in the state. Runway lighting design is important and often requires a radio system that pilots use to turn on the lights from miles away, since many of the airports/runways are remote and unstaffed.

The packaging and physical robustness of luminaires really come into focus when material is shipped to Anchorage, transferred to an airplane or barge, transported to remote Alaska and then

Photo: Roger Weese

Photo: Roger Weese

Photo: Channing Lillo

often delivered to a job site by a four-wheeler, snowmobile or truck driving over rutted, muddy or icy roads and trails. Manufacturers who take care in their packaging will be well reviewed when luminaires arrive unscathed on the remote job sites that define Alaska construction.

And let's not forget our furry, feathered and finned friends. Including moose, bear, bald eagles, owls, humpback whales and orcas, wildlife in Alaska is abundant, but the impacts of color temperature on their migration, reproduction, nocturnal activity and other patterns has not yet been a primary design consideration. As research progresses and design guidance becomes clearer, this issue may find more prominence in the coming years.

Similar to the impacts of lighting on wildlife, dark sky considerations have not been a leading topic of design but will hopefully continue to be part of the conversation. Alaska has an abundance of remote sites where dark sky is naturally found, but the light pollution around the population centers is similar to other cities across the country and world.

Overall, Alaska is an immense, rugged state with an amazing array of ever-changing conditions that keep lighting designers on their toes. From extreme temperatures and environmental conditions to the multitude of coastlines and runways, there is a seemingly endless number of challenges to conquer when working on Alaskan projects. ◎

Top Left: RSA conference room lighting, post-earthquake, 2018.

Bottom Left: A temporary repair in the RSA conference room while waiting for replacement.

Right: Ground thaw leading to collapsed power poles.

THE AUTHOR | Jeremy Maxie P.E., LC, RCDD is an associate principal electrical engineer with RSA Engineering, Inc. in Anchorage, AK. He serves as the West regional director for the IES and sits on the IES Board of Directors.

Photos: Ken Duncan

GO TELL IT ON THE MOUNTAIN

The Forgiveness Cross lights up the lives of Indigenous Australians

By Mark Tailby

At the very heart of Australia, in the spectacular West MacDonnell Ranges, is a new tourism icon with a legacy dating back over 100 years. In the early 1900s, four Indigenous evangelists walked this land, leaving Hermannsburg Lutheran Mission to spread their Christian faith. A monument to these four Indigenous missionaries was built at the base of Bald Hill—now known as Memory Mountain—with plaques dating the site back to 1923. This area is a traditional meeting place for the local people, who gather for Christian celebrations they call Sing Along. The local people spoke about this area from their dreamtime, before the white man came, with a big emu coming from the east and smaller emus arriving with family and friends from the

During the launch event, beams of light were added to accentuate the Forgiveness Cross.

south and north to meet, talk, sing and have fun.

In more recent times, the Traditional Owners and Elders of this region had a vision to construct a cross on the summit of Memory Mountain to reflect the faith, culture and creativity of the local Indigenous people. In 2009, the local Elders shared their vision with renowned Australian photographer Ken Duncan and asked for assistance to bring the idea to fruition. While Indigenous people technically own their land, it is held by Land Trusts, and the community cannot build anything on that land without lengthy discussions to obtain approval from federal government bodies.

The vision of the Elders to build this cross ignited a passion within the local people, with the cross representing an opportunity to share their culture, traditions and creativity with the world. United in their conviction, the communities of Haasts Bluff and Papunya began the process of seeking approval for the cross. One-on-one discussions with community members and numerous meetings in the communities of Haasts Bluff, Papunya and Alice Springs were held before approval was granted.

The Forgiveness Cross was designed and engineered by Graeme Thitchener of Thitchener Consulting, based in Wamberal, New South Wales, Australia, and constructed by PlazArt Creative Metal Work based in Alice Springs in the Northern Territory of the country, and stands 20 meters (~66 ft) tall on the summit of Memory Mountain. It was constructed somewhat like a Meccano or Erector set: using steel angle up to 16 millimeters

Workers are photographed while testing the lights.

thick created the frame, which was bolted together, and then panels of Corten steel were bolted to its sides, along with offset relief corners. The 4.3-meter by 1.8-meter by 1.8-meter (~14 ft by 5.9 ft by 5.9 ft) arms of the cross were raised by a hydraulic winch connected to the main frame by a pivoting bolt, then winched into their final position 14.1 meters (~46.3 ft) above the ground.

The Forgiveness Cross and access pathway to the summit were designed and constructed to be sensitive to the aesthetics of the landscape, minimize erosion and protect native flora, and it was completed with respect to the wishes of the Traditional Owners of the land.

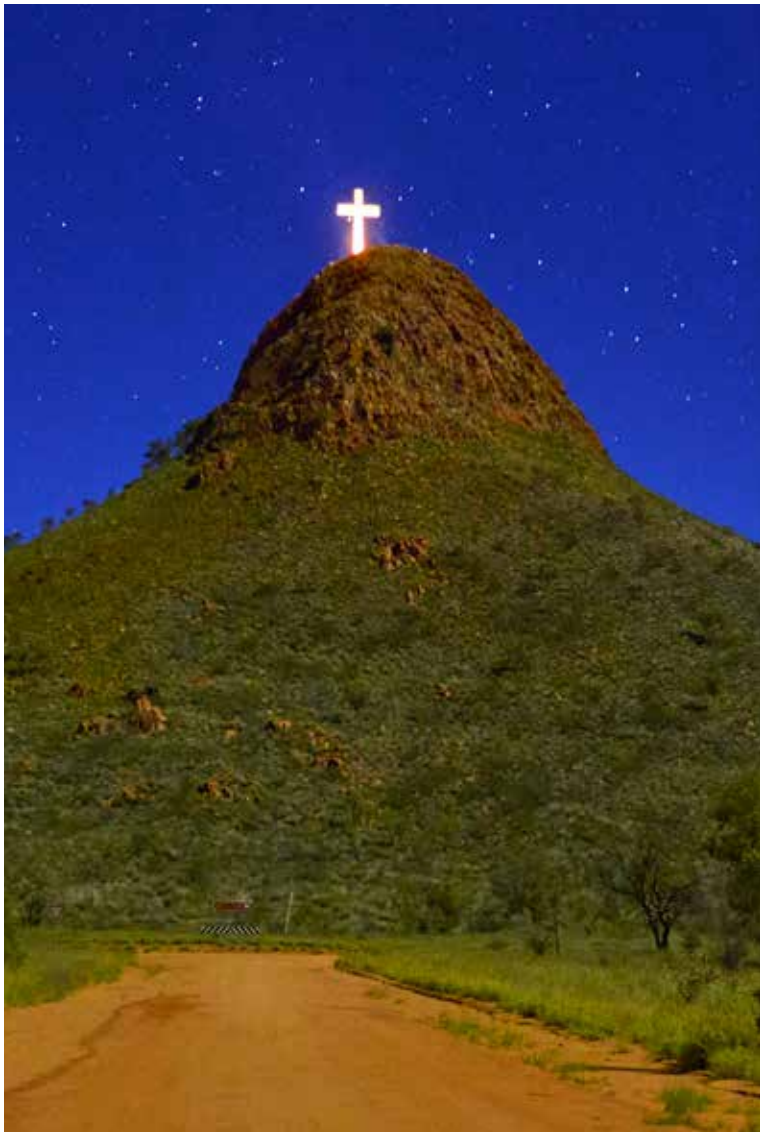
The first stage of construction included building a steel track up the mountain. In some parts, bridges were built, and in others, wire mesh was placed and nailed into the ground so small, converted Suzuki four-wheel-drive vehicles could carry the steel and supplies up the 1-kilometer (~0.6-mile) track. It took hundreds of trips to complete the track and the cross, since the use of helicopters was considered too dangerous due to wind strength at the summit.

In October 2022, construction of the structure was completed with outlined fiber optic lighting installed. That lighting, although recommended, generated insufficient light and proved to be ineffective.

With completion of the project coinciding with the 100-year anniversary of the arrival of the Indigenous missionaries, the Forgiveness Cross was officially handed over by Walk a While Foundation Limited to the Traditional Owners of the land during their Easter celebrations in 2023. The Forgiveness Cross is currently owned by Memory Mountain Limited, an Indigenous organization owned and operated by the Traditional Owners of the land.

