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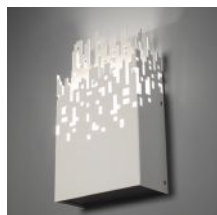
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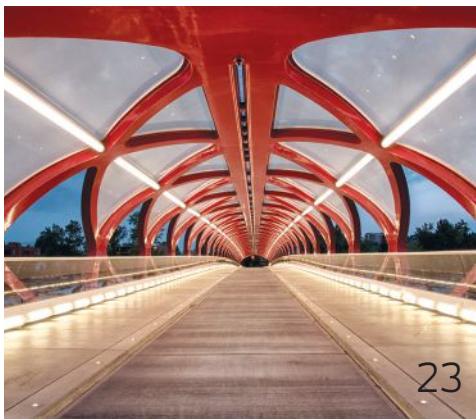
  
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Cover: Sacramento International Airport, Sacramento, Calif. Photograph by Tim Griffith

Clockwise from left: Tim Griffith; Tang Yau Hoong; Csaba Diglics





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**“There are two areas in particular that I believe will have a truly transformative 2013: professional-level lighting education and academic lighting discussions.”**

## THE YEAR AHEAD

**New Year: new plans,** new expectations, new hopes—and 2013 is no different than any other year in that regard. In this month’s Report article, “Nine for Thirteen” on page 26, I asked several individuals who represent different facets of the lighting community for their take on the year ahead of us. It’s an excellent snapshot of the industry’s concerns and aspirations. Inspired by the responses, it seems only fair that I should add my thoughts.

There are a variety of issues that will take center stage in the coming year. The economy certainly will continue to dictate decision making at all levels. Hopefully, both design firms and lighting manufacturers will continue to be able to make rational rather than knee-jerk decisions, and not sacrifice long-term growth for short-term fixes.

Technological developments will also play a major role, as designers and manufacturers continue to adjust to what it means to have LEDs in their lighting toolkits. I particularly hope that manufacturers will ramp up their focus on the technical components that are involved in the design of luminaires, especially as it pertains to optics and issues of brightness and glare. These have always been one of the more complex aspects of fixture design, no matter the type of light source. We take a look at this topic in this month’s Technology article, “Optical Illumination,” on page 33.

Light quality is another phrase that you will hear more often in 2013. It’s an ongoing dance between design, energy codes, and technology; designers and manufacturers continually refine their practices to sync these three together for a better end product.

Social media will play an evolving role in the lighting industry as more firms, organizations, manufacturers, and individuals join in the conversation. There are robust discussion forums on LinkedIn and on manufacturer portals where design inspirations are being shared and technical questions are being asked. And the ability to report live from conferences and trade shows using Twitter will continue to redefine how people connect and receive information at these events.

But there are two areas in particular that I believe will have a truly transformative 2013: professional-level lighting education and academic lighting discussions.

In terms of education, there is a growing awareness that learning does not end at graduation. Once someone enters the workforce, there is so much to learn in terms of project management, client interaction, and budgets, not to mention the hands-on reality of designing with and specifying the proper luminaire. In the past few months, several professional-level lighting courses have emerged. We discuss one of these on page 14: the Brandi Institute, launched by lighting designer Ulrike Brandi. Also, in December, on [archlighting.com](http://archlighting.com), we reported on the establishment of the Rocky Mountain Lighting Academy at the University of Colorado Boulder ([bit.ly/11VjFEb](http://bit.ly/11VjFEb)).

Rumor also has it that the California Lighting Technology Center at UC Davis is exploring the possibility of establishing a degree-granting program through the University of California system. No official announcement has been made yet, but expect to hear about it sometime this year.

Finally, as our analog world becomes more and more digital and the amount that we need to accomplish exceeds the time available in a 24-hour day, there is also the need to step back and remember what lighting is fundamentally about—design. Fortunately, there is a renewed interest in theoretical and philosophical discussions about light. Take for instance *Illuminator*, which we discuss on page 10. A brand-new lighting publication with an extra-large format, it’s interest in advancing a more aesthetic type of discussion adds to ongoing conversations in the lighting design community.

There’s a lot in store as we begin 2013. Continue to make AL part of your reading list for inspiration and news, and connect with us online. And you can always email me directly to let me know what’s on your mind.

Elizabeth Donoff, Editor  
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# tune the light



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Ganzfeld, GCC Moscow, 2011

## ILLUMINATOR MAGAZINE

*A new publication creates a visual feast for the eyes in its discussion of lighting design.*

text by Elizabeth Donoff

**Billed as** “the greatest magazine about light—in nature, culture, art, architecture and design,” Munich-based lighting designer Gerd Pfarré and graphic designer Frank Koschembar have set the bar high—and large. Measuring 19 inches wide by 27 inches tall, *Illuminator* requires space to read—and space to store. Modeled after the art magazine *The Manipulator* (1982–1994), which was launched by Willy Moser and David Colby, the format is the largest page size that a printing press can handle.

But more than anything else, what the large format offers is a vehicle for viewing stunning images and for being inspired. “We wanted to create something that would take advantage of the large TIF files that are created when design

projects are photographed,” Pfarré says. “There’s been no print medium in a magazine format that’s done this for lighting.”

Two years in the making, *Illuminator* is intended to speak to a broad design-based audience, or “anyone who is fascinated by light,” Pfarré says. To that end, Pfarré and Koschembar targeted the initial launch this past October to design communities in Europe and the U.S. with a particular focus on architecture and museum bookshops. “It’s really about reaching a creative audience,” Pfarré says.

Each issue (there will be two per year) has a cover story dedicated to a particular topic. For the inaugural issue, that topic was bioluminescence, and the issue contained a short essay by molecular biologist Heike Körber and stunning images of fireflies. Also included is a look at the work of light artist James Turrell (above) and theatrical lighting designer Max Keller, an interview with Ingo Maurer, a photo essay by Berlin artist Anne Kathrin Greiner titled “Disciplined Spaces,” and an essay written by lighting designer Mark Major on the role of color in architectural lighting design. But the text throughout is secondary to the images, as your eye is constantly drawn to the visual richness of the photographs.

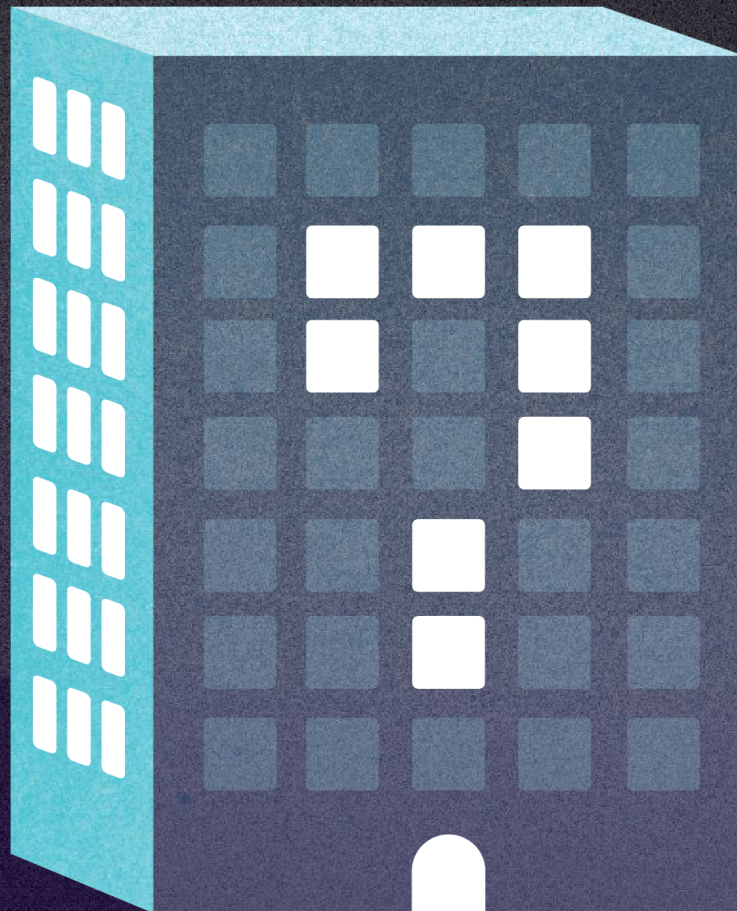
One of the most thought provoking moments in the magazine, and one that fulfills its editorial mandate to speak to light’s essence, is

the reproduction of George de la Tour’s 17th-century painting *The Education of the Virgin*, a depiction of St. Anne teaching her daughter to read the Bible by candlelight. As a full spread, it’s a powerful visual that celebrates light’s incandescent magic.

“Light plays a vital role in our lives,” Pfarré says. “We want this publication to offer people an emotional and philosophical way of understanding the medium.” Interesting then that in this digital age Pfarré and Koschembar have limited the publication to being print-only and have purposely created no companion website. Pfarré readily acknowledges that *Illuminator*—with its size and its cost, €49 (about \$63 per issue)—is not going to be for everyone, and that’s OK. “We want people to have a physical and intimate experience thinking about and viewing light, as if you were in an art gallery,” he says. That said, the duo does not plan to lose money on this project. Costs are covered by subscription and single-copy purchase revenue as well as four full-page ads from lighting manufacturers.

Pfarré and Koschembar are already at work on the next issue, which will focus on artistic light. Future topics might include shadow, color, and divine light. Inquiries can be made to [illuminator@lightingpress.com](mailto:illuminator@lightingpress.com). Peter Miller Books in Seattle serves as the U.S. distributor ([petermiller.com](http://petermiller.com)). •

Florian Holzher, Munich



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# RETROFITTING DAYLIGHT CONTROLS IN NEW YORK CITY OFFICE BUILDINGS

*A new report confirms that advanced daylighting controls contribute significantly to energy savings in commercial office space.*

text by Elizabeth Donoff

On Jan. 15, interested parties gathered at the New York Times building to hear the latest findings concerning the energy savings potential of advanced lighting controls for commercial office buildings. The event was organized by Green Light New York, an independent nonprofit formed in 2011 whose mission is to promote quality, energy-efficient lighting in New York City while involving the design and real estate communities in this effort. The nonprofit has recently released its first major report, "Retrofitting Daylight Controls in NYC Office Buildings."

New York, more than any other major metropolitan U.S. city, has the largest concentration of commercial office space: 542 million square feet. Chicago comes in at a distant second with 110 million square feet of commercial office space followed by Washington, D.C., with 90; Boston with 50; San Francisco with 30; and Seattle with 25. Consequently, New York has a tremendous opportunity to implement a strategy for incorporating daylighting controls that could, according to the Green Light report, "result in electric peak demand reduction of as much as 160 megawatts and 340 gigawatt hours (GWh) of electricity

savings." This would save New York City building owners and tenants more than \$70 million annually.

Since a relatively small group of real estate firms control the majority of the city's commercial real estate, it is easier in New York to introduce a comprehensive plan for retrofit strategies while keeping with the city's overall sustainability goals, as outlined in 2009's "Greener, Greater Buildings Plan." According to the report, Lighting & Submetering law (Local Law 88 of 2009) requires that all large, nonresidential buildings in New York City retrofit their lighting by 2025. Green Light's analysis found that there is currently 1.14 million square feet of office space in the city that can accommodate a daylighting controls retrofit.

Interior lighting represents 26 percent of a commercial building's electricity usage in New York City. Exterior lighting, by comparison, represents only 6 percent. Over the past decade, a number of high-profile, newly constructed commercial office buildings have led the charge in implementing an advanced lighting strategy that incorporates natural and electric light with daylighting and shading control. The new Times headquarters, completed in 2007, is one such project.

Green Light's report indicates that the 1.5-million-square-foot office tower has been able to achieve a savings of \$600,000 annually through its shading system coupled with its dimmable lighting system. The New York Times Co. occupies approximately 600,000 square feet in the building, and although the spaces were designed for a connected lighting load of 1.28W per square foot, due to the lighting control system the offices only use 0.396W per square foot, just one-third of their connected load.

But implementing daylighting and lighting control strategies is not easy, or inexpensive, a point reinforced by Stephen Selkowitz of Lawrence Berkeley National Laboratory during Green Light's presentation. Selkowitz noted that no single solution is appropriate for every building, but if the will exists for the investment, the return can be substantial. The Green Light report is available online at [greenlightny.org](http://greenlightny.org). •

## BY THE NUMBERS

10

Percentage of overall U.S. office space in New York City.

28

The estimated percentage of an office building floor area with "daylight availability."

1.8

Average lighting power density in NYC office buildings, in watts per square foot.



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## DAYLIGHTING IN THE DARKEST CORNER

*Design restrictions often bring inspired solutions, as architects and lighting designers in the Pacific Northwest prove.*

text by Lindsey M. Roberts

“To live in the Pacific Northwest is to know summer’s long low light and winter’s long dark nights,” writes Joel Loveland, director of the Integrated Design Lab at the University of Washington’s College of Built Environments. The Northwest’s northern latitude and cloudy climate—determined by waterlogged weather systems, which blow inland, collide with the Cascades, rise, condense, and cause rain—has meant that architects and lighting designers have to be creative about maximizing light in spaces through building orientation, design, and luminaire selection. But the need for light seemingly runs smack into another Northwest trait: a firm commitment to the environment, generated from a respect for the surrounding mountains and water.

Local designers marry these desires in unique ways, as highlighted in 12 examples in *Daylighting Design in the Pacific Northwest* by Christopher M. Meek and Kevin G. Van Den Wymelenberg, professors of architecture at the University of Washington and University of Idaho, respectively. In an office by the Miller Hull Partnership, baffles diffuse direct sunlight while allowing light into the interiors from the overcast sky. In a college building by Mahlum, a light shelf and an interior light well are two of the key components in the overall lighting solution. At the end, a section on lessons learned offers tips and takeaways for all energy-saving designers—even those who aren’t blessed with 230 overcast days per year. • \$45; University of Washington Press, 2012 •

## THE BRANDI INSTITUTE

*New lighting workshops offer hands-on practical lighting design experience.*

text by Elizabeth Donoff

Seeing the need for more a more hands-on educational experience to support lighting designers already working at the professional level, Hamburg-based lighting designer Ulrike Brandi has launched the Brandi Institute. “I wanted to establish something that would show designers, in particular those just starting out, how the design process works and how the role of a lighting designer fits into the overall project structure,” she says.

The program is open to lighting designers, architects, interior architects, urban planners, as well as employees of lighting manufacturers. “I think it’s important to have a common language of light no matter who you are working for in the industry,” Brandi says.

The five-day courses (which each cost €4,500)—of which there are four overall slated for 2013—are designed to be an intensive workshop experience. Taught by leading architects and lighting designers, the first course, Essentials in Light, will be in May and will be taught by Brandi along with architect Martin Gran of Snøhetta Design. Later workshops will address high-performance energy buildings, workplace design, and health and wellness.

Each course will incorporate theory alongside technical principles of light, and will take place at actual project sites in Hamburg. “It’s a way for the participants to work in a building that is the same project type as is being addressed in the course,” Brandi says. “It’s also a way for them to explore different parts of Hamburg.”

To apply, you will need to fill out a formal application as well as submit a letter of interest. For further details go to [brandi-institute.com](http://brandi-institute.com).

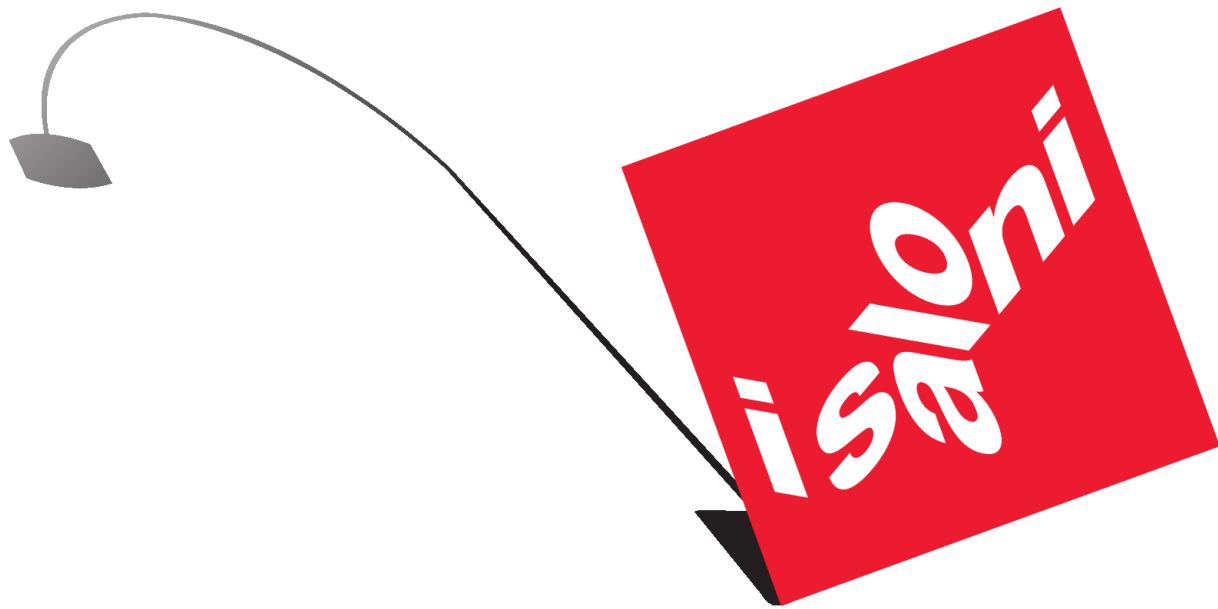
• **Grand Central Centennial** On Feb. 1, New York’s Grand Central Terminal celebrated its 100th anniversary. As part of the celebration, the group Improv Everywhere “staged a surprise performance in the grand windows on the terminal’s west side. Equipped with a variety of LED flashlights and camera flashes, performers appeared suddenly and unannounced along three floors of windows, creating a shower of light for the commuters and tourists below.” To view the video go to: [improveverywhere.com/2013/02/05/grand-central-lights](http://improveverywhere.com/2013/02/05/grand-central-lights).

• **A-L’s LinkedIn Group** Join our LinkedIn Group and engage with the magazine and your fellow readers. Respond to conversations under way and feel free to introduce your own discussion topics. Join at: [linkedin.com/groups?gid=4534015](http://linkedin.com/groups?gid=4534015)



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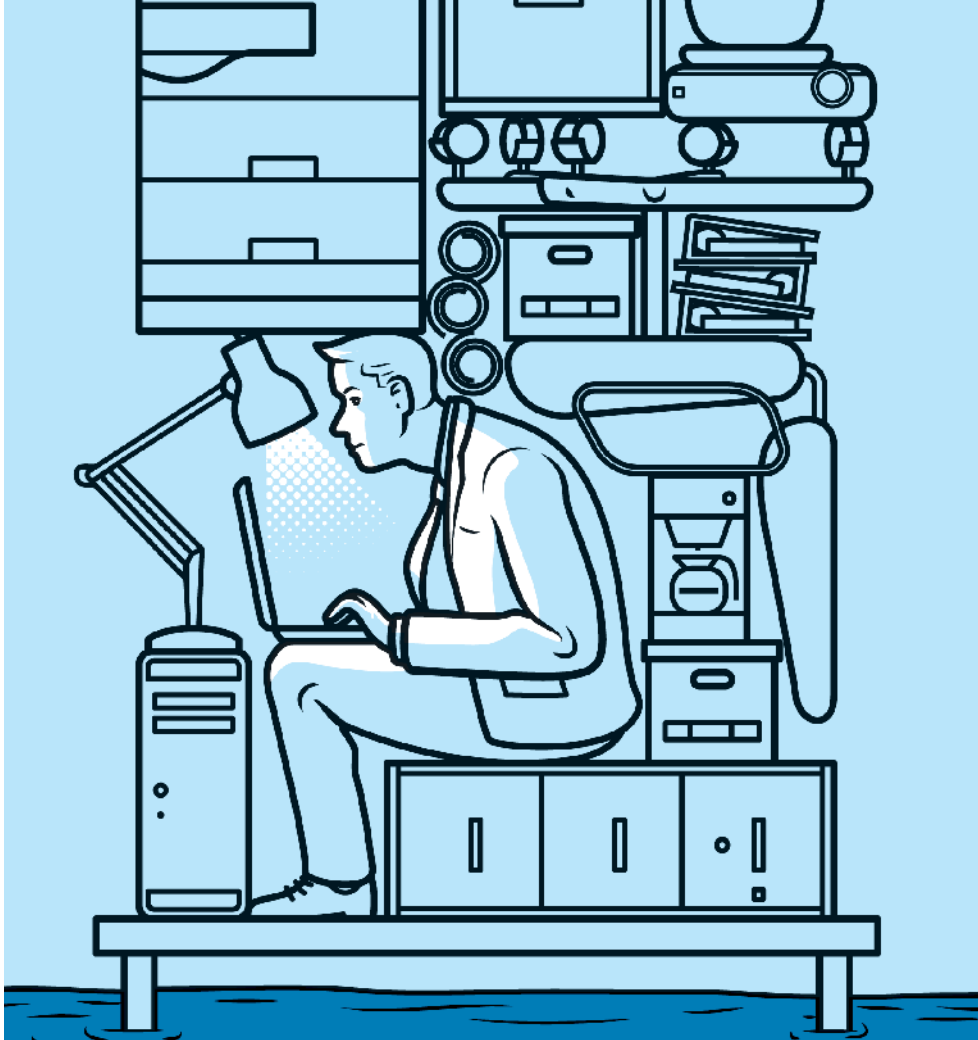


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PROFESSIONAL PRACTICE

## PREPARING FOR THE UNEXPECTED

*After last year's superstorm, ask yourself, 'Does my current insurance coverage adequately protect me?'*

text by Peter J. Lamont

illustration by James Provost

*Peter J. Lamont is a business and commercial litigation attorney nationally recognized in a wide variety of highly specialized areas within the kitchen, bath, lighting, construction, and design industries. He routinely represents various national and international companies within the design sector, and has achieved the highest rating in both legal ability and ethical standards as awarded by AVVO (avvo.com).*

This past October, the East Coast found itself in the crosshairs of a “perfect storm”—Hurricane Sandy. It brought gale-force winds, flooding, heavy rain, and snow to much of the Eastern Seaboard and the Northeast. While this superstorm was devastating for residents, it also took a significant toll on businesses, including a number of lighting design firms throughout the New York metropolitan area. Some researchers suggest that storms such as Hurricane Sandy are not a fluke, but rather the shape of things to come. Researchers from Princeton University and the Massachusetts Institute of Technology have released findings, published in the February 2012 issue of the journal *Nature Climate Change*, that correlate storm surge impact with climate change. What was once considered the “100-year-storm” could now occur every three to 20 years.

Unfortunately, many business owners affected by Hurricane Sandy did not have adequate or proper insurance, or they failed to fully understand the limits of their policy. With no insurance to cover the damages sustained, some small businesses were forced to permanently shut their doors.

Following a disaster such as this, firm principals should evaluate whether their current insurance policies provide adequate protection and coverage against such catastrophes. If not, they should attempt to maximize their insurance coverage immediately.

### Evaluating Coverage

When evaluating the adequacy of a company's insurance, the business's owners must first determine what type of policy is necessary and then determine how much is sufficient. While there are a number of different insurance policies and riders available to businesses, two types of coverage—Property Policies and Business Interruption, which are most often triggered by catastrophic weather—are the policies that most businesses should make sure that they have.

As for the amount of insurance needed, this depends on the content of the premises and the perceived risk. For example, a lighting designer who is seeking to insure a basic office might only need enough to cover his office equipment. But a design firm that has offices and a showroom will likely require more insurance. Ultimately, the amount of coverage needed is something that lighting designers should discuss with their insurance brokers.

### Property Policies

Property insurance, which is often part of a commercial general liability policy or business owner's policy, is the most basic type of insurance that a business owner should have to protect his company's property and its contents. Property insurance will generally provide coverage for damaged office furniture and equipment, including computers and hard drives.

But not all property insurance is created equal. Business owners must decide whether they need coverage based on the actual value of their property or the replacement value. In essence, there are two “values” to a piece of property. The first is the actual value—the depreciated, current value of your property. The second value is what it would cost to replace the property if it was damaged due



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# The most important point here is that payment on the business interruption insurance policy is only triggered if the interruption is a result of property damage caused by a covered event.

to severe weather or some other unfortunate circumstance. If you cannot afford to replace computers, office equipment, office furniture, and related items, you should opt to insure your property for its replacement value.

Of course, insuring property for its replacement value instead of its actual value will increase your premium. Nevertheless, there may be little benefit to insuring office equipment for its actual value since this value is continually depreciating. For example, assume your property policy provides coverage for the actual value of your business's property, and you have four high-end computers that you paid \$2,200 a piece for 12 months ago. These

computers are damaged when the roof leaked during a severe storm. When you submit your insurance claim you may be shocked to find out your high-end computers now only have a value of \$500 a piece, leaving you to make up the difference. But if you insured your office property for its replacement value and the above scenario occurred, you would be reimbursed for the actual cost of buying the same or similar computers.

## **Business Interrupted**

Business interruption coverage is often misunderstood to be a separate policy of insurance, but it is part of a general

commercial liability or property insurance policy. In fact, it is rarely, if ever, sold as an individual policy, but rather can be purchased as an "add-on" to an existing business policy.

The purpose of this type of policy is to reimburse the policyholder for income that is lost when an insured event, which leads to loss of property, interrupts his business. The policy is intended to provide the business owner the profit that he would have earned, had business not been interrupted. But remember, the most important point here is that payment on the business interruption insurance policy is only triggered if the interruption is a result of property damage

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caused by a covered event. So, if your business does not sustain physical damage, you cannot make a claim under the policy.

For example, while many businesses suffered property damage as a result of Hurricane Sandy, many more were forced to close for a number of days because the electricity had been turned off. Many of these businesses submitted claims under their business' interruption coverage only to be denied because they did not sustain physical damage.

In general, business interruption insurance coverage is only triggered in three limited circumstances:

1. There is physical damage to the property, and it is of such magnitude that it causes the business to have to shut down.
2. There is physical damage to other property, caused by a covered event, and that damage totally or partially prevents customers or employees from gaining access to the business.
3. The government shuts down an area due to property damage caused by a covered event, and this prevents customers or employees from gaining access to the premises.

It is important to note that even when business interruption coverage is triggered, most policies have a waiting period of several days before the carrier will begin reimbursing

lost profits. This coverage is also not retroactive to the day of the event.

Separately, business interruption policies provide for the loss of net income, temporary relocation expenses, and ongoing expenses such as payroll—enabling a business to continue paying employees instead of having to lay them off. The company must be able to prove, typically by submitting financial statements, all of its business interruption losses. Most policies will then generally continue to make these payments until the business is back up and running—but this usually does not extend beyond 12 months.

While business interruption policies are limited in scope, they are critical to most small businesses. Lighting design firms, especially, should include one of these in their commercial general liability policies. Often, it can be the difference between staying afloat or going under.

Here's an example. As a result of Hurricane Sandy, a design firm in New York City was forced to temporarily shut down its office and small showroom because their building had lost electricity. The firm had property insurance, which included business interruption coverage. During the course of the power outage, pipes located in the unit above the design firm

froze and ruptured, which caused a significant amount of water to leak through the firm's ceiling and destroy their office and showroom. The firm's owners immediately contacted their insurance broker and started a claim.

It took more than three months to rebuild the office and showroom, and the event had a major impact on the firm's ability to earn revenue. But because they had business interruption insurance, they were reimbursed for three months of lost profit, as well as their payroll expenses. This allowed the firm to continue operating despite the less-than-ideal circumstances.

It is not enough just to have insurance. You must have the appropriate policies and you must understand each policy's limitations. If your coverage does not include property damage or business interruption insurance, it may be wise to speak with your broker and add it. If you are not sure what your policy covers, speak with an attorney or your broker to obtain the information. Hurricane Sandy should be an important reminder to all business owners to review their current policies and take the steps to make the necessary adjustments. When the next superstorm occurs, you don't want to see the design practice you have worked so hard to build be put in jeopardy. •

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Visit [LEDucation.org](http://LEDucation.org)  
for Registration and Event Details.

#### PRESENTATIONS INCLUDE:

**Can LED's Make Code Compliance Easier?**-- Marty Salzberg from Cline Bettridge Bernstein Lighting Design and Michael Mehl from Jaros, Baum & Bolles will lead a discussion of current energy codes and how LED's assist with code compliance.

**The Zhaga Standard – an Overview** -- Greg Galluccio from Leviton Manufacturing will provide an overview of the Zhaga Standard, an industry-wide cooperation aimed at enabling the interchangeability of LED light sources that was comprised from over 200 of the most influential lighting companies around the globe.

**LED Engine Specifications and Dimming Standards - Zhaga and NEMA SSL7** -- Lindsay Stefans from Philips Lighting will discuss the progress of the Zhaga standard that was created to address compatibility between the disparate ways to dim LED light engines that exist in the market

**Anatomy of a Project** - Jan Moyer Gruel and C. Brooke Silber – Design Principles at Jan & Brooke, Luminae will outline some of the issues associated with using LEDs for interior and exterior projects.

**Controlling LED Lighting** - Craig Fox from ETC Architectural and Jesse Lowenstein, iGuzzini Lighting USA will address the recurring question in the lighting industry with regard to controlling LED lighting.