Since the fiber optic lighting installed in 2022 was not fit for purpose, a lighting specialist was brought in for the 2023 Easter Celebrations who illuminated the structure using flood lights powered by a generator. These lights were too powerful, making the cross difficult to see and photograph. As a result, the Walk a While Board sought a power-efficient compromise between the two previous lighting solutions that would work within the power constraints of the Red Earth BlackMax battery backup solar powered unit. Red Earth's BlackMax battery system is a ready-to-run energy storage system for off-grid applications. It consists of a SurePower 5000 hybrid inverter and up to three self-managed lithium batteries (12.4 kilowatt hours [kWh] total). It is fully assembled, factory tested and requires no programming.

Two 4.1-kWh batteries (8.2-kWh capacity) or useable power of 6.56 kWh were employed, where the unit is configured to use 80% of the available batteries to optimize their life. The lights are run from 5 p.m. (sunset) until 11 p.m., but the Black-



Max system has enough power for 24/7 illumination while also running welders and electric tools when needed.

For significant events, there is also the option of running specialist lighting through the Red Earth BlackMax and connecting a generator to supply additional power. There are four solar panels on top of each arm of the cross (a total of eight panels), creating enough power to charge the batteries to full power on a daily basis.

Peter Spirko from 3S Lighting designed, tested and supplied the permanent lighting solution, which was designed with LED spotlights strategically positioned to achieve even illumination of the cross so that it may be seen from long distances. Custom lenses ranging from 10 deg to 70 deg were employed to achieve a 3D appearance of the structure at night.

The plan is to create tourism at Memory Mountain and bring employment opportunities, sustainable enterprises and financial independence for Indigenous communities.

BRINGING A BEACON TO LIFE

The illumination of the Forgiveness Cross was achieved through the following:

- Manufacturer: 3S Lighting
- LEDs: 3,400 lumens (25.5 watts)
- Custom Lenses from 10 deg to 70 deg
- Color Temp: 3500K
- CRI: 90
- Diecast aluminium housing, IP65 rated
- 355 deg rotating and 140 deg tilting

The over-arching philosophy for the Memory Mountain precinct is to conserve, reduce, reuse and recycle. On-site amenities will run on solar power, supplemented by wind-generated power. Grey water will be recycled for gardens, native trees planted for shade and, in time, vegetables grown on site to supply meals for visitors and staff.

The plan is to create tourism at Memory Mountain as part of a long-term, life-changing strategy, where camping facilities and accommodation will benefit Indigenous Australians. Tourism and ancillary businesses will bring employment opportunities, sustainable enterprises and financial independence for the local communities.

In April 2024, the final work, health and safety requirements for the track were completed and permanent lighting for the cross completed using local Indigenous labor working alongside skilled tradesmen. Walk a While employs local Indigenous land-care managers and is training local Indigenous community members for roles in hospitality and tourism, and Memory Mountain will soon be taking bookings for tours starting in 2025. For more information, visit *www.walkawhile.org.au* and *www.memorymountain.com.au*. ◎

THE AUTHOR | Mark Tailby is a retired CEO having supplied materials to the signage and graphics industries around Australia for 40 years and serves as a director on the Walk a While Board.

GARDEN CITY GREENS

Photo: Raphael Olivier

Plant life is the standout feature at an urban commercial complex

By Michele Zimmerman

Photo: Raphael Olivier

Left: "Green pockets" with live trees are built into the façade of a commercial complex in Singapore's Financial District.

Right: A mixture of pastel-green and white lights allow living greenery to remain more visible than interior illumination once the sun sets.

Nestled in the core of Singapore's Central Business District, a bustling location marked with skyscrapers, transit hubs and densely populated commercial and residential areas, is CapitaSpring—a high-rise that takes the concepts of workplace greenery and house plants to a whole new level. The $1.3 billion (USD) new construction project by Singapore-based developer CapitaLand, architects from BIG and lighting designers at Nipek, emphasizes a connection to nature with the placement of "green pockets" that host living trees right within the building's façade. Ficus Lyrata, Ficus Longifolia and Schefflera actinophylla, otherwise known as Fiddle Leaf Fig Trees, Banana Leaf Fig Trees and Umbrella Trees, respectively, extend beyond vertical façade fins—proving that the business district is invested in more than just the color of money. The unique project challenged the lighting designers to come up with a scheme to highlight the plants against the backdrop of bright interior illumination while ensuring that façade lighting was as unobtrusive as possible. The result? The designers found their green thumbs.

Nipek Associate Director Takahisa Yamaguchi said, "It was difficult for the deep green trees (typical of tropical Southeast Asia) embedded in the façade to stand out at night if simply illuminated with usual white light. Therefore, pastel-green colored lighting mixed with 4000K white light is used to emphasize the green [plants] in a subtle

Photo: Nipek

Gobo projectors create leaf-like shadows in community spaces.

way. The lighting trick almost creates an illusion that the greens are livelier and fresher after dark," explained Yamaguchi. The team implemented numerous DAIKO 24-W, 4000K fixtures with Rosco colored lenses and DAIKO 24-W, 4000K white-light fixtures to pull off the illusion. Yamaguchi added, "It was good to see that we were able to try something new and succeed, and that it will be a trend in the future."

Though lighting the project wasn't all a walk in the park. "There were some uncertainties in this project before it was completed, such as how effective the colored lights would be and the use of tree spotlights as the main lighting element instead of downlights," Yamaguchi said. Some of the biggest lighting hurdles pertained to an additional component of CapitaSpring—a parking area, with a required 150-lux light level, surrounded by near-transparent perforated façade panels that had the ability to completely overtake the building's design integrity after work hours.

"Singapore's government authority, the Urban Redevelopment Authority, was concerned that the lighting of the parking floors would affect the overall nighttime appearance as the green pockets that characterize the façade are on the same floor as

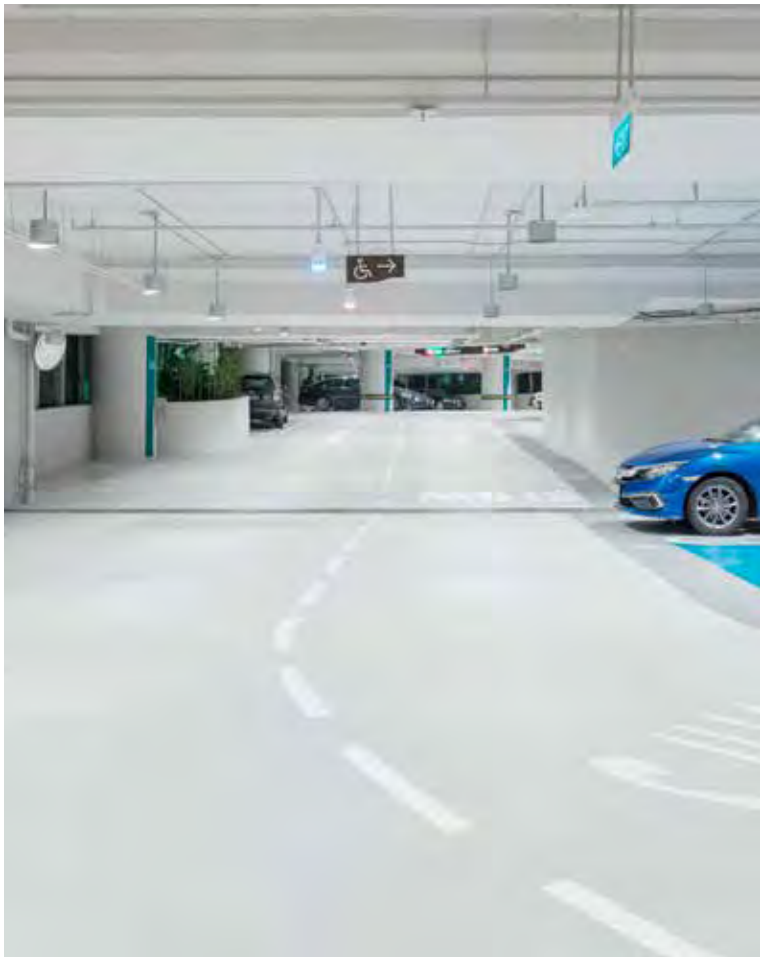


Photo: Raphael Olivier

Photo: Fabien Ong

Even more greenery can be found on CapitaSpring's rooftop and in semi-outdoor community areas that provide moments of tranquility within the busy urban landscape. The lush multi-level roof includes low-level illumination via spotlights by ENDO and path-lighting bollards by Vibia so as to keep the 360-deg panoramic view of Singapore undisturbed for guests. Partial-outdoor and fully outdoor public spaces rely on 47-W, 3500K spotlights/gobo projectors by Meyer Lighting, while a play between light and shadow tie the flora into the architecture to create a dramatic ambiance. Shadows made by real leaves and the illusion of leafy-shadows, produced by 20-W, 3500K fixtures (also by ENDO), carry plant-like visual continuity onto man-made surfaces. ◎

At A Glance

- The project earned a 2023 Illumination Award of Merit.
- The project achieved 2018 Building and Construction Authority Green Mark Platinum Award.
- Tropical flora typical to the region were included in the project.

the parking level," noted Yamaguchi. "This [concern] was especially due to the perforated-façade panels that can become almost transparent in the dark, allowing passersby to see the ceilings of the car-park levels from the nearby streets. Hence, the entire façade of the podium needed to appear evenly illuminated without adversely affecting the green pockets." Nipek and BIG had to come together to find the best solution. "The aperture ratio of a façade screen was precisely designed by BIG and [18-W, 3000K] downlights [by ERCO] with excellent glare control were chosen for the parking lot. The fixtures along the façade are shielded on one side and are not visible from the street level outside," explained Yamaguchi.

Left: Downlights in parking levels are partially shielded, helping to preserve the building's nighttime appearance and keep attention drawn to green pockets.

Right: Illumination levels on the rooftop are kept low so the panoramic view remains undisturbed.

THE DESIGNERS | Takahisa Yamaguchi is an associate director at Nipek.

Shigeki Fujii is a director at Nipek.

Natsuko Ueda is a director at Nipek.

Li Ying Chai is a project lighting designer at Nipek.

SMART OUTDOOR LIGHTING

Zhaga-D4i offers a potential transformational change in the lighting world

By Mark Duffy

The Zhaga Consortium, with over 600 member companies, develops specifications for standardized interfaces between luminaires and LED modules, intelligent sensors, communication modules and LED drivers. Together with the DALI Alliance, digital products certified to the Zhaga-D4i specifications by multiple vendors provide a platform supporting the needs of smart outdoor lighting systems in the circular economy. Our 24 regular member companies actively prepare the specifications, known as Books, that form the foundation of interoperability within the lighting system. Together with the associate members, more than 180 companies are eligible to certify products to the Zhaga Books.

The popular Zhaga Book 18, Edition 3 *Smart Interface Between Outdoor Luminaires and Sensing/Communication Modules* offers a hybrid architecture for classic cobra-head luminaires featuring a NEMA and one or two Zhaga 4-pin receptacles (see **Figure 1**). Zhaga worked with the ANSI Accredited Standards Committee C136 to align the Book 18 specifications with the ANSI 136.41 standard for the NEMA receptacle. With these receptacles available on the same luminaire, the lighting system is ready to come alive with sensing and communication functions extending far beyond dimming. Functions such as environmental sensing (weather, air quality or smoke), area security monitoring (surveillance cameras, noise detection), vehicular and pedestrian traffic detection and control, emergency response and parking space assistance become available to smart outdoor lighting systems. Zhaga likes to imagine them as the digital equivalent of our common sensing and communicating organs, eyes, ears, nose and mouth. In addition, the outdoor lighting system designer can specify networking to connect with the IoT, thereby accessing a broad communication network.

Zhaga Book 18, Edition 4 will provide mounting surfaces for lighting controls via a pole-mounted bracket assembly containing one or two Zhaga 4-pin interfaces (see **Figure 2**). The bracket is expected to be available as a retrofit option for existing luminaires. The specification will address requirements for long cables needed to connect the bracket-mounted devices with the D4i drivers in the luminaire. This will enable these decorative and heritage luminaires to become part of the smart city lighting system.

A key aspect of the Zhaga Book 18 platform is its embrace of the transformation to digital control of lighting by complying with DALI requirements. By specifying the DALI D4i protocol for LED drivers, luminaire communication in the lighting system provides energy usage monitoring and reporting as well as diagnostic and maintenance tools to assist in asset control. To fully support this vision of a large variety of functionalities and interoperability, the Zhaga platform incorporates multi-master devices and the two-node architecture. Control devices mounted on a Zhaga receptacle are required to be type-A or type-B as specified in DALI – Part 351 *Luminaire-mounted Control*

Devices. DALI type-A control devices have an integrated multi-master application controller and support 2-W average power consumption from the auxiliary power supply. DALI type-B control devices have either an integrated multi-master application controller with an arbitration algorithm for one or more input device instances, or both, and support 1-W average power consumption from the auxiliary power supply. When a type-A module and a type-B module are attached to the luminaire, the DALI application controller of the type-B module is disabled, and the DALI application controller of the type-A module controls the system. For more information, see the Zhaga-D4i technical guide (18-Oct-2023) in Zhaga publications: *https://www.zhagastandard.org/media-events/publications.html.*

Zhaga and the DALI Alliance have developed a joint program for the certification of interoperable luminaires and sensing or control devices and communication modules. Luminaires, sensing or control and communication modules based on complementary Zhaga Book 18 and DALI D4i specifications are eligible for dual certification and subsequently to display the combined Zhaga-D4i logo (see **Figure 3**). Separately, Book 18 receptacles, bases and caps are eligible for certification from Zhaga and LED drivers are eligible for D4i certification from DALI Alliance. Features of Zhaga-D4i certified products make several advantages clear. The ability to easily add new sensors or upgrade communication modules to existing luminaires in the lighting system makes the Zhaga platform resilient and supports a circular economy where the luminaire is repurposed rather than discarded. The intra-luminaire D4i interface enables bi-directional communication between sensors or communication modules and LED drivers. D4i certified LED drivers can report operational and diagnostic data to an external network and provide inventory-related information about luminaires. Finally, with a suitable wireless communication module, the luminaire can become part of the IoT.

Specifying Zhaga-D4i certified luminaires opens an eco-system of multiple vendors supplying interoperable products and reducing the "vendor-lock" risks associated with proprietary systems. If the original vendor goes out-of-business or no longer supports the original lighting system, then there will be multiple vendor options to repair or upgrade the system without scrapping the luminaire and starting all over. Procurement is made easier through the maintained certified product databases of the Zhaga Consortium (*https://www.zhagastandard.org/products.html)* and the DALI Alliance (*https://www.dali-alliance.org/products*). The Zhaga product database contains over 340 Zhaga-D4i luminaire families by more than 50 manufacturers. The DALI product database contains over 400 D4i certified drivers. These databases are growing steadily. By specifying Zhaga-D4i in tenders, luminaires selected today can keep up with the rapid technology advances of tomorrow. In short, specifying Zhaga-D4i gives confidence that the product works, it's repairable, it's upgradeable and it's available.

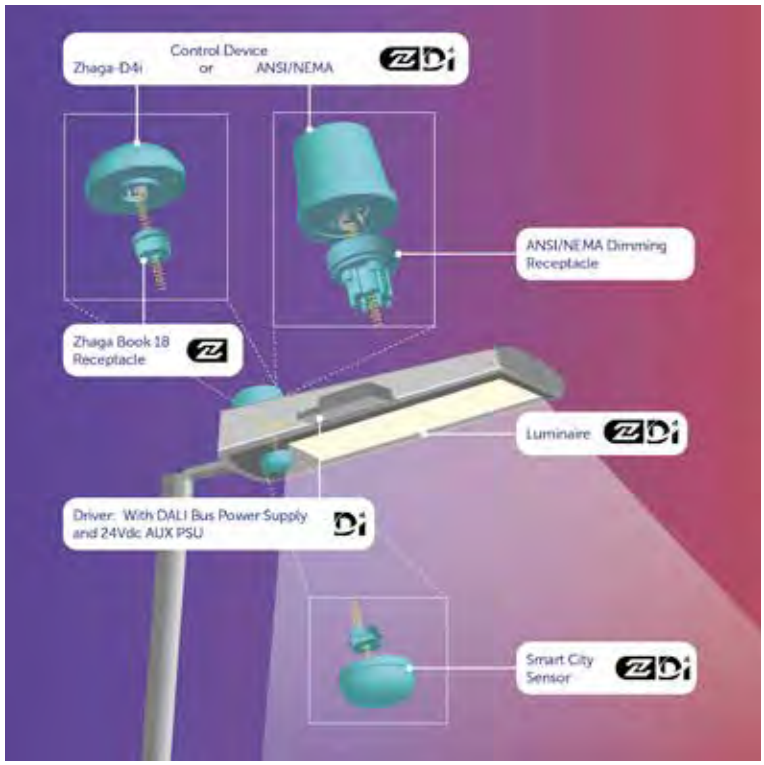


Figure 1: A Zhaga Book 18 luminaire with hybrid NEMA/Zhaga architecture.