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IMAGES FROM LEFT TO RIGHT : IALD PRESIDENT KEVIN THEOBALD, IALD | 2012 AWARDS DINNER | IALD TRUST PRESIDENT DAWN HOLLINGSWORTH, IALD | 2012 AWARD OF EXCELLENCE, UNITED STATES INSTITUTE OF PEACE, WASHINGTON, DC USA; LIGHTING DESIGN BY LAM PARTNERS; PHOTOGRAPHY © GLENN HEINMILLER, IALD + © BILL FITZ-PATRICK, UNITED STATES INSTITUTE OF PEACE | 2012 IALD RADIANCE AWARD WINNER RUDOLF TEUNISSEN | 2012 AWARD OF MERIT, ST REGIS OSAKA, LIGHTING PLANNERS ASSOCIATES, PHOTOGRAPHY © TOSHIO KANEKO

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# • DESIGN

IN FOCUS

## PEACE BRIDGE, CALGARY

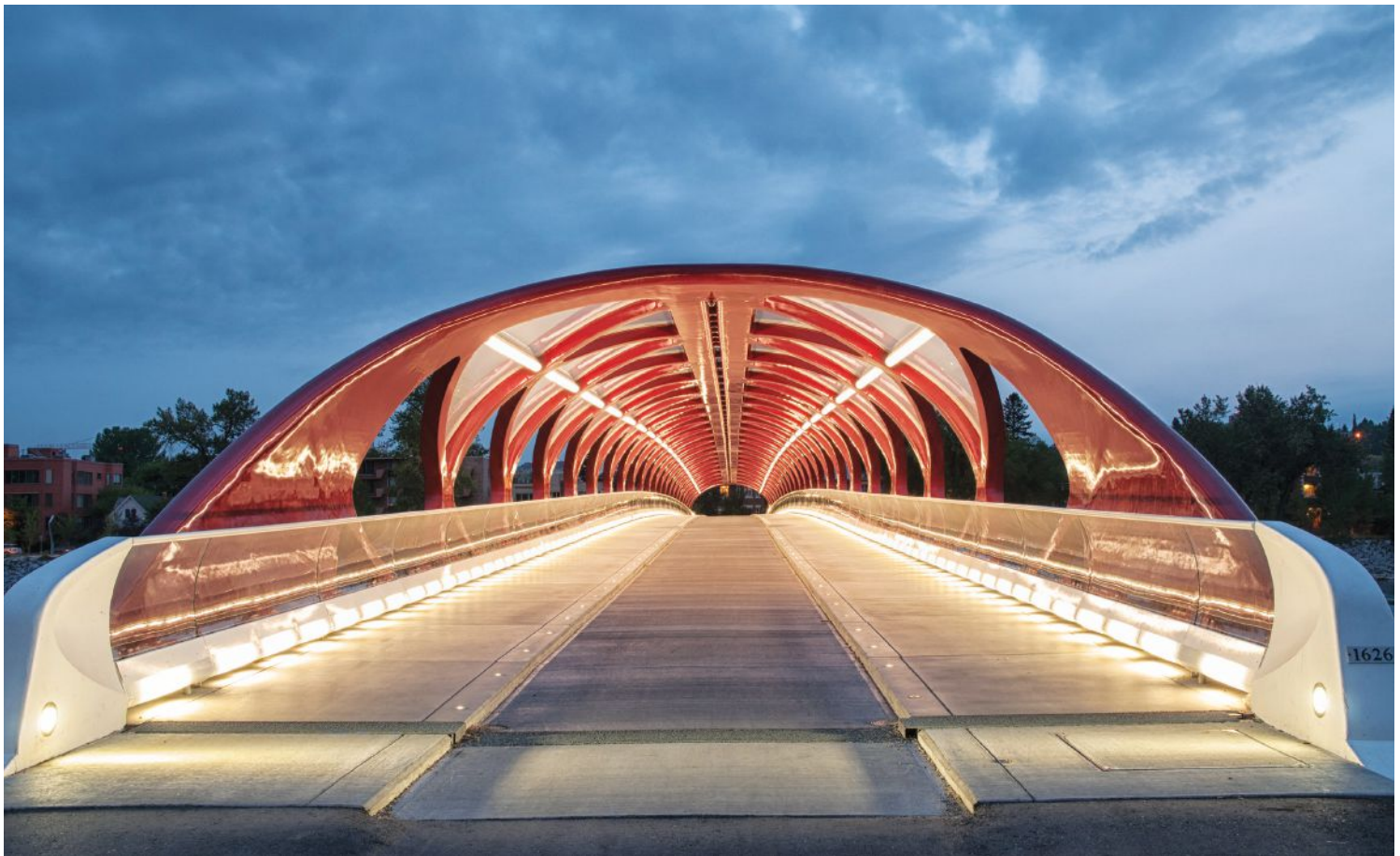
*Custom luminaires illuminate  
Calgary's signature-designed  
Santiago Calatrava structure.*

text by Deane Madsen  
photos by Csaba Diglics

In 2007, the need for an additional crossing over the Bow River presented Calgary, Alberta, Canada, with both an opportunity and a dilemma. Existing routes into the city for the more than 13,000 daily commuters—both pedestrians and cyclists—used three bridges. With an expected doubling of the city's population in the next 20 years, the need for another bridge seemed an appropriate solution to ease congestion for the anticipated traffic. However, the problem with building a new footbridge lay with city restrictions that only allowed for a 23-foot vertical building envelope, thanks to a helicopter flight zone above the proposed site, the flood level of the river, and ecological concerns that prohibited mid-span

supports in the water. The opportunity, then, lay in finding an architect to design a structure given these parameters, and the city chose Santiago Calatrava for the task.

Six years later, the new Peace Bridge is now open and each day brings more than 6,000 commuters into Calgary at a connection point just west of Prince's Island. In a departure from Calatrava's usual palette of white suspension apparatus, the Peace Bridge is a low, red cylinder slung between the two river banks it joins. A minimally profiled structural tube (approximately 19 feet high by 26 feet wide) was the design solution for Calatrava, who worked alongside structural consultant Stantec to develop a helical bridge that would



Calgary's new Peace Bridge carries pedestrians and bicyclers into the city center from the surrounding suburbs (facing page, top). Bicycle traffic occupies two lanes in the center of the bridge and pedestrian walkways run parallel on either side. Inground LED fixtures accent the walkway curbs. The linear aspect of the bridge is reinforced by two symmetrical lines of light. The first is a series of linear fluorescent T5HO luminaires integrated into the base of the pedestrian handrail. The second is a custom-length cathode light strip with opaque acrylic sleeves in the bridge canopy (above and previous page). An IP65-rated 26W compact fluorescent floodlight is mounted at the centerpoint of the bottom cord of the structure to uplight the underside of the bridge (see cross section, facing page).

perform without the claustrophobic side effects of a tunnel for its users. Bent structural glass between the curved steel frames forms the roof canopy over an open-air bridge deck, supported by diagrid steel decking, with lightweight cement as the surface. Originally, city planners had estimated about 4,000 daily users for the bridge. A recent study, however, found the numbers to be 50 percent higher than anticipated, with 1,600 users between the hours of 6:00 p.m. and 9:45 p.m., and 700 users after the commuter rush, from 8:00 p.m. to 9:45 p.m.

Lighting the bridge meant finding a way to integrate fixtures into an already minimal structural frame. Illuminated pathways at the deck level provide wayfinding for cyclists and pedestrians, respectively, while custom-length cathode light strips with opaque acrylic sleeves above form continuous lines of light. "The challenge was mostly from [Calatrava's] office,

in that they had this unusual length the lighting had to span, so we made custom fixtures," says Steve Grossman, president of Cathode Lighting Systems, the Maryland-based company that fabricated the 14-foot luminaires. "There is steplighting below, but this was more of a decorative line of light, not driven by footcandle requirements, with segments of that lighting that go from one structural beam to the other."

The decision to use linear fluorescents, Grossman recalls, was based on the flexibility of those sources and how they can be customized to any specification; in their Peace Bridge application, each unit contains three 4-foot 4000K linear fluorescent fixtures, with the appeal being their consistent color rendering and reliable technology. Inset within tubes, these fluorescent fixtures reinforce the bridge's structural complexity, complementing the bridge's form with their own and keeping the Peace Bridge aglow at all hours. •

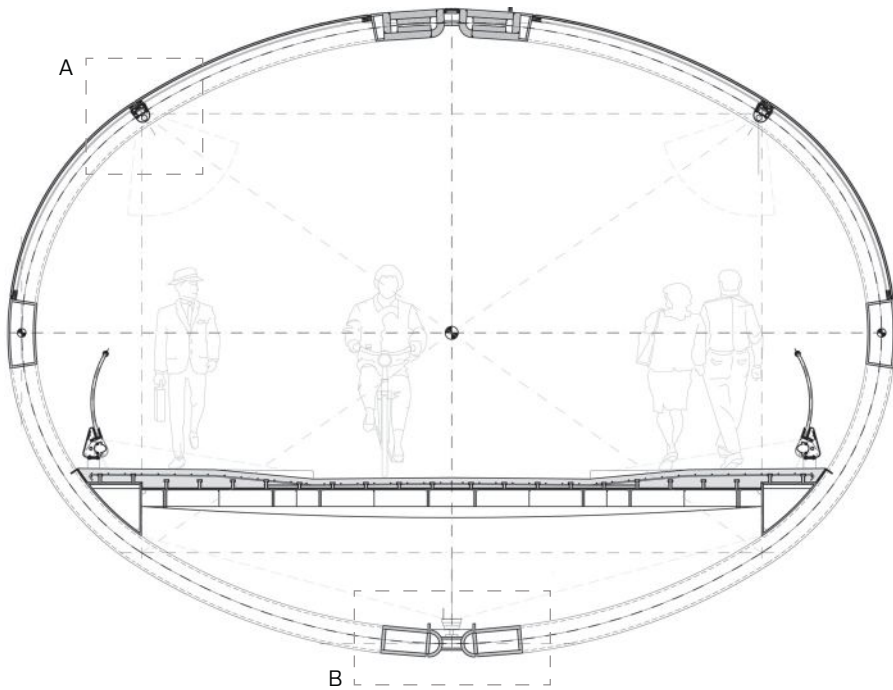
## Details

**Project:** Peace Bridge, Calgary, Alberta, Canada • **Client:** City of Calgary • **Architect:** Santiago Calatrava Architects and Engineers, New York • **Engineer:** Stantec, Calgary, Alberta, Canada • **Glazing Consultant:** GIG Fassaden, Austria • **Project Size:** 10,840 square feet (150 square meters) • **Manufacturers/Applications:** Bega (26W compact fluorescent IP65-rated floodlight at bottom bridge cord); Cathode Lighting Systems (14-foot custom-length cathode light strips); The Light Edge (4100K T5HO linear fluorescents recessed at base of pedestrian balustrade); Senso Light (inground LED uplights at pedestrian walkway curb)

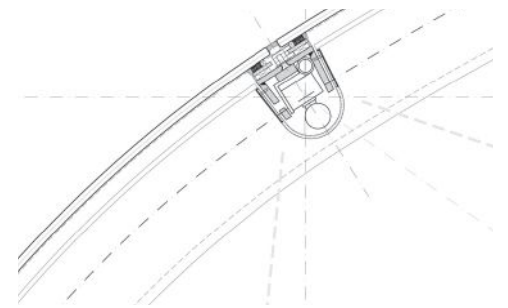
Courtesy Santiago Calatrava (facing page)



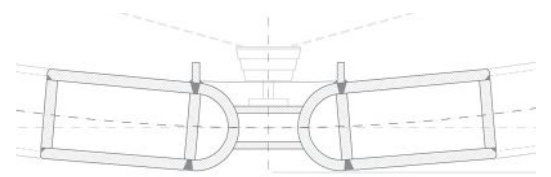
**Cross Section through Bridge**



**A: Custom Striplight Detail**



**B: Floodlight Detail**



REPORT

# NINE FOR THIRTEEN

*What are the issues that will impact lighting in 2013? ARCHITECTURAL LIGHTING asked constituents of the lighting community for their thoughts, given their particular vantage point (design, manufacturing, education, administration), on what might be in store for the lighting industry this year. In the responses that follow is an optimistic outlook, albeit a tempered one, thanks to the economic realities of the past few years. Technology issues are at the forefront of discussions as LEDs continue to transform luminaire offerings and, by extension, designers' toolboxes. Also critical is technology's impact on design and "lighting quality." 2013 promises to be another defining year.*

edited by Elizabeth Donoff

**Shelley Wang**  
W.A.C. Lighting



We are extremely optimistic about the economic climate for investments this year. We have just launched a new company called Modern Forms, a future-forward manufacturer of unique interior and exterior LED luminaires featuring design sophistication and unsurpassed performance. It was very well received at the International Lighting Market held this past January in Dallas. Given the softness of the economy in recent years, attendees were impressed by the extent of our investment in this new company, which included a full presentation of bath and outdoor luminaires designed to achieve superior illumination from clean upscale forms, exclusively with LED technology.

In addition, we are continuing to invest in performance technologies and the research side of R&D. Our new Argos and Logos families of LED track luminaires demonstrate that with the right engineering LED can now replace 39W HID for commercial usage without sacrificing on performance or price.

**Kevin Houser**  
Penn State



While "lighting quality" and "energy efficiency" need not be at odds, they often are. For example, color rendition is sacrificed to increase luminous efficacy and glare control is sacrificed to increase luminaire efficacy. During the past several years we've seen most LED companies design and market their products around energy and life. Few focus on quality considerations such as color and glare. We'll see a renewed interest in lighting quality, not for altruistic reasons, but because the market is so flooded with products that "quality" is one way to differentiate from the masses.

I hope that flicker with LEDs will be addressed, though that may be in 2015 or beyond. Flicker was a problem with fluorescent lamps and magnetic ballasts. With the adoption of electronic ballasts, flicker is no longer an important consideration. I fear that with many LED products, old problems are being duplicated with this newer technology. This goes unnoticed because there are no flicker standards for LEDs.

In 2013, we'll also see a more widespread deployment of optical wireless communication using LEDs. We'll see USB sticks that allow communication between laptops and LED systems. In the next few years, I even expect to see a prototype airplane cabin where the overhead spotlight will also provide an Internet connection. The data stream will be transmitted with light, which cannot interfere with cockpit communications.

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**Project:** Colorado School of Mines: Marquez Hall  
**Architect:** Bohlin Cywinski Jackson and Anderson Mason Dale Architects – **Photographer:** ©Nic Lehoux



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# selux

“Given the myriad LED products that have been introduced over the past three years, buyers are becoming more demanding. It’s not enough just to be LED. Designers have a choice and are in a position to be discerning. LED education has permeated all the way to the key decision makers, and they know the right questions to ask to ensure they are getting the right products for their applications.” —Josh Weiss

**Josh Weiss**  
*Tech Lighting and  
LBL Lighting*



The economy won’t suddenly turn a major corner, but I do think we’ll see slow growth throughout 2013—and likely more than we saw in 2012. Home prices are increasing, new construction is up, but perhaps more importantly, it feels like people are ready to spend again. I’m very optimistic about our outlook for next year. However, I don’t believe the economic lift will benefit all lighting companies equally; those that have invested in their products and their partnerships over the past several years should capitalize disproportionately on the industry expansion.

In 2011 and 2012, LEDs began to make more sense in many more applications. That will continue in 2013, but LEDs won’t be embraced universally. LEDs are held to a higher standard than most conventional light sources, and many are still skittish to adapt, and rightfully so: There are still challenges when integrating LEDs into our spaces.

We’ll also see many more applications that take advantage of the digital nature of LEDs, and more fixtures and replacement lamps that integrate features like RGB and color-tunable white. It won’t become mainstream in 2013, but I do think it will help set the stage for the coming years.

Finally, just because we care about energy conservation doesn’t mean we have to stop caring about beautiful design. I hope that designers continue to hold manufacturers to incredibly high standards when it comes to how fixtures appear. It can’t only be about maximizing lumens per watt.

**Marsha Turner**  
*IALD*



Associations are being asked to do more with less, and resources—funding, sponsorship support, volunteer time, and availability—are increasingly scarce. This means associations must plan carefully and efficiently, husband resources responsibly, and spend intelligently. Strategy is more important than ever, as is research to inform strategic decisions. The IALD, fortunately, with its strong income from the increasingly successful Lightfair, is not heavily dependent on dues. This has enabled the organization to expand and develop programs and services to benefit members at a time when many associations are cutting programs and staff.