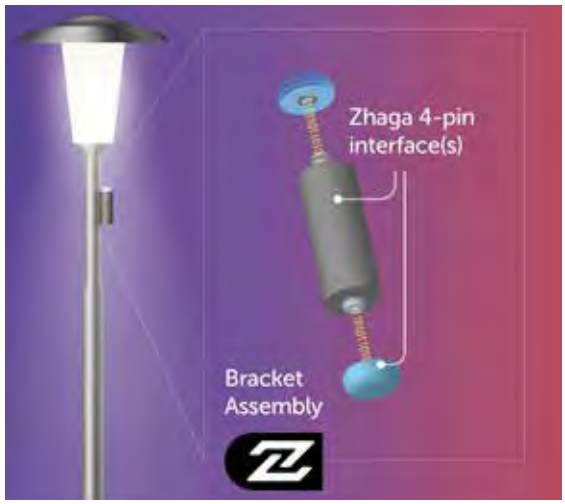


Figure 2: Zhaga Book 18 Ed 4 bracket assembly with interfaces for decorative and heritage luminaires.

Figure 3: The Zhaga-D4i dual logo.

The aims of a circular economy are to limit consumption of resources and raw materials as well as avoiding landfill waste. Armin Konrad, an active regular member in the Zhaga Consortium expressed the concept of circularity lighting and serviceability very succinctly (see text box below). Konrad points out that the key to serviceability is modular design through standardized interfaces. Serviceability requires luminaires and light management systems that can be repaired, when broken, upgraded as technology advances, and replaced when necessary. That is where Zhaga comes in and develops specifications for standardized interfaces enabling LED luminaires to promote a circular economy.

"Circularity lighting encompasses products and systems that support the aims of the circular economy through enhanced serviceability. To be serviceable, these products and systems must be designed in a modular way and use component interfaces that are based on standardized and widely recognized specifications," said Armin Konrad, senior director at LEDVANCE GmbH.

Visit the Zhaga special page on circularity lighting: *https://www.zhagastandard.org/circularitylighting*

Interoperable products designed for the Zhaga platform bring benefits to designers, specifiers and end-users and support a circular economy. As pressure mounts to combat light pollution, another form of waste, and provide healthy lighting to humans, animals and plants, the need for design flexibility and product options increases. Zhaga-based luminaires are future-proof because light sources can be purchased from multiple suppliers. The latest-generation technology can be adopted easily. Luminaires can be specified for future projects in the knowledge that a current, up-to-date LED light source can be fitted when the project is installed.

The use of Zhaga-D4i luminaires for smart outdoor lighting systems is happening around the world. In Sydney, Australia, the Southern Sydney Regional Organization of Councils working jointly with Ausgrid, an electricity distribution company, initiated the Street Lighting Improvement Program in May 2023 to deploy more than 62,000 Zhaga-D4i-certified LED luminaires with smart street lighting controls and additional Zhaga interfaces for sensors.

Algeciras, Spain, has started an upgrade project for the city's 5,600 luminaires that aims to introduce centralized management, save energy and increase security in sensitive areas at night. Using Zhaga-D4i luminaires and components, they can transfer DALI luminaire, energy and diagnostics data to their connected lighting system, enabling users and customers to remotely manage, monitor and control the city lights. In some areas, lighting is regulated automatically according to vehicle and pedestrian traffic through the use of a Zhaga-D4i-certified radar motion sensor. The new system has reduced energy consumption by more than 50% and is future-ready due to the interoperability provided by standardized Zhaga and DALI technology.

In Dortmund, Germany, a 15,000 streetlight project is redefining urban lighting. Using Zhaga-D4i-certified products, the power of a networked lighting system is on display as each luminaire can be individually monitored and controlled. The unparalleled flexibility allows for the central management system to collect information on lamp status, radio communication, failure analysis, energy consumption and even set lighting profiles throughout the city. As a result, the city's quality of life is improved and the operational costs, CO_2 emissions and maintenance requirements are dramatically reduced.

Zhaga Book 18 with Zhaga-D4i may effect a transformational change in the lighting world. Michael Davidson of Synapse Wireless Inc., an active Zhaga regular member, said, "[Zhaga Book 18] will definitely change lighting by having an universal interface, just like USB changed the world of cameras and computers, it's going to change lighting so there is one interface [that] everyone's going to design to. You put it into every luminaire so it's controls-ready, it's sensors-ready. It's going to change the whole lighting industry... for the good." ◎

THE AUTHOR | Mark Duffy chairs the Zhaga Consortium General Assembly, a leading developer of specifications for luminaire interfaces and interoperable components. A 39-year veteran of the lighting industry, he has been active in ANSI, IEC and IES lighting standards development organizations for over 20 years.

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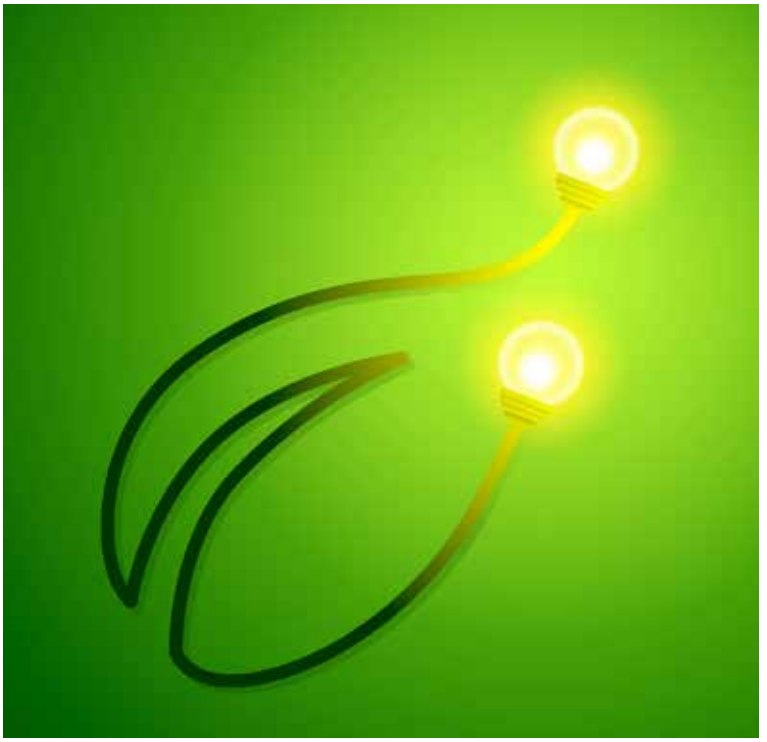


SPECIFYING SUSTAINABLE LUMINAIRES

The good, the not-so-bad, the TBD

There are many good, not-so-bad and yet-to-be determined elements of sustainability that are helpful to understand when attempting to balance the quality and effectiveness of luminaire specifications and applied lighting design with their net environmental impact. Let's take a look at these three categories and explore the various elements of each.

By Scott Roos

The Good

According to a soon-to-be-published GreenLight Alliance Life Cycle Assessment luminaire incubator study, Operational Carbon—the carbon emitted from the electricity consumed during the use phase of a luminaire—constitutes about 98% of the total life cycle environmental impact from a luminaire.

Tremendous progress has been made on reducing lighting energy consumption through the vastly improved efficacy of LED technology, improved luminaire optical design that more efficiently directs lumens into useful zones and the uptake of more granular lighting controls that ensures lights are on at the minimum required level only when needed. Our industry deserves a big pat on the back for our attainment and continued quest to reduce the energy consumption of luminaires and applied lighting designs. And while many other metrics associated with sustainability are still emerging, specifiers design and predict the attainment of lighting energy use with great clarity, consistency and project specificity.

A study by the Carbon Leadership Forum that focuses on a wide range of new office buildings informs that the lion's share of the embodied carbon of a new building comes from its structure, sub-structure and façade with LED luminaires only comprising between 0.5% to 1.5% of a building's total.[1] Nonetheless, manufacturers have a responsibility to reduce luminaire embodied carbon through more innovative design and publish their embodied carbon content to enable comparisons.