The desire as professionals to be taken seriously, and for the profession of architectural lighting design to be recognized as important and relevant—irrespective of geographic location—also remain key concerns of the IALD’s constituency. To that end, public policy is one of the strategic areas in which the IALD has established a presence. Engaging in public policy initiatives results in increased awareness of our organization, an important factor in our efforts to raise the profile of the architectural lighting design profession worldwide.

In the year ahead, the IALD will continue to work with other professional lighting groups, as well as a long list of related organizations with which we have close working relationships, including the American Institute of Architects and the National Electrical Manufacturers Association.

“The difficult trading conditions created by current issues within the world economy, and in particular the U.K. and Europe, will no doubt see fees continue to be tight, projects to be ‘stop/start,’ and the need for a continuing emphasis on our international portfolio. Working at a distance can be demanding, but the scale and diversity of projects in other parts of the world often offer incredible opportunities not always realized at home.” —Mark Major

**Denise Fong**  
*Candela*



These are the areas of focus/topics of concern for 2013 that I see taking center stage:

- **Convergence:** the integration of controls with fixture hardware. Controls need to be simple and intuitive. Lighting is not a standalone element anymore but rather is tied into other systems to convey data about the performance of the lighting system or about unrelated elements.
- **Commissioning:** There is now a real expectation that the controls we specify really perform. Part of that is code driven and part of it stems from people wanting to know if they are achieving the energy savings they think they have designed and purchased. There are many stories of installations that did not work as predicted. This keeps pressure on designers to spend the time to get the documentation complete and correct, and pressure on the manufacturers to provide what they promise in their product literature.
- **Training/Education:** More rapid change, in both the equipment we specify and the tools we use, requires constant training and education of staff and is a big (and expensive) commitment on the part of employers. Investing in staff and their training when you don't know if you will benefit from the investment is an ongoing challenge.
- **Healthcare:** Not unique to lighting is how to provide healthcare benefits that are affordable in a small-to-medium-size design firm. How Obamacare is fully implemented remains to be seen.

**Mark Major**  
*Speirs + Major*



In creative terms, we see the combination of continuing improvements to solid-state lighting technology, and in particular control, providing exciting new possibilities. LEDs continue to improve in terms of quality, output, and efficiency such that “all-LED schemes” are now becoming the norm. We are interested in lighting technology and the potential of new materials, especially those that react to light. This can include new types of composites, resins, glasses, plastics, and films.

We are also driven by our quest to address the need for sustainable lighting development. We have long subscribed to the idea that environmental considerations such as energy use, light pollution, and the impacts of light on sleep patterns and biodiversity must be properly balanced with the considerable social and economic benefits that artificial (electric) lighting brings to society and the built environment.

Other things that excite us for 2013 are those projects that allow us to break down the barriers between different design disciplines and lighting. This includes the more traditional areas such as architecture, landscape, and interior design, but also environmental graphics, wayfinding, branding and identity, urban design, product design, and environmental art. We continue to be interested in what lighting design can bring to such areas of design and how it might lead us into collaborating with interesting people on a wide range of diverse and exciting projects.

**Dan Blitzer**  
*Practical Lighting  
Workshop*



Developments I look forward to seeing (time frame uncertain, of course):

- Integration of non-visual aspects of lighting into lighting design. I hope to see prescriptive recommendations for application of lighting to educational, healthcare, and commercial facilities.
- Form factor fashion from LED and OLED luminaires and material-integrated sources. The market can support and reward luminaires that are both “lighting to look at and lighting to see by.”
- Simplified approaches to mainstream lighting. Lighting has become quite complex as a result of rapid advances in light source, control, and communications technology, as well as the demands of codes, sustainability, an aging population, and energy conservation. While lighting today can attack more problems than at any time in the past, the very depth and breadth of this enhanced capability seems to immobilize many everyday decision makers. Isn't it time to develop, market, and support simplified, high-value solutions that enable users to commit resources to improving their lighting?
- Portable, upgradable, replaceable lighting systems. Much of the delight and utility of the “electronic revolution” comes from the continuous improvement, flexibility, and creative potential of the products we use at home, work, and play. Built-in lighting limits improvement to those who are building new or have the resources to remove and replace. Can't we apply technology to lengthen the life cycle of lighting equipment while increasing functionality and enhancing user satisfaction?

**Wolfgang Eggers**  
*Zumtobel Lighting*



The shift from fluorescent and metal halide sources to LEDs in downlights and track products will continue to take on speed. I don't expect any major specifications to be “non-LED” in those product categories in the future.

In 2012, for nearly all commercial office projects we saw, design teams compared fluorescent solutions against LED options for general lighting and, on several occasions, the team opted for the fluorescent solution. I think that will change in 2013 simply because costs for LEDs will continue to decrease, while color shifts are becoming less of an issue and LEDs, in general, have become a more-accepted source for office lighting products.

We are also seeing a trend among lighting designers and architects preferring to use smaller lighting products (and luminaires). Using LEDs as a source allows us to meet this demand without compromising quality and efficiency.

Last but not least, I believe that controls will play a much stronger role in commercial lighting than ever before. For example, beyond the typical control of lumen output of a fixture, we will see options to control the color of LED sources.

**Lance Bennett**  
*Cooper Lighting*



Lighting technology has been a great enabler. Faced with the challenge of revised energy codes and sustainability standards, many thought the ability to light interesting and important spaces with a sense of creativity while also meeting new power density requirements might be impossible. Instead, the design community has met this challenge and, with new technologies, now has a larger toolbox from which to choose. On the other hand, this also works to create an ever-present learning curve for designers and manufacturers.

While the industry has come together to develop a new group of standards and metrics to help better define and measure expectations, many issues still need to be addressed as a result of this ever-changing technology. There is a need for continued dialogue on issues such as future compatibility and new technology to upgrade current designs. A good example of both can be found within the design community, which is continuously tasked with the challenge of designing and specifying products for projects that will not be completed for several years.

Sustainability and globalization are also issues the industry faces, along with how and where the design industry will go to find new staff with the right skill sets to address the changing landscape. These and many other factors will continue to drive the need for all parts of the lighting industry to collaborate and share information and best practices. •



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# • TECHNOLOGY



TECHNOLOGY

## **OPTICAL ILLUMINATION**

*After some initial grappling with LED technology, the lighting industry has begun leveraging its distinct performance and potential.*

text by Wanda Lau

illustration by Tang Yau Hoong

**In most retrofit cases “the distribution will be very different. In order to properly retrofit an existing luminaire with LEDs, one would need to replace prior reflectors, lenses, or other internal optics with new designs that are appropriate for LED sources.”**

**—Peter Ngai, vice president of research and development, Acuity Brands Lighting**

**As LEDs have taken** the lighting market by storm, manufacturers have been quick to sell this new illumination source principally on the basis of its efficacy. Implausible lumens-per-watt packages became plausible, and lighting specifiers and end-users alike were intrigued. “We were all kind of drunk on efficiency,” says Chris Bailey, a solid-state lighting technology strategist at Hubbell Lighting.

Consequently, in the rush to get products on the market, little attention was given to the optical distinctions and opportunities offered by solid-state lighting early on. Original equipment manufacturers (OEMs) and lighting manufacturers designed LED fixtures to look and function just like other luminaires in the 130-year history of electric lights, Bailey says. “Because the technology wasn’t what it is today, we sacrificed some of the human response to the product. [We generated] light, but don’t look up.” While the goals of comfortable, glare-free, and uniform lighting hold true, manufacturers and fixture designers are re-charting their course.

#### **Deciphering the Differences**

To understand how LEDs differ from their conventional (filament) light-source counterparts, you first need to know how they work. Diodes are polarized semiconducting chips that generate photons through electroluminescence, or via an electric current. Incandescent lamps create light through radiance or heat.

Light distribution is another distinction between the types of sources. While conventional lamps distribute light spherically, in 360 degrees, LEDs have a 180-degree distribution. “Because of that, the way that we do our optics has to be tailored to that specific character of the light,” says Peter Ngai, vice president of research and development at Acuity Brands Lighting.

An LED’s directional, forward-throw of light means retrofitting a conventional fixture isn’t a matter of simply switching the source. For example, reflectors intended for an incandescent or compact fluorescent lamp would be rendered useless, in part because LEDs aren’t sending any backlight for the reflectors to redirect. In most retrofit cases, Ngai says, “the distribution will be very different. In order to properly retrofit an existing luminaire with LEDs, one would need to replace prior reflectors, lenses, or other internal optics with new designs that are appropriate for LED sources.”

Quantity matters too. LED luminaires use multiple diodes or “miniature lamps” whose luminance they have to collect and redistribute appropriately, Bailey says. Each point source “packs a lot of lumens,” creating ample opportunity for discomfort glare and a distribution that looks pixelated rather than continuous and uniform.

#### **Fallback Devices**

With conventional lamps, manufacturers use a combination of a lens and a reflector to deliver light to the target and diffuse the luminance. Though these optical devices, such as a sandblasted glass dome, may reduce light output by as much as 50 percent, “there is plenty of light generated that could be absorbed,” says Maria Topete, senior applications engineer at Bridgelux.

But when efficacy is the name of the game, as in the case of LEDs, lighting manufacturers who use conventional optical devices “take a terrible hit,” Topete says. “So we’re getting smarter about designing. The [optical] solutions look similar, but there is actually much thought and technology in how to do the same thing better.”

With LEDs, as in conventional lamps, delivering glare-free light requires enlarging and diffusing the light source. Though OEMs may “want the most lumens out of the tiniest little package possible,” Topete says, “they can’t necessarily use it that way because it might cause discomfort.”

Subsequently, LED fixtures typically have two optical layers: a primary optic, such as a dome-shaped lens that extracts and distributes the light in accordance with the desired photometric specification; and a secondary optic to collimate, diffuse, direct, or control the light if it needs further distribution and directionality. This secondary optic also dutifully increases the source size. Conversely, the primary optic may be the diffuser and the secondary optic may be the lens or reflector that directs the light.

#### **Tweaking Old Technologies**

Regardless of the optics employed—which will depend on several factors including application—the key to using light efficiently is “allowing it to exit” and reach its target, Topete says.

Because the emission of light from an LED is contained within 180 degrees, “lens optics turns out to be, in most cases, a suitable methodology” for controlling output, Ngai says. The diminutive size of an LED also means that a complete lens is about equal to the size of the light source and can be used in lieu of a compact or Fresnel lens to collimate the light. As a result, the light output is less compromised—or scattered—from the start.

Manufacturers are also improving the quality of lenses. “We’re changing the interior surface of the lens to have more of a matte finish,” Bailey says. “We’re eliminating a lot of the bounce light that would normally be reflected off of the inside finish of the lens.”

Improvements in diffuser technology have also enabled greater control of light while maintaining efficacy. Rather than sandblasting or embedding diffusive particles in glass or polycarbonate, Topete says, manufacturers can mold plastic

lenses with surfaces and shapes tailored to the LED's application, and potentially decrease the amount of light lost to less than 10 percent.

Because an LED outputs relatively little heat in a forward direction, it can be positioned closer to the lens or diffusing medium. This provides the opportunity for a smaller overall luminaire that can work with materials such as film and wood veneer, which were previously incapable of sustaining the high heat levels generated by conventional lamps, Bailey says.

Lighting manufacturers and OEMs also use parabolic and hyperbolic reflectors to block the LED source from view, reduce glare, and direct light. However, the parabolic shape, though successful in capturing enough light from lamps with spherical distributions, can miss spill light emanating near a lamp's central axis—a significant proportion of light for LEDs given their 180-degree distribution. As a result, some lighting manufacturers are experimenting with different orientations for LED arrays inside the parabolic reflector to improve control of light output.

#### In With the New

Existing optical technologies aren't always adequate for the desired lighting application.

Manufacturers are now exploring the potential of refractive technologies. "We're developing prisms versus reflectors," Bailey says.

Total internal reflection (TIR) optical devices combine a reflector and a refractive lens to control direct and reflected light from an LED. Light beams from the LED's central axis enters and exits through the refractive lens, while TIR surfaces handle perimeter lighting.

By capitalizing on internal reflection, fixture designers can also use edge lighting to distribute the intense LED light through the luminaire body itself in what is called a lightguide. "Light is injected and distributed throughout the lightguide due to total internal reflection, and optics are created within the lightguide to properly extract from the plate," Ngai says.

Lighting manufacturers are also experimenting with holographic films made from materials such as polycarbonate and polyester. The microstructure of these diffusers can eliminate LED imaging and pixelation, shape the distribution of light to myriad beam angles, and transmit light efficiently.

Injection-molded acrylic and plastic optical devices, designed to distribute and diffuse the light in a specific manner, are garnering interest from LED and lighting manufacturers as well.

Optical engineers are experimenting with microfacets and microfeatures on lenses. "These nearly invisible features on the optics will have massive implications in terms of how the light exits the product," Bailey says.

Manufacturers recently gained another option for customizing optics for LEDs: 3D printing. Norwegian firm Luxexcel has scaled down printing to the diode level with its patented Printoptical process. Using modified, wide-format, industrial inkjet printers, it can print flat and three-dimensional optics—including lenses, prisms, microstructures, and laminates with colors and surfaces—from CAD files without the use of tools, molds, or dies. Several players in the global lighting industry have begun experimenting with the technology, says Luxexcel's marketing manager Marco de Visser.

The size, efficacy, and reliability of LEDs have opened doors to a realm of optical and luminaire designs that manufacturers are only beginning to realize. Marveling at concurrent lighting advancements in technologies such as electroluminescence and remote phosphors, Bailey says the industry has "been reborn in the light ... It's been a very inspired time where we have the freedom to take this new technology and create beautiful light with it." •



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PRODUCTS

# OUT AND ABOUT

*New product offerings for a range of outdoor lighting applications.*

text by Lindsey M. Roberts



**Slim, Rab Lighting** • Available in 12W, 18W, and 26W models and with cool-, neutral-, or warm-color temperatures, Rab's new line of LED wallpacks are designed for wall-mounted lighting on building perimeters and entrances. There are three versions: Slim12 can mount up to 8 feet; Slim18 up to 14 feet; Slim26 up to 22 feet. • [rabweb.com](http://rabweb.com) • Circle 126

**Viper, Beacon Products** • Viper is a pole-mounted LED luminaire suitable for roadway, walkway, and parking-lot applications. It comes in two models: VP-L at 29<sup>1</sup>/<sub>2</sub> inches by 12<sup>1</sup>/<sub>4</sub> inches, or VP-S at 22<sup>3</sup>/<sub>4</sub> inches by 11<sup>1</sup>/<sub>4</sub> inches. Either can be specified in one of 10 wattages, seven distribution patterns, seven standard colors, and five mounting options. • [beaconproducts.com](http://beaconproducts.com) • Circle 125



**1Puck LP, Minimis** • With a 10mm aperture, 30mm diameter, and 12mm thickness, Minimis's new LED flushed-mount luminaire is composed of a marine-grade aluminum housing and designed to be tucked away in any wood or drillable material for wall or recessed lighting. Color temperature options are 2700K to 3200K warm-white, 5800K to 6300K pure-white, or 7800K to 8300K cool-white, and the product is designed to work with 12V DC power sources. • [www.minim.is/index1.htm](http://www.minim.is/index1.htm) • Circle 127



**Design Pro LED Lights, Kichler •**

Kichler has expanded its Design Pro LED line of luminaires to include 12V accent and in-ground versions. Each one is fully potted and sealed for landscape installation and comes in 2700K or 3000K, five lumen options, and three beam-spreads. While the fixtures themselves are available in several finishes—tan, white, textured bronze, brass, or black—the accessory lenses are available in amber, green, or frosted colors. All Design Pro LED luminaires have a cowl for glare control. • [kichler.com](http://kichler.com) • Circle 128



**StreetSense LED Roadway Sign Light, Dialight •**

Dialight's next-generation roadway light is available in two versions and offers two mounting options. Choose either a 70W unit used in multiples to illuminate signs larger than 14 feet by 14 feet, or a 40W version used in multiples on signs equal to or smaller than 14 feet by 14 feet. Both options can be top- or bottom-mounted and weigh less than 20 pounds. The 13-inch-by-7-inch-by-6-inch luminaire uses either 5000K cool-white or 4500K neutral-light LEDs. • [www.dialight.com](http://www.dialight.com) • Circle 129



**XSP Series LED Streetlight, Cree •**

Designed to use half of the energy of a traditional high-pressure sodium lamp and to last three times as long, Cree's new streetlight is offered in two sizes: 86.2 inches by 69.8 inches or 86.2 inches by 139.6 inches. Color temperature options are 2700K, 3000K, and 4000K. Backlight shields, bird deterrents, field-adjustable outputs, and remote monitoring capabilities are optional features. • [cree.com](http://cree.com) • Circle 130

**Arabesque3, a•light •** This 8-inch-by-5-inch luminaire can be pendant- or surface-mounted as a single fixture or in multiples in a variety of formations. Arabesque3 is available in lengths of 2, 3, 4, 6, 8, 9, or 12 feet and can accept T5, T8, or LED lamps of 3000K, 3500K, or 4000K. The fixture housing is finished with a powdercoat and is made from 60 percent recycled aluminum extrusions. • [alights.com](http://alights.com) • Circle 131



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L E D

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# CALIFORNIA LAUNCHES VOLUNTARY LED LAMP SPECIFICATION

**\$78 billion**

The projected world demand for lighting through 2016.