Calculating the embodied carbon of a luminaire can be a simple exercise, and the TM65 Embodied Carbon Calculation Methodology developed in the UK is expected to become available later this year for use in North America. In the not-too-distant future, it is reasonable to expect that a consistently calculated and comparable Embodied Carbon metric will become a standard piece of information on luminaire spec sheets. In the meantime, know that, in most cases, the number, size and weight of the fixtures specified are a good proxy (i.e., if fewer, smaller/lighter fixtures are specified chances are good that embodied carbon will be reduced).

Circular design, in conjunction with a supporting circular economy infrastructure, eliminates waste and maximizes continual use, reuse, sharing, repair, refurbishment and recycling to minimize resource inputs, waste, pollution and carbon emissions. To help assess a luminaire's attainment of circularity, the UK-based Chartered Institute of Building Service

Engineers (CIBSE) developed a simple-to-use TM66 Circular Economy Digital Assessment Tool that evaluates a product's design, manufacturing, materials and supporting ecosystems.

The TM66 assessment tool, which can be downloaded from the CIBSE website, results in a score ranging from Very Poor to Excellent, providing a basis of comparing the level of attained circularity for two like-kind products. While we have a long way to go to achieve the full potential of a circular economy, TM66 is a relatively simple evaluation tool that should become widely adopted to aid both manufacturers and specifiers in identifying gaps and driving toward greater circularity.

Another "good" aspect of luminaire sustainability is the relatively minor role luminaires play in the overall material health concerns of a building. For the most part, luminaires do not contain volatile organic compounds or significant amounts of other chemicals of concern found in many other building products that are most likely to cause direct health hazards to building occupants.

Lighting specifiers that have concerns about the presence of particular chemicals of concern can prioritize the selection of fixtures that provide material transparency in the form of a Declare Label, Health Product Declaration (HPD) or, for example, specify luminaires with PVC-free eco-friendly wire insulation and Restriction of Hazardous Substances (RoHS)-compliant electronics as disclosed on spec sheets.

Another "good" is that the steel and aluminum, which comprise the highest material content by weight in many luminaires, are produced from a high percentage of recycled content and are infinitely recyclable with very high rates of recycling. Industry estimates show that in aggregate, the recycled content of die-cast aluminum parts is 80%,[2] extruded aluminum 54%,[3] and sheet steel 25% to 35%,[4] which significantly reduces embodied carbon as compared to virgin material. Metals producers have every incentive to use as much recycled content as is available because it lowers their cost to produce.

Finally, Corporate Social Responsibility Reports (CSR) demonstrate progress in many areas including commitments to lower operational greenhouse gas emissions (GHG) using science-based targets working toward Net Zero.

The Not-so-Bad

Like any electrical product, luminaires have some less-than-desirable chemical ingredients that manufacturers should feel obligated to identify and reduce, as the industry is starting to do. Looking at the list of ingredients in a typical luminaire, one finds a lot of commonalities among fixtures from all manufacturers, regardless of whether they have embraced material transparency.

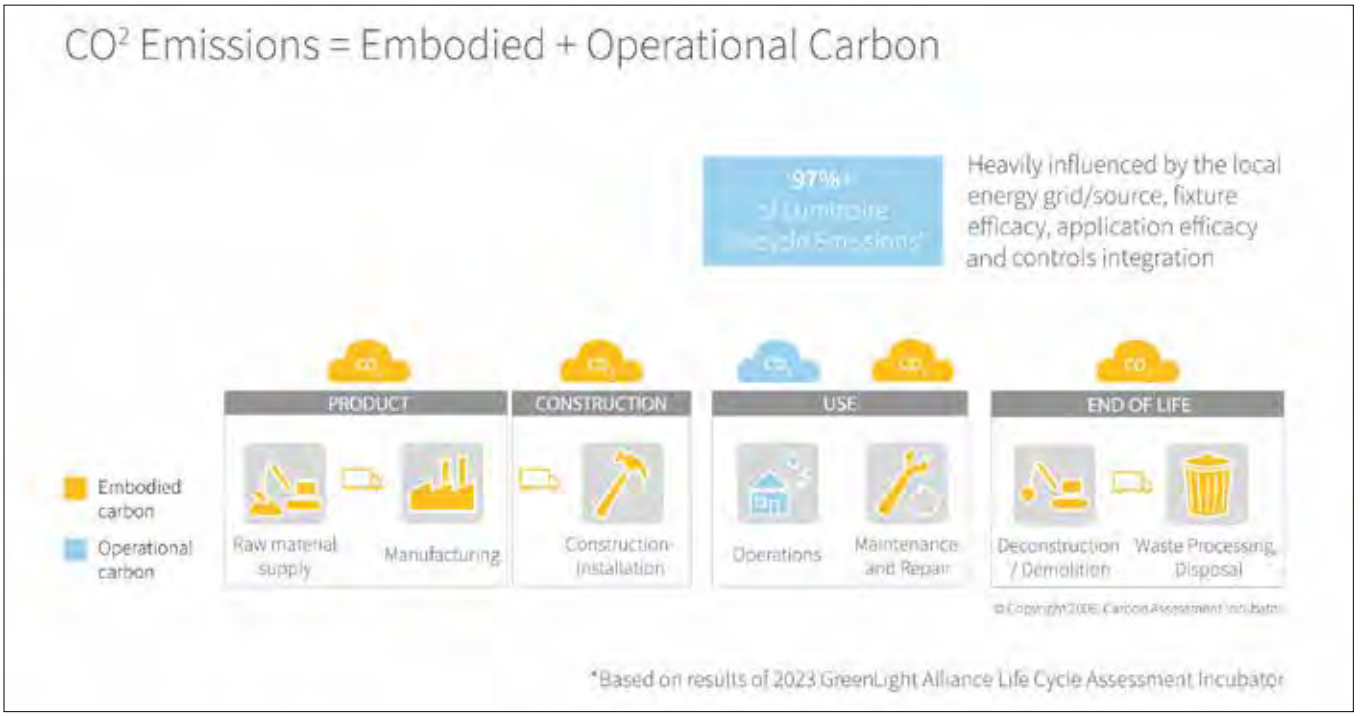
Most drivers from global suppliers comply with RoHS, a mandatory requirement for electrical components sold into the European Union, meaning that hazardous substances are restricted to levels that reflect the current state of the art of electronics manufacturing. This is why Declare "Red List Approved" labels have an exemption for small electronics and Declare "Red List Free" labels for luminaires likely earned that status by excluding the electronics, as is the case with incandescent socketed fixtures that ignore the ingredient impacts from the requisite LED lamp and for remote driver fixtures.

While the migration away from PVC wire insulation in luminaires is progressing slowly due to limited supply and significantly higher costs, it is helpful to have the perspective that the length of wire used in luminaires comprises an infinitesimal part of the PVC used throughout a typical building relative to the miles of building wire, electrical boxes, plumbing pipe and fittings, flooring, window casements, roofing membranes, etc.

The trace amounts of additives used in plastics and coatings in many luminaires include a diverse group of chemicals, some of which are of concern. Most of these additives are required to provide the necessary mechanical, thermal, electrical, optical, UV, flame-retardant and durability properties with no environmentally friendly substitutes. While certainly an area for improvement, these small amounts are much less concerning than, for example, their greater use in building products such as fabrics, wall coverings, flooring and furniture, which have more prolonged and intimate human contact.

Specifying fixtures that minimize the use of plastic components, including considering products using more innovative bio-based materials, will reduce the presence of additives and mitigate another "bad." Most of the plastic used in luminaires are classified as #7 compound materials that cannot be easily recycled, which means they will likely end up in a landfill, even if the luminaire has been perfectly designed for disassembly.

Likewise, the current chances of drivers and other electronics in luminaires being recycled at end-of-life is very low because the electronics



Embodied vs. operational carbon.

waste regulations and infrastructure are not in place to support wide-scale recycling for all types of electronic componentry to include those found in luminaires. Additionally, the ecosystems needed to support the recovery, remanufacturing and reuse of complete luminaires simply don't exist yet outside of a few small-scale pilots.

The TBD

An emerging sustainability metric for luminaires is a comprehensive life cycle assessment (LCA) of the complete environmental impacts of a product over defined stages of its cradle-to-grave lifetime. The most accepted form of an LCA is an Environmental Product Declaration (EPD), an independently verified and registered document that communicates transparent information about the life cycle product impacts in seven categories as they effect the health of the atmosphere, water and earth.

EPDs have been available for many years for a variety of high environmental impact building products and materials such as concrete, structural steel, glazing and flooring. The rules and assumptions to create EPDs for luminaires in North America are still in development, although some luminaire EPDs using rules developed for Europe are starting to become available.

Theoretically, EPDs would enable lighting specifiers to make accurate comparisons of the total life cycle environmental impact of different luminaires. In practice, there are many challenges for luminaire EPDs to be scaled in a meaningful and comparable way.

First, the significant amount of time and expense to create an EPD poses a challenge to scale them to large portfolios of fixtures and accurately represent the wide variety of product configurations and options within a product family. In the future, AI may provide an on-demand solution to creating configuration-specific luminaire EPDs.

Second, there are many yet-to-be resolved underlying inconsistencies that hinder both the accuracy and comparability of EPDs, including the use of different primary and secondary data/databases and variations in the software platforms used to collect/interpret data. Even the EPDs available for other building products caution that the results of like products are not directly comparable.

Third, the fact that approximately 98% of the life cycle environmental impacts of a luminaire come from the electricity consumed during the use stage, something already well-characterized on a project specific basis, makes the value-add of luminaire EPDs above and beyond TM65 Embodied Carbon Reporting and TM66 Circular Economy Assessment of questionable value.

Fortunately, a middle-ground solution in the form of industry-wide EPDs (IW EPD) is on the near-term horizon. An IW EPD uses aggregated data from multiple manufacturers to characterize the environ-

mental impact of a product type, such as a downlight, 2-by-2 troffer or linear fixture. Since most of the impact in an EPD is from the use stage, manufacturer-specific embodied carbon differences will be an insignifant source of variation relative to the category average, making the IW EPD more than just directionally accurate. Simply specifying the highest efficacy fixture will result in achieving the lowest possible life cycle impact. If a manufacturer supplies data toward an IW EPD, which is not nearly as resource intensive as a product specific EPD, their product qualifies toward earning a point in LEED. Look for the first IW EPDs for several major fixture types to be published later this year as an outcome of the GreenLight Alliance Lifecycle Assessment incubator study.

Our industry is on an important journey to drive improved sustainability in the products that are designed, manufactured, specified, used and ultimately decommissioned. Much progress has been made toward reducing the dominant energy use or operational carbon impact from luminaires and their applied lighting and controls design. Emerging metrics will help improve understanding of the environmental impacts from luminaire embodied carbon and circular design attainment. However, there is still a long way to go to put the ecosystems in place to support a more circular economy that maximizes recovery, reuse and recycling. ◎

THE AUTHOR | Scott Roos is vice president, Sustainability and Business Optimization, Specialty Lighting Group at Acuity Brands Lighting and Controls. The products on which Roos has worked have earned numerous patents and awards including the Industrial Design Excellence Award and LightFair's Most Innovative Product and Technical Innovation awards.

References

1 The Carbon Leadership Forum, "Life Cycle Assessment of Mechanical, Electrical, and Plumbing in Commercial Office Buildings," Apr. 2019.

2 (Marshall) Jinlong Wang, "The Environmental Footprint of Semi-Fabricated Aluminum Products in North America," The Aluminum Association, Jan. 2022.

3 Aluminum Extruders Council, "Extrusion EPDs/LCA," 2022. Available: *https://aec.org/extrusion-epdslca*

4 Steel Recycling Institute, "The Inherent Recycled Content of Today's Steel," Oct. 31, 2001. Available: *https://www.nerdsofsteel.com/wp-content/uploads/scrap-use-calcs.pdf*

2024 Lumen Award Winners Announced

The IESNYC celebrated the 10 winning firms (11 projects) of this year's Lumen Awards at the 56th Lumen Award Gala held in Manhattan's Chelsea Piers in June. The awards program honors excellence in lighting design in innovation; Lumen Committee Chair and Principal at Focus Lighting Christine Hope said, "Each winning project showcases the transformative power of lighting design in enhancing architectural spaces and experiences." Shoshanna Segal, president of the IESNYC and principal at Hartranft Lighting Design, added that "[the program] not only celebrates individual achievement but also underscores the collaborative nature of lighting design. This year's awardees exemplify the innovative spirit and technical expertise that drive our industry forward."

Winning firms were either awarded the Lumen Citation or Lumen Award of Merit. Recipients of the Lumen Citation are as follows:

- **Anita Jorgensen Lighting Design** for Touro University Flagship Campus Lobby at Times Square
- **Atelier Ten** for The Omaha RiverFront.

Recipients of the Lumen Award of Merit are as follows:

- **Cooley Monato Studio** for KHAITE
- **Flux Studio Ltd** for Korean War Veterans Memorial
- **DLR Group** for Saint Nicholas Greek Orthodox Church and National Shrine
- **HLB Lighting Design** for I-74 Mississippi River Bridge
- **LOOP Lighting** for % Arabica—Union Station, Toronto
- **Map Design Studio** for David Zwirner Office Headquarters
- **Studio Atomic** for Hotel AKA NoMad
- **Tillotson Design Associates** for 712 Fifth Avenue Atrium and Lobby and Christ Church United Methodist.

Photo: Alexander Severin


Photo: Erik Petschek


Photo: Michael Moran/OTTO


Photo: John Muggenborg

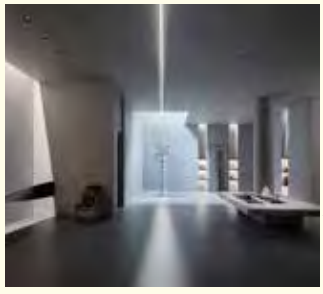


Photo: Eric Petschek; Aditi Govil

Winning projects include Touro University (top left); 712 Fifth Avenue Atrium (center); Christ Church United Methodist (top right); % Arabica—Union Station, Toronto (bottom left); and KHAITE (bottom right).

IES-PHIL Invests in the Future Generation

The Philadelphia Section announced its annual IES Philadelphia Lighting Education Scholarship winners, as well as the recipient of the new Raymond Grenald Lighting Design Excellence Award, in June. The Lighting Education scholarship awards single-year, merit-based $5,000 scholarships to undergraduate and graduate college students studying architectural lighting, interior design lighting, industrial lighting, landscape lighting or theatrical lighting. This year's awardees are Emma Hogan (pictured left) and Mason Meo (pictured right), both of Thomas Jefferson University. Two $500 Honorable Mention Awards were awarded to Pooja Anil Bhoge, also of Thomas Jefferson University, and Connor Cohen of Drexel University.

The newly established Grenald award honors the late, renowned lighting designer Raymond Grenald. A founding member of IALD, Grenald was known for progressing the art and science of lighting as well as lighting design for architecture and well-being. The award, a prismatic statue in theme with the program, salutes a deign project that embodies the principles of good lighting and impresses visitors with a subtle yet impactful use of illumination. The selected project this inaugural year is Simmer Down at the Quoin Hotel by designers from BEAM, ltd. and Stokes Architecture + Design.

IES Goes to India

Photo: Messe Frankfurt India

The first-ever IES event in India, a three-hour lighting workshop held in collaboration with global event coordinators Messe Frankfurt, took place at the LED Expo Event in May. With over 200 guests, the pilot workshop to test the interest level of audiences in Mumbai and beyond was a success. The workshop allowed for the possibility of another international Section to be explored and served as a mode of marketing LightFair as well as a precursor for the largescale Fundamentals of Lighting Workshop that will take place in New Delhi in November. Attendees had the opportunity to hear past LightFair presentations and each received a certificate of participation from the Society.

MEMBER MENTIONS

Sarah Danke (top left), James Foster (top right), David Lincecum (bottom left) and Durrell Ramer (bottom right) have been appointed vice presidents of marketing, finance, international operations and professional services, respectively, at **ETC**. Jeff Welch, current vice president, is retiring at the end of 2024.

Bold = Individual or Sustaining Member

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- ALUZ
- Sazan Group

Whether you are a manufacturer, utility company, distributor, sales agency, engineering firm, architectural firm, or any other professional or technical business that engages with lighting, each organization can pick and choose levels of benefits and discounts for their company employees directly—and in certain cases, non-employees' partners, as well—furthering the reach to a larger group of professionals. The complete new Sustaining Membership structure (including the tax deduction levels) is listed at: **www.ies.org/membership/ies-sustaining-membership**.