**\$13.5 billion**

The projected demand for lighting through 2016 in North America.

**\$41.5 billion**

The projected demand for lighting through 2016 in the Asia/Pacific region.

**\$3.8 billion**

The projected demand for lighting through 2016 in Central and South America.

**\$33 billion**

The projected global demand for LED lighting by 2016.

**7.4**

The annual percentage rate of growth anticipated for LED lighting sales between 2016 and 2021.

Source: *World Lighting: Lamps & LEDs report*, published in January 2013 by the Freedonia Group

*A group of the state's public utilities, energy entities, and lighting industry partners have introduced a voluntary LED lamp specification to address issues of lighting quality.*

text by Elizabeth Donoff

**Developed in collaboration** with the California Public Utilities Commission (CPUC), the California Energy Commission (CEC) has adopted a voluntary lighting quality specification for LED replacement lamps. The new standard requires that LED lamps meet certain performance criteria such as light color, consistency of light output over time, and color rendering accuracy to qualify for utility incentive programs and rebates. Dimming and flicker are also addressed in the specification requirements.

The original concept for this specification stems from research conducted by professors Michael Siminovitch and Konstantinos Papamichael of the California Lighting Technology Center. The CEC worked with

technical experts, utilities, and industry entities to establish the performance level required for a lighting product to meet or exceed customer expectations for lighting in residential application. Residential lighting was selected as the focus because of the sector's overwhelming use of incandescent lamps.

As the report's abstract states: "This *Voluntary California Quality LED Lamp Specification* ... support[s] energy policymakers and the lighting industry in their collective goal to move consumers away from the inefficient incandescent lighting of the past century and toward more efficient light emitting diode (LED) lighting technology."

For more details about the specification go to [cltc.ucdavis.edu/content/view/1263/488](http://cltc.ucdavis.edu/content/view/1263/488).

• **LED Workshops** The Department of Energy has announced the dates for its remaining 2013 solid-state lighting workshops: The Manufacturing R & D Workshop will be held June 5–6 in Boston; and the Market Introduction Workshop will take place Nov. 12–14, location to be announced. The R&D Workshop took place Jan. 29–31 in Long Beach, Calif. For details go to [eere.energy.gov/buildings/ssl/conferences.html](http://eere.energy.gov/buildings/ssl/conferences.html).

Photo (previous page): Markus Tollhopf



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# CALIPER 2012 YEAR IN REVIEW

*The U.S. Department of Energy's testing program continues to makes headway in reviewing LED luminaires.*

text by Elizabeth Donoff

The U.S. Department of Energy has released its CALiPER 2012 Year in Review Report summarizing the activities of this product testing program. Since its launch in 2006, the CALiPER program has tested more than 500 products. In 2012, CALiPER issued reports numbered 14 through 20, and tested a range of LED luminaires including linear pendants, wallwashers, and retrofit downlights as well as PAR38, AR111, and BR30 LED replacement lamps. In a departure from previous years, the 2012 reports each focus on a single product type. All told, CALiPER reported on 150 products in 2012. The report can be downloaded at [ssl.energy.gov/reports.html](http://ssl.energy.gov/reports.html).

## LEDUCATION 7

*The annual day-long event promises to provide another thorough look at solid-state lighting.*

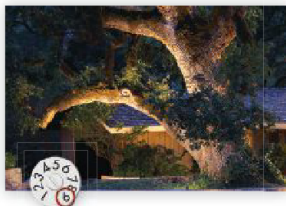
text by Elizabeth Donoff

Now in its seventh year, LEDucation will once again take place in New York City at the Hotel Pennsylvania. This year's event will be held on March 20.

In addition to the more than 100 manufacturers exhibiting their latest product offerings with tabletop displays, there are a series of seminars addressing different aspects of solid-state lighting. This year's sessions will include discussions about LEDs and energy codes, LEDs and lighting controls, LED integration in project design, the Zhaga Consortium, and the Next Generation Luminaires Competition.

For complete details and information on how to register, go to [leducation.org](http://leducation.org).

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# THE SOLID-STATE SCENE

*New LED products for a range of architectural lighting applications.*

text by Lindsey M. Roberts



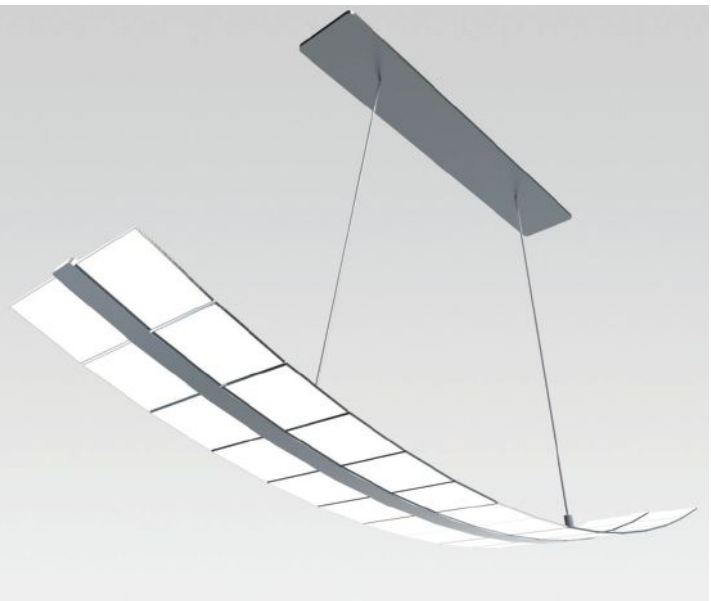
**GLED, RAB Lighting** • Ideal for parking-garage applications with restricted ceiling clearances, RAB Lighting's new high-performance luminaires have a slim profile—5 1/2 inches deep by 16 inches wide—and are offered in a 52W or 78W version, both at 5000K. A pendant-style model is available for garage facilities with taller ceilings. The luminaires are UL-listed for wet locations. • [rabweb.com](http://rabweb.com) • Circle 135



**Vault, Focal Point** • Featuring a flangeless installation and a 1/8-inch reveal, the Vault luminaire, with its rounded corners and domed reflector, fits cleanly into ceilings to offer indirect illumination. The 2-foot-by-2-foot fixture is available in two outputs—28.2W or 41.9W—and two color temperatures—3000K or 3500K. The driver offers zero-to-10V dimming. The luminaire finish is matte satin white. • [focalpointlights.com](http://focalpointlights.com) • Circle 136

## **LightCell Plus, Oree** •

This ultrathin planar LED module offers a large illumination area with a small footprint in two module sizes: LightCell Solo, which covers 70mm square in 1W or 5W, and LightCell Duo, which covers 140mm square in 2W or 10W. The modules are 70mm by 70mm and 70mm by 140mm, respectively, and have a CRI of 90 to 95, three color temperature choices (2700K, 3000K, and 4000K), and are dimmable for glare- and hotspot-free illumination. • [oree-inc.com](http://oree-inc.com) • Circle 137



**Metalux Arcline LED Series, Cooper Lighting •**

Suitable for offices, schools, and other areas needing glare-free, ambient illumination that can be accessed below-ceiling, this new LED series comes in four plenum lines—1-foot-square, 2-foot-square, 2-foot-by-4-foot, and 1-foot-by-4-foot—and seven different lumen packages of up to 103 lumens per watt (depending on fixture size), three color temperatures (3000K, 3500K, and 4000K), and it is equipped with a zero-to-10V continuous dimming driver that works with any standard wallbox driver for dimming, down to 15 percent. • [cooperindustries.com](http://cooperindustries.com) • Circle 138



**Vero, Bridgelux •**

Bridgelux's next-generation round LED array—the Vero—features three technical advancements: a higher flux density, a 20 percent increase in efficacy, and a more streamlined assembly process. An on-board connector port enables a solder-free electrical interconnect, while mounting features enable plug-and-play installation. The array can be specified in four different light-emitting surface configurations and is available in a color temperature range of 2700K to 5000K. • [bridgelux.com](http://bridgelux.com) • Circle 140



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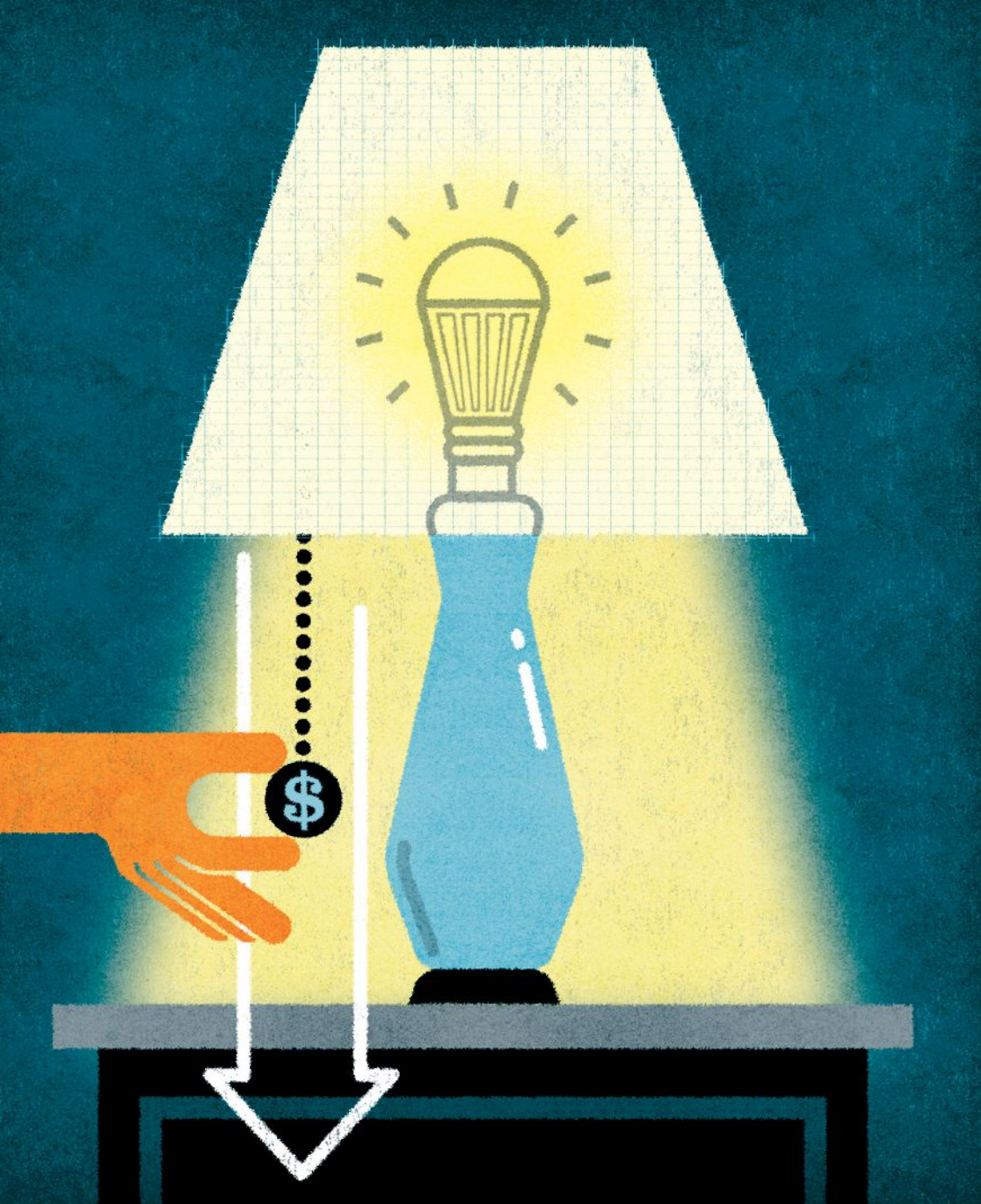
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## BREAKTHROUGH POINT

*The price of LEDs, and some LED lamps, is continuing to drop. Has LED lighting reached a moment of parity with conventional sources?*

text by Jeffrey Lee

illustration by Headcase

**LED lighting is set** to transform the entire lighting industry. On that much, nearly every lighting expert can agree. The question that remains is: When? When will the technical capability, reliability, quality, and, perhaps most importantly, cost, reach the point where LEDs can compete with conventional commercial and residential light sources?

To determine where the price of LED lighting is heading, it's simplest to start with the building blocks: the light-emitting chips themselves. Driven by a host of technology and production improvements, LED manufacturers are driving down the price of their products at a blistering pace. Measured by light output, the cost for LEDs and LED components has dropped in half in just one year, from \$10 per kilolumen (klm) at the beginning of 2011 to \$5 per klm at the beginning of 2012, says Boston-based Jed Dorsheimer, managing director of the Equity Research, Lighting & Solar division for investment bank Canaccord Genuity and an author of several LED market reports. "We expect it [the cost] to go to 500 lumens per dollar [\$2 per klm] by 2014," he states. The Department of Energy (DOE) predicted similar price drops in its March 2011 report, "Multi Year Program Plan (MYPP)," estimating that the package price for warm-white LEDs will drop from \$18 per klm in 2010 to \$7.50 in 2012, \$2.20 in 2015, and \$1 in 2020.

"Costs are still a major obstacle" to the adoption of LED lighting, Dorsheimer says. "They won't be in two years. Our prediction is 2012 is actually going to be a pretty tough year for most LED manufacturers. But 2013 and 2014, where we get that five-times reduction in cost compared to the beginning of 2011, now you start to really get mass adoption."