Education institutions that have dedicated lighting programs as well as those higher learning institutions that focus on "lighting" in their curriculums qualify for the University Membership. For more information on program benefits go to: **www.ies.org/membership/ies-university-membership**.

PRODUCTS

1.

3.

2.

4.

1. Trace-Lite, a division of Barron Lighting Group, introduces CCT and power-switchable downlights for new construction and retrofit residential and commercial applications. Designed with versatility in mind, the Title 24-compliant, IC-rated for insulated ceilings, line of fixtures offered in a range of sizes and shapes can provide soft and focused illumination in numerous architectural styles without disturbing décor. *www.barronltg.com*

2. Acclaim Lighting introduces Adapt Linear DMX, a flexible, dimmable, color-changing indoor fixture for linear graze, flood and cove applications. Offering quad-color LEDs for high-quality color mixing and a wide variety of optics, fixtures also have built-in link cables for easy daisy-chaining. Liner lights are available in 4- and 1-ft lengths and can run up to 140 ft in a series while providing 130,000 hours of life. *www.acclaimlighting.com*

3. Cyclone Lighting introduces the Lupa luminaire for welcoming, dark-sky friendly illumination in urban landscapes such as corporate campuses and transit areas. As human-focused lighting in nighttime spaces increases, the disk-shaped Lupa with no visible hardware was designed to have lower pole heights and produce a more-comfortable gradient of light for a softer aesthetic than those of traditional pole lights. *www.cyclonelighting.com*

4. Altman Lighting announces the Chalice 200 Pendant, an RGBL house light for theaters. Also known as the CFP 200, the fixture is an updated version of the Hydra Par (AIP 200) and offers a patented zoom lock feature, which can be disabled to allow for more flexibility in performances; CCT ranging from 2700K to 10000K; and various mounting options including aircraft cable, pendant, wall and yoke mounts. *www.altmanlighting.com*

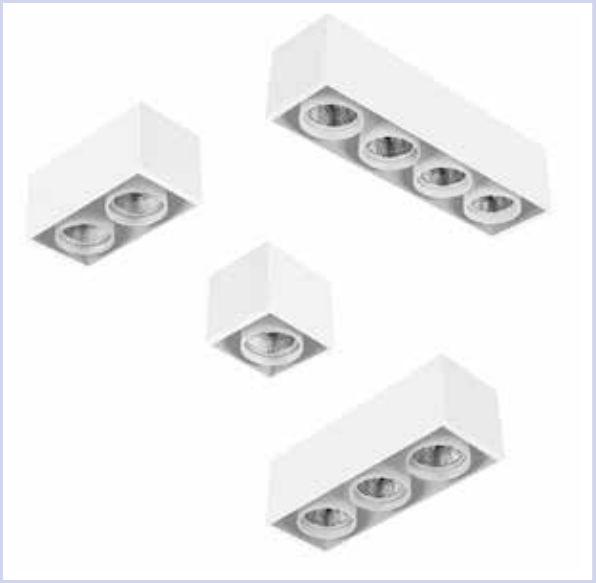
5.

6.

5. Resident introduces the Phase lighting collection by Estudio Persona. Inspired by moon phases, femininity, darkness, mystery and renewal, luminaires in crescent shapes with bronze bodies and warm LED-lit acrylic diffusers add intrigue to indoor spaces. The hand-made collection includes two pendants (large and small), a wall sconce and a table light.
www.resident.co.nz

6. ZLEDLighting launches Magnilumen Plus LED Bars and Retrofit Kits for high-output locations that require long-lasting reliability and safety. Converting fluorescent lights to LEDs, bars offer up to 10,000 lumens while using 60 watts, an average lifespan of 50,000 hours and a five-year warranty. Additionally, fixtures are prewired for easy installation and include 0-10-V dimming compatibility along with advanced controls technology such as occupancy sensing.
www.zled-lighting.com

SPOTLIGHT Intense Lighting



Intense Lighting, a Leviton company, expands the line of GX Adapt luminaires for hospitality, high-end retail applications and office spaces. Available in surface-mount (pictured bottom left) and pendant (pictured bottom right) configurations, the new fixtures feature an adjustable multi-head accent system inside a rectangular extrusion that allows up to four heads; 30-deg vertical tilt and 360-deg horizontal rotation on each head; and a nearly 3-in. square profile that can be made recessed or semi-recessed in the field.
www.intenselighting.com

PRODUCTS

7. iGuzzini announces a double-length version of Spacepad (pictured top), a lighting solution for enhanced comfort in workplaces. The minimalistic product offers built-in Organic Response technology, allowing the fixture to be moved without the need for reprogramming as well as automatic reconnection with nearby modules (pictured bottom). *www.iguzzini.com/us/*

7.

8. LightArt introduces the Clear Coil Collection to the Coil family. Optically clear, 3D-printed and made from 100% recycled materials such as dense plastic and clothing/carpet fibers, the Clear collection features six new pendant shapes. Three of the shapes are geometric (pictured) like those in the original collection, while three are biophilic, recalling beehives and elongated raindrops. Along with the collection, LightArt introduces the Coil Collection Takeback Program, which encourages end users to return Coil fixtures for further repurposing. *www.lightart.com*

8.

9. Cooper Lighting Solutions announces BioUp, a melanopic lighting technology now included across multiple CLS brands and products. Designed to provide enhanced well-being in professional spaces, BioUp integrates cyan light into the LED spectrum to promote healthy circadian rhythms without changing perceived color. Available in static and dynamic options, the former is ideal for daytime usage in offices and public buildings, while the latter is better suited for spaces that require daytime and nighttime usage such as hospitals and some educational institutions. *www.cooperlighting.com*

9.

10.

10. VEROZZA Lighting announces new inserts (two examples pictured) and finishes, as well as the ability to phase dim in 0-10 V and DALI, to the the MODULINE 48-V track system. The system for indoor hospitality and commercial illumination features a 1-in. wide aluminum profile for recessed pendant or surface ceiling- and wall-mounting as well as magnetic click-in spot, accent or general light modules.
www.verozza.com

11.

11. Tivoli Lighting introduces the Natura Turtle Safe tape light for wildlife-protecting illumination in coastal environments. Emitting a wavelength less disruptive to sea turtles than traditional tape lights, amber luminaires are IP67-rated for harsh environments and operate on low-voltage 24-V DC power. Offered with dimming capabilities, Natura consumes 7 watts per foot and has a maximum run length of 13 ft.
www.tivolilighting.com

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At the Illuminating Engineering Society, everything we do is meant to advocate, engage, and educate the public about the impact of light on human life. Join us on our journey as we share how our beliefs guide us in our mission to *improve life through quality of light.*

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Illuminating ENGINEERING SOCIETY

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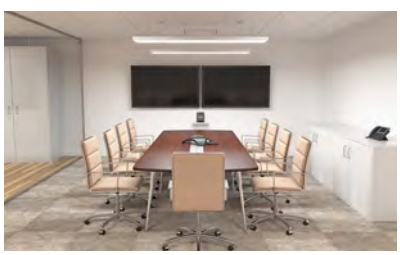
*Note: not all courses are eligible for CEUs. Please look for the CEU indicator on each course description to determine eligibility.

THE IES RELEASES
SIX NEW STANDARDS

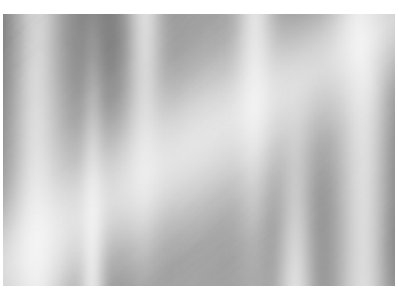
The Illuminating Engineering Society (IES) recently introduced six new standards documents addressing current challenges that face the lighting industry – lighting recreational areas, office spaces and videoconferencing rooms, measuring far UV-C optical radiation sources, risk group classification for all ultraviolet lamp systems, and security lighting for people, property and critical infrastructure. The new standards are available at **store.ies.org.**

RECOMMENDED PRACTICE: LIGHTING SPORTS AND RECREATIONAL AREAS (ANSI/IES RP-6-22)
store.ies.org/rp-6

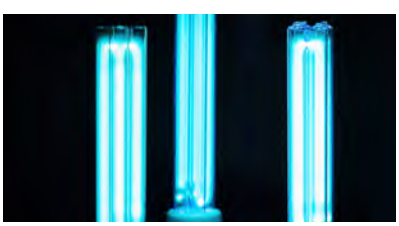
RECOMMENDED PRACTICE: LIGHTING OFFICE SPACES (ANSI/IES RP-1-22)
store.ies.org/rp-1



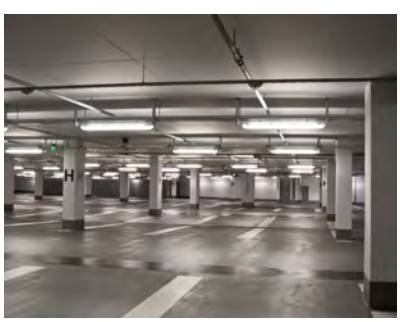
RECOMMENDED PRACTICE: LIGHTING PERFORMANCE FOR SMALL TO MEDIUM SIZED VIDEOCONFERENCING ROOMS (ANSI/IES/AVIXA RP-38-17(R2022))
store.ies.org/rp-38-17



APPROVED METHOD: OPTICAL AND ELECTRICAL MEASUREMENTS OF FAR UVC EXCIMER SOURCES (ANSI/IES/IUVA LM-93-22)
store.ies.org/lm-93



RECOMMENDED PRACTICE: RISK GROUP CLASSIFICATION AND MINIMIZATION OF PHOTOBIOLOGICAL HAZARDS FROM ULTRAVIOLET LAMPS AND LAMP SYSTEMS (ANSI/IES RP-27.1-22)
store.ies.org/rp-27-1



GUIDE FOR SECURITY LIGHTING FOR PEOPLE, PROPERTY, AND CRITICAL INFRASTRUCTURE (IES G-1-22)
store.ies.org/g-1

In the suburb of Surfers Paradise, off Australia's Gold Coast, lies Ocean, a 76-story apartment and leisure complex. Housing private residences, a five-star hotel, retail areas, a café and an exclusive 24/7 resident-only amenities level with a sauna and gym, Ocean also provides an eye-catching glow at night. Colorful façade lighting designed by integrated solutions provider bluebottle is created with Color Kinetics Compact Graze fixtures, placed at levels 33 and 76 and controlled by Pharos Designer LPC, to add dynamic flair to the beach's skyline.

Photo: Courtesy of bluebottle.

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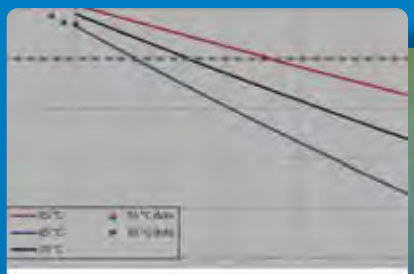


TM-21 Calculator

The official IES TM-21 calculator projects luminous flux maintenance based on the 2021 American National Standard, approved and maintained by the IES Testing Procedures Committee.

TM-30 Spectral Calculator

The official IES TM-30 calculator provides values and creates vector graphics based on the 2021 American National Standard, approved and maintained by the IES Color Committee.

The Illuminance Selector

The IES Illuminance Selector is a search tool developed to provide fast access to critical lighting criteria from over 25 tables published in ANSI/IES Recommended Practice Standards.

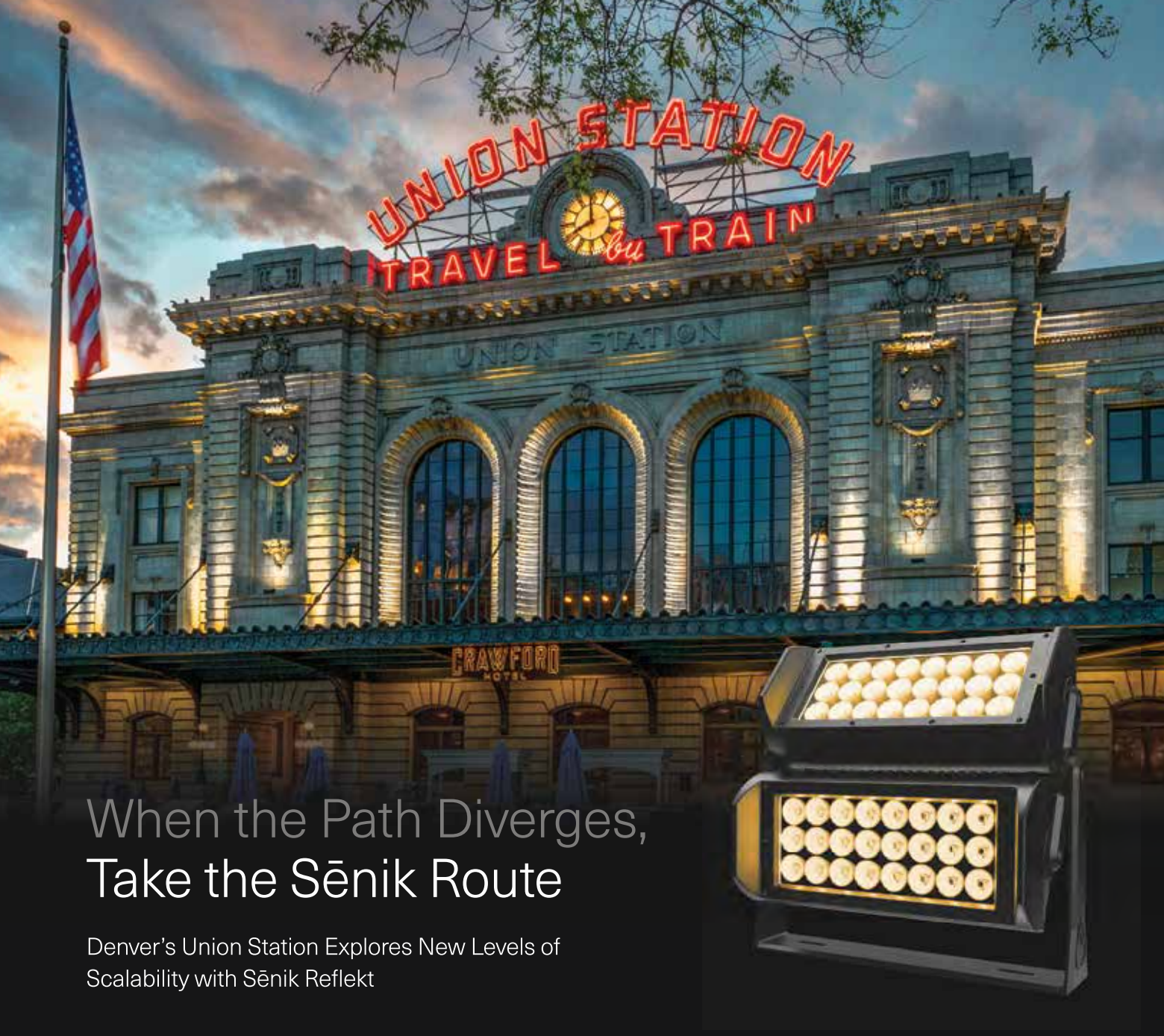
IES Reference Retriever ‡

The IES Reference Retriever is a catalogue of all documents, articles, publications and studies that are referenced throughout IES standards, searchable by title, topic, keyword, author or date.

‡ Available for IES members only.

Illuminating ENGINEERING SOCIETY

Access the IES Standards Toolbox at **ies.org/tools**



When the Path Diverges, Take the Sēnik Route

Denver's Union Station Explores New Levels of Scalability with Sēnik Reflekt

MODULAR
The modular design allows for up to three Reflekt luminaires to be stacked together, producing anywhere from 23,000 lumens all the way up to 45,000 lumens.

ADAPTABLE
With seven different field placeable lens accessories, the Reflekt is primed to transform any installation.

CONNECTED
In addition to the on-board DMX512 RDM connections, the Reflekt RGBW with built-in LumenRadio Wireless DMX can connect up to 30 units together, completely wirelessly.

FUTURE-PROOF
The Reflekt is built with the latest LED technology. Powered by Cree LED™ XLamp® LEDs, each luminaire is optimized to far exceed the L70>60,000 hours rated life.

Scan the QR Code to watch our Sēnik Reflekt video to learn more. You can also visit prizmlighting.com or contact our sales team at sales@prizmlighting.com or (888) 297-0484.

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