Part of the reason for those dramatic price reductions are technology-driven improvements in the efficacy of the LEDs. LEDs have improved to 95 to 120 lumens per watt from 8 to 10 lumens per watt in 2001, says Chicago-based Ann Reo, vice president and general manager at io Lighting, a division of Cooper Lighting that focuses on architectural LED lighting. The DOE's "MYPP"

**For LED lighting to make inroads in the indoor commercial and institutional settings dominated by linear fluorescent fixtures, “there has to be this combination of better performance coupled with lower price.”**

**—Bob Davis, director of product innovation and marketing for Litecontrol**

states that both warm and cool LEDs are expected to reach 266 lumens per watt by 2020.

LED prices are also dropping with scale as manufacturers develop more-efficient platforms and improve their yield. LED manufacturers sort their products into bins based on color temperature and other quality factors—“tighter” bins offer better, more predictable lighting performance, but they’re also more expensive. So as manufacturers refine their processes and tighten the distribution of their products, they improve their yields, leading to lower prices for more carefully binned chips. While the leading manufacturers have net yields for lighting-class LEDs just under 80 percent, Dorsheimer says, the average is about 50 percent, so improving yield is low-hanging fruit. And because better yield leads to higher production, there’s little need for LED manufacturers to build new capital-intensive manufacturing facilities, which keeps costs low. And at least one manufacturer—Philips Lumileds—is offering “freedom from binning” with a selection of white LED emitters that the company says are uniform and consistent enough that no color-bin selection is needed.

The lighting industry is also seeing an influx of excess LEDs from the screen, video, and display arenas, Reo says. That’s leading to lower prices for common, low-to-mid-range fixtures such as downlights and troffers. But because those LEDs are more broadly binned, they’re having a smaller effect on luminaires for high-end, architectural-accent applications. Smaller LED lamp manufacturers also still face a disadvantage in price because they are purchasing in lower volumes, says Bob Davis, director of product innovation and marketing for Litecontrol in Massachusetts, although he predicts that price premiums will become more manageable as overall LED volume increases.

#### **Fixture Finesse**

For LED lamp manufacturers, the chips are only one part of the cost—and while they’re the most expensive portion today (making up about 45 percent of the cost of an interior downlight in 2011, according to the DOE’s July 2011 solid-state lighting report “Manufacturing Roadmap,” that will no longer be true in the years ahead, Reo predicts. Lamp manufacturers are refining their own processes and designs to decrease cost and boost performance.

For instance, bonding the LED chip directly to the heat sink, rather than going through a printed circuit board, is one way to reduce the number of steps in the

LED fixture manufacturing process, says Nadarajah Narendran, professor in the School of Architecture at Rensselaer Polytechnic Institute in Troy, N.Y., and director of research at its Lighting Research Center (LRC). Remote phosphor technology, meanwhile, while expensive, has shown promise as a way to gain additional light from an LED source while reducing uncomfortable glare. In addition, as overall LED lighting product volume increases, more companies will begin to manufacture the subcomponents needed in LED lamps, increasing availability and lowering costs, Narendran says.

While the technology is rapidly improving, these innovations incur research and development costs, Narendran notes. Manufacturers “need to recoup some of the investment they’re making in research as well,” he says. Investing in the design and manufacturing of an injection-molded acrylic optic, for instance, can cost \$15,000 to \$25,000, Reo says.

#### **Tipping Point**

With costs falling for LED chip and lamp manufacturers, LED lighting has reached a breakthrough point—for some applications. Residential consumers face two psychological thresholds, at \$20 and \$10, Dorsheimer says, and retail prices are already creeping down toward those barriers. He’s seen a Philips 60-watt-equivalent LED replacement lamp going for \$14 with rebates at his local Home Depot store in New England, and Narendran says that replacement lamp prices could fall below \$10 by the end of the year.

LED lighting can also be cost-competitive with conventional metal halide sources in some exterior accent applications, says lighting designer Jeff Gerwing, principal and director of operations for SmithGroupJJR in Detroit. And while there’s still often a price premium for LED downlights, some of them can compete with high-end compact fluorescent downlights, especially when maintenance and energy use are factored in. “There’s now legitimately an energy story where I can justify using an LED downlight,” he says. “That changes everything.”

Because they offer directional light, LED downlights can have a higher overall fixture efficacy than comparable compact fluorescent products, says Naomi Miller, senior lighting engineer at the Pacific Northwest National Laboratory. For a downlight that offers quality dimmability, LED downlights may also even be cheaper than CFL, she says. “Plus,” she adds, “you’re getting better life, and in many cases you’re getting better color out of it.”

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Competing with linear fluorescent lighting, however, is a different matter. “Linear fluorescent is still one heck of a cheap, reliable workhorse lamp,” Miller says. Linear fluorescent lamp manufacturers continue to improve the life of their products, with at least one manufacturer touting a product with a 60,000-hour life that rivals LED. Linear fluorescent lamps also offer energy performance similar to comparable LED lamps, and they’re often available for 20 to 50 percent of the price. For LED lighting to make inroads in the indoor commercial and institutional settings dominated by linear fluorescent fixtures, Davis says, “There has to be this combination of better performance coupled with lower price.”

**Design Driven**

For lighting designers, though, the cost of LED fixtures is only one part of the equation. In the right application, LED lighting can provide functionality or aesthetic features that other energy-efficient lighting can’t match. A linear LED fixture can provide more punch to graze the texture of a wall than a fluorescent fixture, for instance, Gerwing says. “Am I going to pay a premium?” he asks. “Yes, but it also allows me to achieve something that I wouldn’t be able to achieve with a linear fluorescent source.”

LED lighting also can provide more controllability and the dynamic experience that clients are looking for, says lighting designer Barbara Horton, president of Horton Lees Brogden Lighting Design in New York. She recently completed a casino project, for instance, where all of the general ambient illumination for the first three floors and dynamic color changing in the coves is provided by LED sources. “We’re putting the ‘wow’ where we need to and spending the money where it’s important,” Horton says.

Of course, beyond just cost, a host of concerns remain about LED lighting, most regarding the unknown. Designers and manufacturers agree that the question of how to replace an LED source at the end of its life has not been adequately resolved. Designers are also concerned about finding manufacturers who can provide consistent products and testing data, as well as manufacturers who will stand by their products if something goes wrong.

In Horton’s opinion, intelligence and smart technology will play as much of a role as cost in driving the future of LED lighting. “Forget the shapes and the sizes and the things that we’ve had,” she says, “and start to think about it [LED lighting] in a more innovative way.” •

*Note: This article first appeared in the Spring 2012 issue of AL LED.*

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## COOL IT

*Advancements in thermal management strategies for LED fixtures pave the way for design innovation.*

text by Wanda Lau

illustration by Tang Yau Hoong

All the talk about the exciting design opportunities afforded by LEDs is often hampered by two words: thermal management. While incandescent lamps can exhaust heat through radiation, says Michael Gershowitz, Bridgelux's director of technical marketing, LEDs produce little infrared heat. As a result, they must be cooled through conduction, or risk, diminished performance in luminance, lifespan, and color stability.

But time and market demand have a way of advancing technology to the point where thermal management may soon be just an afterthought rather than an obstacle in luminaire design. With each generation of LEDs, efficacy continues to rise exponentially; LEDs today are more than 50 percent efficient—that is, they convert more energy into light than they do into heat. Most original equipment manufacturers (OEMs) have moved

away from simply retrofitting conventional fixtures in order for them to use LEDs, and instead are creating luminaires tailored and optimized for LED output. And LEDs can now “withstand higher temperatures longer without depreciating light and lumens,” says Mark Hand, Acuity Brands Lighting's director of indoor new product development and technology.

Improvements to LED technology and fixture design aren't the only things that manufacturers can boast about. Thermal management strategies have been improving and expanding as well. Though passive and active cooling are still the primary options, other innovative technologies are entering the game.

### Passive is Aggressive

More than 90 percent of LED fixtures employ passive cooling. With this strategy, heat is conducted away from the LED assembly by direct physical contact with a heat sink, a material with high thermal conductivity. Aluminum—often extruded or cast in a circular shape with fins—is the standard material used for a heat sink because of its light weight, cost effectiveness, and ease of manufacture, says Christopher Reed, Xicato's strategic partners manager. For now, manufacturers prefer passive heat sinks for their reliability. “At day one, their performance is going to be very similar, if not the same, as 50,000 hours later or 20 years later,” Reed says.

But even a tried-and-true solution can be improved. Along with heat sink optimization, in which designers finesse different fin thicknesses and spacing, passive solutions have taken a new form with pin-fin heat sinks. Instead of an extruded profile, pin-fins resemble an upside-down round table with a copious number of legs, and the diode affixed to the tabletop surface.

Pin-fins, Reed says, allow heated air to rise and then flow out unencumbered around the fins. This attribute is advantageous in fixtures with rotatable heads such as tracklights. “When you tilt a standard fin that's been extruded, the

## Improvements to LED technology and fixture design aren't the only things that manufacturers can boast about. Thermal management strategies have been improving and expanding as well. Though passive and active cooling are still the primary options, other innovative technologies are entering the game.

air can't flow up on the same orientation or axis as gravity because it actually runs into the fin," Reed says.

Lighting manufacturers have also begun turning fixture bodies into integrated thermal solutions. With this strategy, the trim around a luminaire in an insulated ceiling system

can serve double duty as the finishing trim and as the heat sink. Similarly, the fins of such sculptural fixtures as Cree's Aeroblades streetlight function as more than just eye candy.

As LEDs become more efficient, the size and weight required for a heat sink will decrease,

says Mark McClear, Cree's vice president of applications engineering. In turn, material and shipping costs will decrease. "Everything goes in the right direction when LEDs get more efficient," McClear says.

### Actively Engaged

The ease of passive thermal management is often countered by the bulkiness of the heat sink. This size can be problematic for small fixtures, inadequate for sealed outdoor luminaires, and not feasible at all for high-lumen downlights. By forcibly circulating air instead of relying on natural convection, active cooling "allows you to dissipate a lot more heat in a lot smaller space," Hand says.

Because active cooling inherently has more moving parts and costs more, its adoption by OEMs has been slow. However, recent advancements have made active strategies more efficient and reliable.

Even the de facto active solution—the fan—has made strides. As Xicato's Reed explains, the long-standing configuration options use either a sleeve bearing—typically constructed

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out of plastic or polymer-based materials and susceptible to wear from dust buildup and time—or a more durable metal ball-bearing system.

To eliminate the friction between the fan bearing and shaft, cooling design company Sunon, in Brea, Calif., introduced MagLev, which uses magnetic levitation. To counter dust buildup, the company also developed a two-way rotational technology that counter-spins fans for the first few seconds of operation, which “peels off dust from the fan blades,” Reed says.

Sound is another source of complaints with active solutions. In rooms where track fixtures are installed, for example, the noise created by active solutions—which currently ranges from 15 to 30 decibels each, on average—can build up noticeably. “It sounds like a beehive,” Reed says. Farmington, Conn.-based Ebm-Papst offers a fan that operates at 7 decibels, which is the quietest product that Reed has seen to date.

For manufacturers still leery of fans, Nuventix in Austin, Texas, offers a pulsing silicon membrane technology that moves air from the LED to a heat sink, which in turn can

be reduced to as little as one-third the size of a standalone passive solution. The synthetic jet technology, or SynJet, “has no rotational or frictional parts,” says Nuventix’s senior vice president of sales and marketing Tom Dalton. Instead it uses power from the LED driver—about 0.35W to 1W, he estimates—to pulse the membrane 50 times per second. These pulsations create a turbulent airflow that results in “better heat extraction in terms of convection” than the laminar airflow created by a fan, Reed says. The technology, which SynJet guarantees for five years, stretches the silicon membrane to about 10 percent of its limits, Nuventix’s Dalton says.

Though some manufacturers remain wary of active cooling solutions’ moving parts, most agree that active strategies are more efficient than passive ones. “The more air you can move and do it quietly, the better off you’ll be,” Gershowitz says.

#### Hybrid Heat Pipes

Heat pipes, an established cooling mechanism for computers that combines attributes

from active and passive solutions, have also garnered newfound interest from OEMs and lighting manufacturers. Composed essentially of a sealed metal tube filled with a thermally conductive liquid, heat pipes wick heat away from an LED and take it to a remote cooling mechanism. Though the system’s efficacy decreases as the distance between the heat source and heat sink increases, heat pipes do enable the components to be disparate. This separation is a great design opportunity, Gershowitz says. For example, heat pipes in a compact pendant fixture could transfer heat to a creative ceiling canopy. Designers could “come up with some very attractive solutions,” he says.

FrigoDynamics has even imbued this technology with new tricks. By threading heat pipes through passive sheet metal heat sinks strategically shaped in geometries to maximize cooling, the German company has created an efficient hybrid cooling technology. “The heat pipe is the element that takes heat from one side of the heat sink to the other,” Reed says. “It’s very efficient at moving heat around and

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Technologies that have yet to prove their mettle in practice are also attracting interest from curious manufacturers. Sandia Corp. has been working at length on the Sandia Cooler, a one-piece metal fan unit that spins on an air bearing, eliminating the potential for a physical bearing to fail.

Conversations on thermal management strategies would be remiss without mention of the thermal interface material, which fills the microscopic voids between the metal LED backing and its heat sink. Choosing a thermally conductive pad material to fill the air gap is critical to transferring heat from the LED. Phase-change materials are one plausible, effective, and tidy alternative to plastic or a metal-filled compound, Gershowitz says.

Cambridge Nanotherm also focuses on these intricacies at the microscopic level. The U.K.-based company recently introduced a nano-ceramic dielectric layer for an LED's printed circuit board (PCB) with a thermal conductivity of 7 watts per meter Kelvin (W/mK). Metal-backed PCBs (MBPCBs) typically use epoxy fillers with a thermal conductivity between 1W/mK and 3W/mK. Nanotherm says its MBPCBs conduct heat away from the LED die 20 percent more efficiently than aluminum-backed PCBs on the market.

With the rate at which LED efficacy is rising—Cree's McClear foresees efficacies reaching as high as 65 percent by 2020—in addition to the advancements in thermal management strategies, cooling LEDs may no longer be a concern in luminaire design. Acuity's Mark Hand predicts that low-power LEDs, strategically distributed to self-diffuse heat, may even forgo a dedicated thermal management strategy. “On the upper end of the scale, where people will try and get more lumens out of a smaller space, they will start looking at thermally conductive polymers” that can be injection-molded into multiple LED components, he says.

Bridgelux's Gershowitz thinks thermal management will continue to have some relevance despite the gains in LED efficacy. “Every time there's a step forward ... rather than looking to reduce the power or reduce the thermal solution ... [OEMs are] staying with the same thermal solution and putting in a larger light source.” The good news: The rate of advancements in thermal management technology will allow OEMs and lighting manufacturers to expand solid-state lighting into more markets without fear of burning up. •



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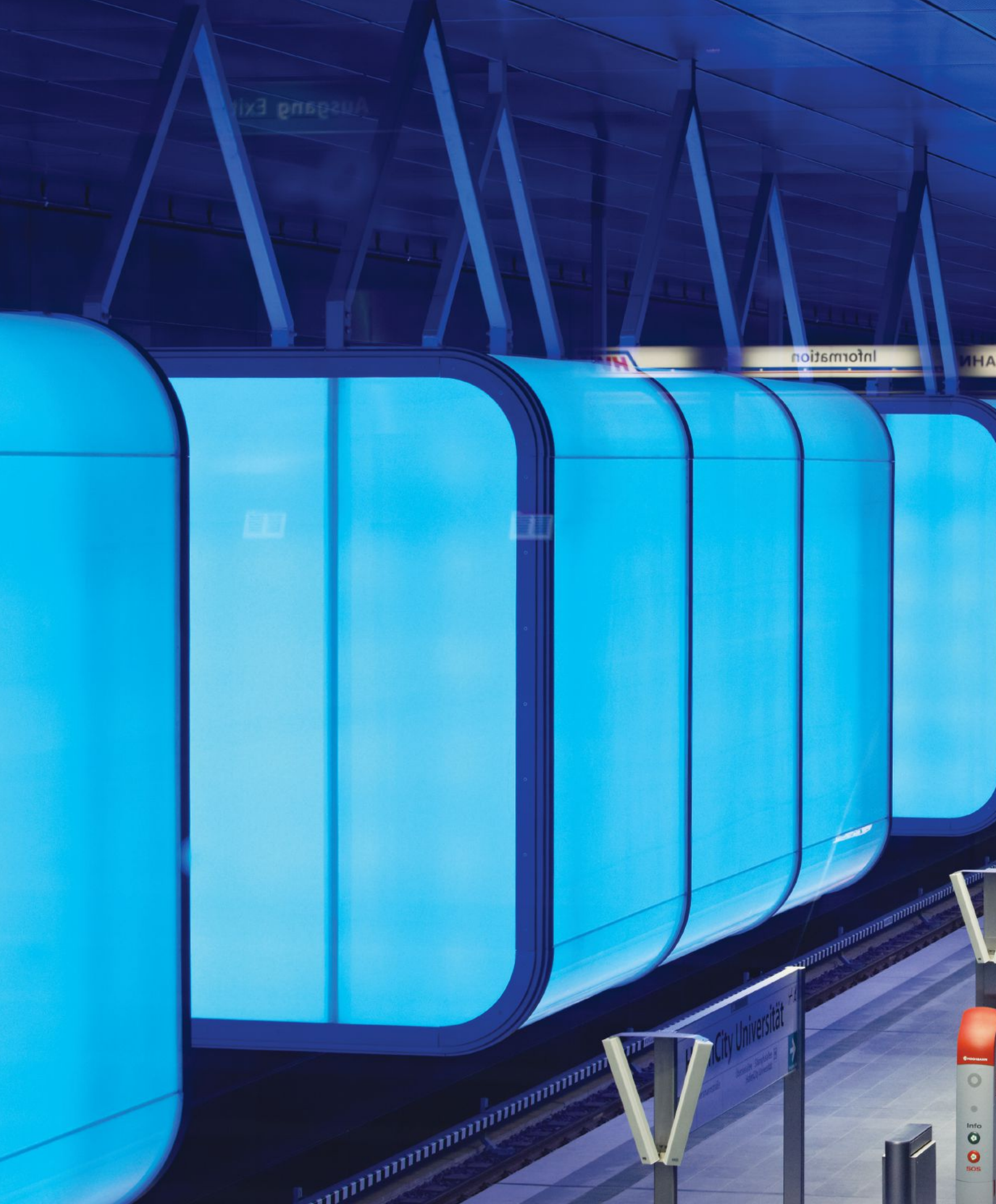
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# COLOR COMPOSITION

*Pfarré Lighting Design uses color-changing LEDs in a new Hamburg subway station, making it a metaphor for the vibrant and evolving quarter it serves.*

text by Aaron Seward

photos by Markus Tollhopf





The light boxes are each equipped with two distinct lighting systems: fluorescent luminaires located along the bottoms of the containers provide illumination to the subway platform and RGB LEDs infuse the side and end panels of each container with a wash of color.

**HafenCity is the** largest urban redevelopment project currently under way in Europe. It involves the transformation of an underused, 388-acre section of the Port of Hamburg, Germany, into an upmarket, inner-city district with mixed residential, work, cultural, and recreational uses. One of the centerpieces of the redevelopment plan is a new home for HafenCity University Hamburg, which was founded in 2006 as Europe's only higher education and research institution dedicated solely—according to the school's website—to “contemplating and concretising what the future of metropolitan areas could and should look like.” To service the new quarter and university, the city expanded its subway system—the U-Bahn—with the construction of a new station, the HafenCity University subway station, which opened in November 2012.

Designed by Munich-based practices Raupach Architekten and Pfarré Lighting Design, the new station seeks to establish an associative connection with the activities of the port and the architectural character of the harbor district. “We took our inspiration from the brick façades of the warehouses changing their appearance due to daylight, and the steel hulls and modules of transport containers changing their colors with the seasons,” says Christian Raupach, principal of Raupach Architekten. In the station, the design team translated these inspirations into a moody yet sleek subterranean space where light and material interact in much the same way as they do above ground.

The designers clad the interior of the station, with its soaring 30-foot-high ceilings, entirely in steel panels with a bluish-brown gunmetal finish that is somewhere between glossy and matte. Above the platform, they hung 12 light boxes made of shipping-container-size steel and matte-white glass, each of which measures 21 feet long by 9 feet high by 9 feet wide and weighs 6 tons. “We were thinking of many different materials for the light containers such as layers of fiberglass or resin to make them lighter,” says Pfarré Lighting Design principal Gerd Pfarré. “At the end, we decided that it had to be glass. Glass is the best from the standpoint of lighting quality and [light] transmission, and in terms of achieving a surface that is easy to clean, which is an issue in such a project.”

The light boxes are each equipped with two distinct lighting systems. The bottoms of the containers are outfitted with fluorescent fixtures that provide the necessary soft white illumination to the platform. The side and end panels of each box, on the other hand, are brought to life by 280 RGB color-changing LED fixtures. Each container requires 1,100W of power, a large amount and one that would not be possible in the U.S., where energy codes for public projects restrict such power usage. In Germany, there is no such code. Access doors at the end panels of the containers allow entrée for maintenance. The station's ticketing and entrance areas are lit with recessed, compact fluorescents and a smattering of 35W metal halide downlights.

The light boxes, which are connected to a central control system, can change color individually or as a coordinated unit. Pfarré's intention was for the containers to morph color in calm, smooth transitions, moving slowly through the boxes like a ship moving through a harbor—extending the design's metaphorical connection to the Port of Hamburg. “The entire concept for the containers and colored light was not to turn it into entertainment,” Pfarré says. “It's more like a color composition that you would like to look at while listening to classical music, rather than something funky.”

Whether or not the city's transportation department will carry out the slow-style color change was unknown at press time. Pfarré withdrew from the project during the third phase due to difference of opinion with the client on this point. “This project resulted from a competition initiated by the city government inviting architects to design a subway station that would be [more than just] an infrastructure project,” he explains. “When we won, we thought we'd explain our concept and find open-minded people, but it was the opposite.”

Despite client–designer difference of opinion, there can be no mistaking HafenCity University subway station as another run-of-the-mill infrastructure project. The interaction between the light—whether white or colored—and the mottled surface of the steel paneling, which is reflective without creating glare, makes for a brooding yet animated experience. In Pfarré's words, it's “a breathtaking atmosphere.” •

## Details

**Project:** HafenCity University Subway Station, Hamburg, Germany • **Client:** Hamburger Hochbahn AG, Hamburg, Germany • **Architect:** Raupach Architekten, Munich • **Lighting Designer (competition schematics through Phase 3):** Pfarré Lighting Design, Munich • **Lighting Designer (phase 3 to project completion):** D-Lightvision, Munich • **Light Box Designer and Fabricator:** Design Stauss Grillmeier, Munich • **Project Size:** 51,667 square feet • **Project Cost:** Not Available • **Lighting Cost:** Not Available • **Watts per Square Foot:** Not Available • **Energy Code Compliance:** In Germany, there is no energy code regulation that restricts energy usage for public spaces. • **Manufacturers/Applications:** Alexander Weckmer GmbH (custom color-changing LEDs for light boxes); Erco (35W metal halide downlights in the ticket areas); manufacturer unknown for fluorescent covelights throughout station.

Raupach Architekten and Pfarrer Lighting Design drew inspiration from Hamburg's architectural features and function as a port city in their design of the new HafenCity University subway station. Gunmetal steel panels line the station walls recalling the patina of a ship's hull. This, in concert with the light emitted from the 12 light boxes suspended over the subway platform, recalls the shimmering effect of water, and is a nod to the harbor above (this page). The light boxes are a visual reference point throughout the station with its 30-foot-high ceilings (facing page, top). Metal halide downlights provide illumination at the ticket vending machines (facing page, bottom).









# ERIC LIND

interview by Elizabeth Donoff  
portrait by Sioux Nesi

**“A lot of the lighting energy savings data we have about today’s buildings ends up being merged with HVAC and plug load improvements. It’s hard to know what can be attributed to the lighting strategy. We need that granularity to allow us to move to a consumption-per-square-foot guideline. If we allow watts per square foot to be maintained, it’s singular and limiting.”**

**After studying mechanical engineering** at Bucknell University, Eric Lind was recruited by Lutron Electronics, and has worked for the company his entire professional career. No surprise since it’s one of Lutron’s tenets to nurture, train, and promote from within. Over time, Lind has become one of the lighting industry’s leading voices on the subject of controls and has been a key member in developing Lutron’s architectural controls portfolio, a role he continues to play as vice president of global specifications.

**What still fascinates you about light?**

The varied global perspectives on lighting and the different mix of people getting involved.

**Do you have a business philosophy?**

Pay attention to the details.

**What do you consider innovation in lighting?**

Something that hasn’t been done before, that is truly a breakthrough, not incremental.

**What’s the next frontier for lighting controls?**

To get people to understand how much energy they are using. That’s most likely done through intelligent controls, sub-metering, and the smart grid. And, if it’s deployed well, you are able to set guidelines for what, for instance, a typical commercial office building should use on a per-square-foot basis. That information starts to give you some real usable data.

**What’s the most misunderstood aspect of lighting controls?**

Open protocols versus proprietary protocols. People believe that “open” is a way to guarantee the most cost-competitive solution, which simply isn’t true, nor does it ensure that the system will work properly. Even supposedly open systems very often still have proprietary elements.

**What’s the concern you hear most from designers when it comes to LEDs?**

Of all the things I deal with in terms of adoption of LEDs, the biggest resistance is because people are unsure of the replaceability factor.

**What are you excited about as the areas of controls and LEDs begin to work together?**

LED is a new source in a string of many. The opportunity is its potential to be dimmed, because with that comes space flexibility and enhanced energy savings. •

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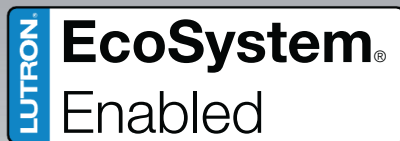
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# LUMINOUS HEIGHTS

*THE DAYLIGHTING AND ELECTRIC LIGHTING DESIGN FOR THE SACRAMENTO INTERNATIONAL AIRPORT CREATES A MODERN TRANSPORTATION HUB FOR TODAY'S AIR TRAVELER.*

text by Elizabeth Evitts Dickinson  
photos by Tim Griffith







Horizontal louvers on the exterior of the concourse building (previous spread) serve as one of the key elements in the project's daylighting strategy and mitigate sun penetration and heat gain inside the building. In the terminal (landside) building, exterior horizontal louvers also shade the interior. At night, the wooden ceiling is highlighted by ceramic metal halide uplights, surface mounted on the square structural columns of the main circulation spine.





**Located at the confluence** of the Sacramento and American Rivers, and cradled in Northern California's Central Valley, Sacramento is a city of agriculture, undulating vistas, West Coast sun, and, perhaps, most importantly, trees. While exploring the city in 2005, architect Brent Kelley, principal of Corgan Associates, understood how the place earned the moniker *City of Trees*. "You get these large canopies overhead and the sun filters down creating a dynamic of shadow and light," he says.

It was this interplay of light that inspired the design for the new Sacramento International Airport, designed by Corgan with Fentress Architects and completed in October 2011. The city had been in desperate need of an airport upgrade and wanted a building worthy of being located in the state's capital and capable of luring travelers away from nearby airports, such as Oakland and San Francisco. "They were looking to make a statement—what they referred to as an iconic structure—that would be associated with Sacramento," Kelley says.

Corgan and Fentress designed two structures, a new terminal (landside) building and a 19-gate (airside) concourse connected by a train shuttle system. Allowing natural light to filter in, as well as allowing views out to the city and distant mountains, became the central design goal, and the architects proposed a sweeping terminal building with three-story, canted glass curtainwalls and clerestory windows. The design was initially met with skepticism. "When we first presented the building, one of the members of the board of supervisors said, 'You're obviously not from Sacramento if you're proposing a glass building.' It took a lot of convincing," Kelley says.

The conviction that a building with east, west, and south facing glass walls could earn LEED status, meet California energy codes, and not overheat or blind its users was achieved, in large part, through the careful analysis and lighting design of Arup. The firm joined the design team in 2007 to execute electric and daylighting design for both of the buildings. The architects had already designed an exterior sunshading system of louvers meant to protect against heat gain and glare, and they asked Arup to assess

the design with lighting in mind. "Our starting point was this big glass box and our goal was to make the space feel daylit, but to make it visually comfortable," says Jake Wayne, senior consultant in lighting for Arup, who is based in their San Francisco office.

How then do you take advantage of the benefits that the California sun provides while also controlling it? Arup conducted extensive analyses of the daylighting attributes of the site and how the sunlight would interact with the building through the proposed shading design. "The architects built a very detailed 3D model," Wayne says. "We could take that and bring it into Radiance and run a series of simulations for winter solstice, summer solstice, and the equinox."

Initially, the client and the architects had concerns about Sacramento's intense summers and how to mitigate heat gain, but Arup's investigation revealed a different challenge: the low-in-the-sky winter sun. In winter months, the sun doesn't rise above 40 degrees and the study showed how light would pierce the gaps in the exterior louvers from mid-morning to late afternoon, effectively blinding the airport employees working at the ticket counters. "Everyone thinks 'summer' when you think about the sun and the heat, but it really is the winter sun that plays the biggest role," Kelley says.

Arup's findings led to a redesign of the exterior louvers. "In school, most architects are taught that when you want to protect an east and west façade then you go with a vertically oriented sunshade," says Mark Outman, associate principal at Fentress. "We learned from Arup that the horizontal shades work much better."

After multiple mock-ups using a variety of materials, the louvers were fabricated out of perforated metal and attached to the exterior mullions at specific angles based on Arup's data. The result was exactly what the architects envisioned. "You still get views out, you still see sky, and you get this wonderful, dappled daylight in the space that changes throughout the day," Outman says. The natural light is so prevalent that electric lights are only required in the evening.



Travelers can relax and get something to eat in the concourse building's food court. Primarily lit by daylight, electric light—linear 32W T8s—is concealed in the sweeping expanse of the wooden-slatted ceiling. Decorative pole luminaires outfitted with 24W compact fluorescent lamps add an accent of light to the bright and pleasant space.



But the use of light—natural or electric—throughout the project is more than just atmospheric. In the terminal (landside) building, it serves as the central wayfinding tool. The architects created a central spine that attracts travelers as they enter from the curbside drop-off. “You gravitate to the center of the building and move along this axis of natural light,” Outman says. Once inside, visitors encounter a majestic glass-and-steel space capped by a wood ceiling constructed, in part, with redwood reclaimed from a pedestrian bridge in Sacramento. This gives the building the appearance of a tree-lined street.

Minimal electric light supports the wayfinding. A concentrated amount of illumination at the ticket counters, which are treated like linear kiosks with an LED backlit lightbox as a header, is mimicked at the train platform that takes passengers to the concourse building. “We wanted to create a hierarchy of light,” Wayne says. “You enter the ticket hall and see the glowing ticket counter. You go up the escalator and you find the train by looking for the glow at the loading stations.”

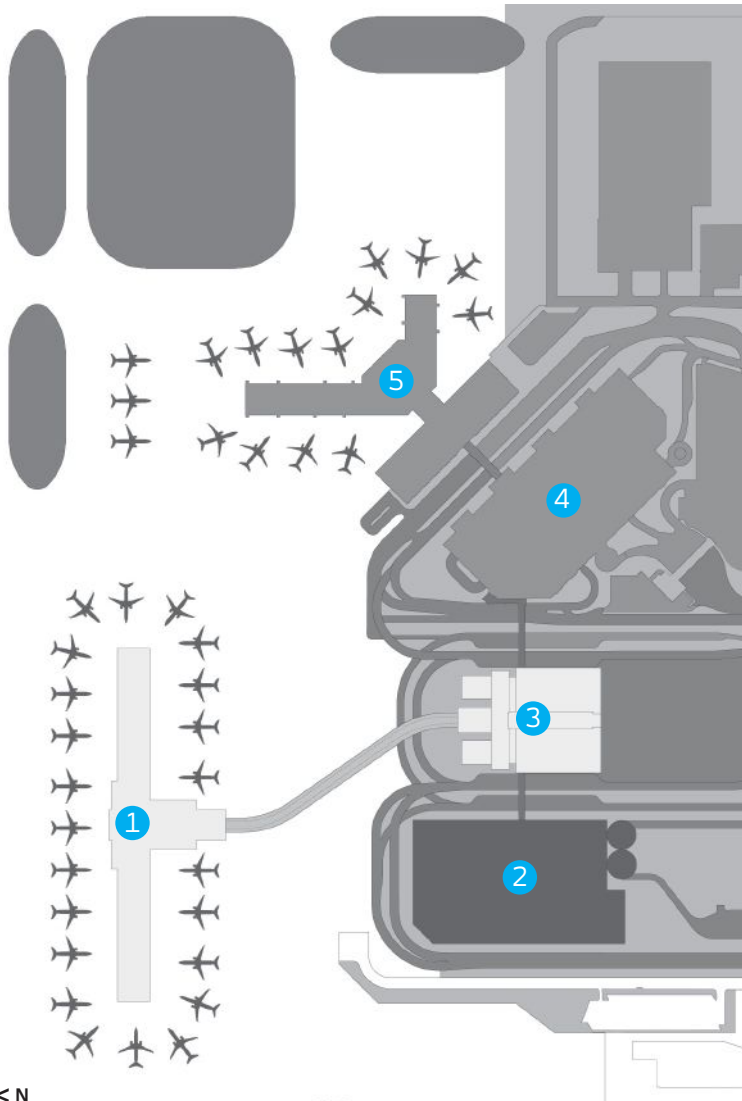
At night, electric light is used judiciously to prolong the radiance that the building has during the day. Arup lit the redwood ceiling in the ticket hall using 315W T9 ceramic metal halide asymmetric uplights surface-mounted on the square structural columns. A line of 150W T6 ceramic metal halide downlights accent the center band of each ceiling bay. Arup also supported the airport’s \$8 million public art program by working with some of the country’s top artists to achieve dramatic effects, such as lighting, with adjustable monopoint fixtures, a 60-foot-tall red sculpture of a rabbit that seems to dive through the main ticket hall.

The interplay of material, light, and surprising architectural form continues in the concourse building. Once passengers make it through security, sufficiently well-lit with a combination of 39W T6 downlights and 32W T8 fixtures, they encounter a sweeping, curved ceiling with clerestories on the sides that leads to a food court and the gate areas. The undulating ceiling is composed of wood shingles that appear to be



The ticket kiosks in Terminal B (top) are accented with a lightbox header backlit by LEDs. The glow of light serves double duty as a wayfinding device for travelers. Linear pendants with 54W T5HO lamps put light on the ticket counter and 26W compact fluorescent downlights illuminate the baggage belt behind the ticket agents. In the baggage claim area (above), a cove-mounted linear LED fixture uplights the wooden ceiling panels above each carousel.

## Site Plan



1. Concourse B
2. New Garage
3. Terminal B
4. Existing Garage
5. Terminal A

lit from within, thanks to the concealed T8s. A dramatic and ample architectural gesture, the ceiling required a unique lighting treatment. “We were staring at this long ceiling and wondering what we were going to do to light this, and then we thought of using tiled ceiling panels where the light would glow through,” Wayne says.

As with all the elements of this project, Arup wanted to test the proposed design. “We built quarter-scale mock-ups and hung them up in our mail room,” Wayne says. “It was the only place big enough to hold them. Then we invited the architects [to look at them].”

Outman remembers that meeting. “It was a tight space. But that was a creative solution that began as a germ of an idea. And that’s what it takes: You have an idea, you go and test it, if it looks good and works, you move forward,” he says.

In January 2012, Arup had the opportunity to see how all of their analysis, planning, and prototyping turned out. They returned to the airport to conduct a post-occupancy light study, taking time-lapsed photos of the space and comparing them to the 2007 analysis. They wanted to see how well the finished, implemented design matched their calculations. (See video link in Details, below.) “We have a side-by-side video from the entire day to see if there is parity from what we predicted, and you can see that it basically matches,” Wayne says. “The post-occupancy study was one of the most exciting things. This was a [large] building for this kind of in-depth analysis and to see that we were able to pull it off is pretty cool.” The project team’s attention to architectural detail and understanding of light’s nuances has created an airy yet intimate space for air travelers and has given the city of Sacramento a building uniquely its own. •

### Details

**Project:** Sacramento International Airport Central Terminal B, Sacramento, Calif. • **Client:** Sacramento County Airport System, Sacramento, Calif. • **Architect (terminal landside building):** Fentress Architects, Denver • **Architect (concourse airside building):** Corgan Associates, Dallas • **Lighting Designer:** Arup, San Francisco and New York • **Electrical Engineer:** The Engineering Enterprise, Alameda, Calif. • **Project Size:** 669,000 square feet (landside and airside buildings combined) • **Project Cost:** \$1.1 billion total cost • **Lighting Cost:** \$7 million for materials and labor; \$10.46 per square foot • **Energy Code Compliance:** California Title 24 • **LEED Certification:** Silver • **Watts Per Square Foot:** Landside: 0.432 (landside building); 0.51 (airside building) • **Manufacturers/Applications (only main architectural lighting components):** Terminal building: Elliptipar/The Lighting Quotient (315W T9 ceramic metal halide uplights in ticket hall); GE Lumination (surface-mounted LED array for lightbox header at ticket kiosk and train platform); iLight (cove-mounted linear fixture at baggage carousels); Insight (pendant-mounted 54W T5HO luminaire at ticket kiosk); Kramer (compact fluorescent downlights throughout); Targetti (150W T6 ceramic metal halide downlights and 20W to 39W accent lights in ticket hall) • **Façade glazing:** Solarban (70XL) • **Concourse building:** Cooper NeoRay (32W T8 linear fluorescents concealed in wooden slatted ceiling); Hess (decorative pole lights at food court); Kirlin (39W T6 6-inch square downlights in concourse)

**Video:** To watch the video of Arup’s daylight modeling comparison go to [www.arup.com/Projects/Sacramento\\_International\\_Airport.aspx](http://www.arup.com/Projects/Sacramento_International_Airport.aspx)



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# Glenn Heinmiller

interview by Elizabeth Donoff

photo by Tracy Powell

**“Technology allows us to deliver work at light speed but the creative lighting designer will still find time to dream, and muse, and let new ideas percolate from the subconscious.”**

**Glenn Heinmiller** has grown up with light, literally. “My father designed a house in the International Style with a young architect by the name of Giles van der Bogart,” he says, “and fitted it out with the latest lighting the 1950s had to offer: T12 fluorescent strips behind valences, colored PAR38 lamps, and low-voltage relay lighting controls.” Surrounded by architecture and light, he found himself drawn to theater and stage lighting in high school and college. After graduating, he worked for a laser light show company for several years, but a desire to get back to design led him to a lighting class at the Boston Architectural College. His teacher was Paul Zaferiou, a principal at lighting firm Lam Partners. Hard work has taken care of the rest; Heinmiller has carved out the second phase of his professional career with Lam Partners working on a bevy of award-winning projects and serving as the profession’s guide to lighting and energy code regulations.

#### **What fascinates you about light?**

It’s still surprising how subjective “good lighting” is. There is no one “right” answer.

#### **Do you have a lighting design philosophy?**

It’s what Bill Lam taught us: quality, not quantity; meet human needs; it’s about the architecture, not the light fixture; and lighting design is an inseparable part of architectural design, it’s not a separate technical exercise.

#### **How has the practice of lighting design changed since you started working?**

Speed. The expectation today for instant turnaround by owners, and even architectural colleagues, is striking.

#### **Most misunderstood aspect of lighting design?**

That lighting design is just “doing the calculations”—getting the “light levels” and “photometrics” right. There’s also those who think it’s just about picking fixtures.

#### **Best lighting lesson learned from working on a project?**

Make sure the detail drawings are all figured out and if you have a non-standard solution you’ve never done before, do a mock-up.

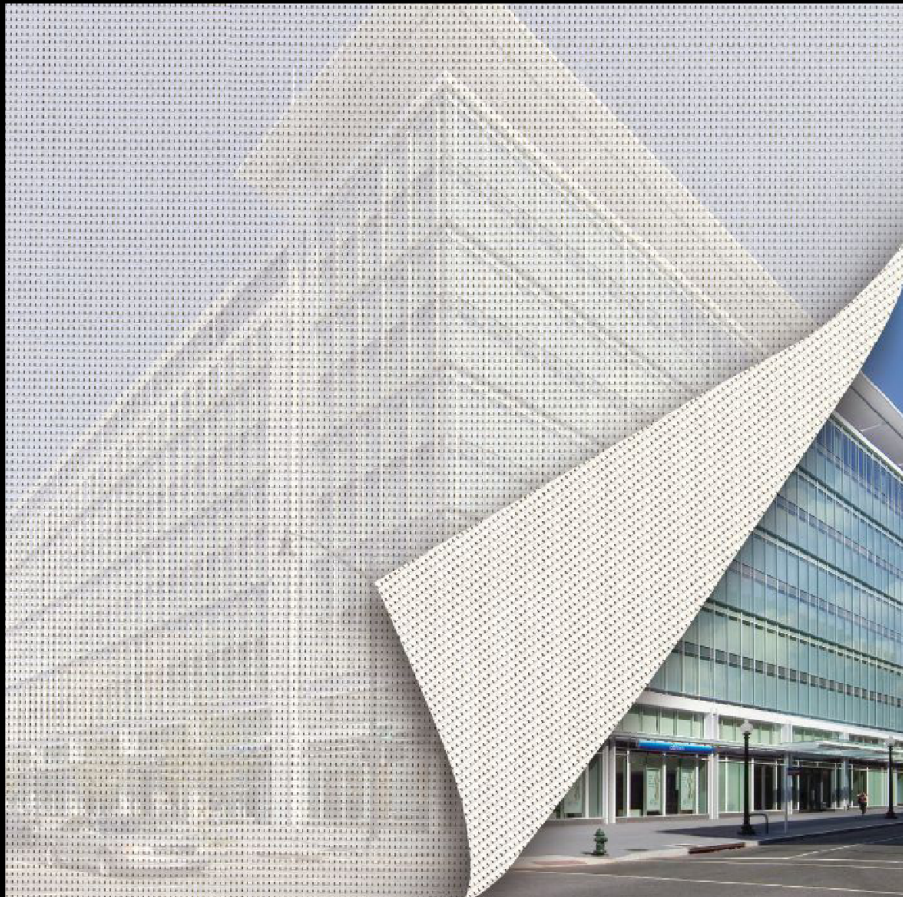
#### **How are new lighting technologies, such as LEDs, affecting the industry and design?**

It’s given designers a whole new language. That being said, the fundamentals of lighting design remain the same, we just have new tools.

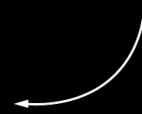
#### **What advice would you give a young lighting designer just starting out?**

Network. Get to know people. Never stop learning. School is just the beginning. •

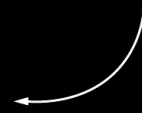
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Automated shades in Washington's USGBC Headquarters.



MechoSystems makes the key automated window-shading ingredients for LEED® points in Daylight, Lighting Controls, and a number of other categories. Our SolarTrac® WindowManagement® system, as an important example, is part of the recipe for the LEED® Platinum-rated USGBC Headquarters.

**SolarTrac®**

 **MechoSystems**  
Design with light.®

T: +1 (800) 437-6360  
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SolarTrac ingredients:

- Calculates sun angles according to building and zone criteria.
- Automatically adjusts shades to five incremental positions.
- Optimizes natural light and avoids glare.
- Maximizes views to the outside.
- Minimizes solar-heat gain.
- Reduces HVAC and lighting costs.
- Lessens greenhouse emissions.



And it all makes everyone happy.

Circle no. 78 or <http://archlighting.com/productinfo>

# Lutron systems help the Empire State Building achieve sustainability goals.

Lutron lighting controls and sensors **save up to 65% of lighting energy.\***

- **Wireless** – simplifies installation and minimizes disruption
- **Flexible** – for easy retrofits or new construction
- **Expandable** – add to a system or reconfigure at any time

“Lutron products are state-of-the-art, cost effective, and architecturally beautiful. We worked with Lutron to develop wireless solutions for the Empire State Building — now you can buy our choice for energy-saving light control.”

**Anthony Malkin**

Empire State Building Company

## Empire State Building sustainability goals

|   |                     |
|---|---------------------|
| Building energy reduction                                   | 38%                 |
| Building carbon emission reduction (over the next 15 years) | 105,000 metric tons |
| Annual building energy bill reduction                       | \$4.4 mil           |
| <b>Lutron contributions toward overall goals</b>            |                     |
| <b>Projected lighting energy reduction</b>                  | <b>65%</b>          |
| <b>Projected lighting controls installed payback</b>        | <b>2.75 years**</b> |

For more information please visit [www.lutron.com/esb](http://www.lutron.com/esb) or call 1.800.523.9466 for 24/7 support.

\* Compared with manual (non-automated) controls, up to 65% lighting energy savings is possible on projects that utilize all of the lighting control strategies used by Lutron in the ESB project (occupancy sensing, high-end trim, and daylight harvesting). Actual energy savings may vary, depending on prior occupant usage, among other factors.

\*\* Estimates based on Lutron controls installed in ESB pre-built tenant space. Payback claims assume 65% reduction in energy costs and energy rates of 22 cents per kwh. Actual payback terms may vary.

The Empire State Building design is a registered trademark and used with permission by ESBC. Empire State Building sustainability goals are provided by ESBC and contain energy saving strategies in addition to lighting control.

Learn about our other energy-saving projects at [www.honestbuildings.com/lutron](http://www.honestbuildings.com/lutron)



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